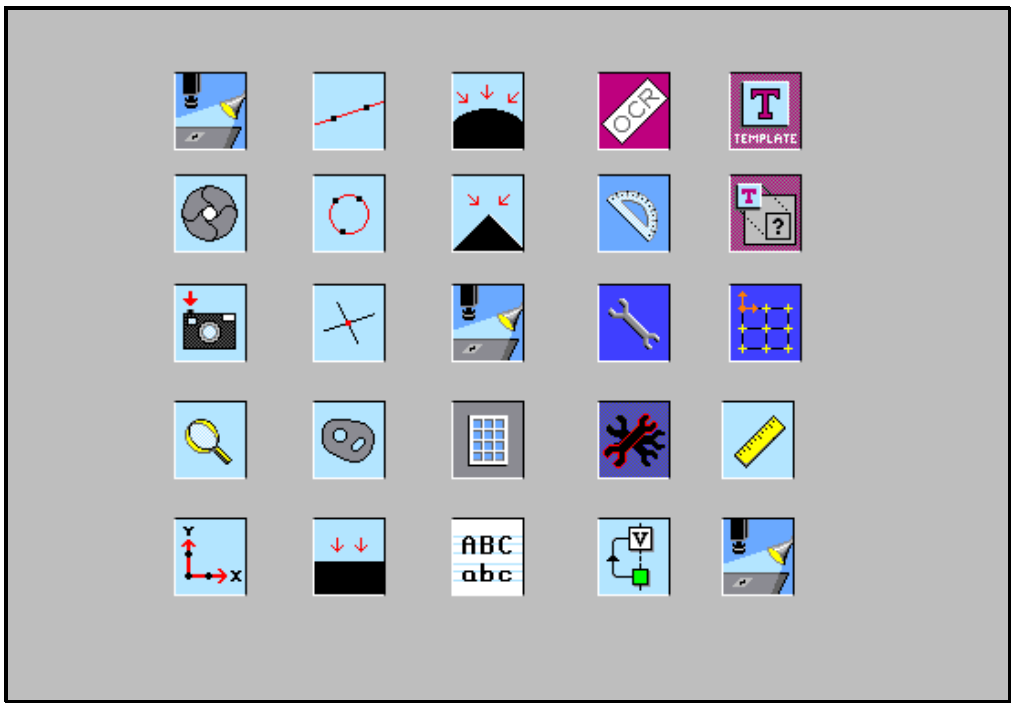
VisionWare

Reference Guide



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Chapter 1
Introduction and Overview

This manual presents a detailed description of the vision control module (the Vision Module) and the VisionWare Application Module (the VisionWare Module) for the Adept Assembly and Information Management (AIM) software system. This manual is for use by AIM system customizers who want to provide an interface to application-specific vision operations or special algorithms. This manual contains detailed information regarding the internal organization of the software, the data structures, and the Vision database.

An understanding of the information in this document is *not* required to set up and operate the AIM system, or to make simple modifications to the operator interface.

For a description of how to operate your AIM system, please see the user's guide for your application module (for example, the *VisionWare User's Guide* or *AIM PCB User's Guide*).

1.1 Do You Really Need to Read This Manual?

This manual is for use by AIM system customizers who wish to customize aspects of AIM that are related to vision. Many modifications can be made to the base AIM system; they are detailed in separate manuals. The common modifications and the manuals that cover them are:

1. Procedural and appearance changes

   These apply to the start-up and appearance of the operator interface. These are not specific to the Vision Module, but rather are common to all AIM applications. See the *AIM Customizer's Reference Guide*.

2. Adding or modifying statements

   The basics of creating statements are covered in the *AIM Customizer's Reference Guide.*

   Requirements for statements that involve vision records as arguments are covered in Chapter 5 of this manual. This chapter describes the VisionWare Module, as opposed to the Vision Module, including the standard statements and how to use vision arguments in new statements.

   You should probably also read Chapters 1 and 2 of this manual (they are short), but you can skip over 3. Otherwise, the rest of this manual may be needed only as reference.

3. Adding custom vision operations

   This is the purpose of this manual, and you need to read at least some of it. You have come to the right manual.

1.2 Prerequisite Background Information

This manual assumes that you are at least a fairly proficient user of an AIM application that uses the Vision Module. Therefore, you should already be familiar with the contents of the following user's guides:

- *VisionWare User's Guide*

  This manual describes how to use the AIM VisionWare Application Module.

- The User's Guide for your AIM application module

  If your application module is not VisionWare, you should also be familiar with the user's guide for the application you are using, for example, the *AIM PCB User's Guide* or the *MotionWare User's Guide*.

- *AdeptVision VME User's Guide*

  This manual describes all the aspects of the use of the optional AdeptVision VME system. You need to be familiar with this manual in order to set up and operate the vision system.

In addition, you need to be familiar with the following reference manuals:

- *AIM Customizer's Reference Guide*

  This manual presents a detailed description of the AIM baseline software. The manual covers data structures, standard databases, internal organization of the software, and strategies for customizing the AIM system.

- *V+ Reference Guide*

  This manual describes the V+ robot control and programming system. Since all of the AIM software is written in the V+ programming language, most customizers find it necessary to have a good working knowledge of the V+ programming language. In particular, customizers wishing to make use of the advanced features of the operator interface, or those wishing to add new statements or strategy routines, find it necessary to understand V+. However, simple changes to the operator interface (or the addition of new menu pages) can be accomplished without a knowledge of the V+ programming language.

- *AdeptVision VME Reference Guide*

  This manual describes all aspects of the V+ programming system that pertain to the AdeptVision VME system. Most customizers who work with the AIM Vision Module find it necessary to have a good working knowledge of the AdeptVision system. This is most important when adding new record types that make use of vision primitives.

1.3 Overview of the Aim Vision Module

The AIM Vision Module is a collection of programs and menu pages that maintain and operate on data in a database to allow vision to be used for inspection or robot guidance. In making any changes or additions to this module, the system customizer should keep in mind the goals of simplicity, consistency, and modularity.

The major components of the AIM Vision Module are:

1. A Vision database that contains the data needed for the various vision operations to compute results at runtime

2. A Camera database that specifies the physical camera to use, the camera model, various other camera characteristics, and the camera calibration data
3. Menu files that permit this data to be displayed and edited in a convenient manner (for example, point, click, and drag)
4. Many subroutines that are used in the initialization, editing, execution, and displaying of vision operation data and results

Vision Database

The Vision database holds the information necessary to perform vision operations. Each record in the database represents a unique vision operation, containing the data needed to use that operation to compute results at runtime.

Different types of vision operations require different types of information from the database. To distinguish one type of vision operation from another, we use the concept of a *record type*. All the records of a particular record type use the database record structure the same way and share the same routines for editing and execution.

Models (prototypes, templates, and fonts) are associated uniquely with each Vision database. Therefore, each time you unload a module containing a Vision database, all the models associated with it are deleted from the system. When you load a module containing a Vision database, the model files for the new Vision database are loaded from disk. This can take a considerable amount of time, so it is expected that you will not be loading and unloading Vision databases frequently.

Menu Summary

This section describes the menu files that are part of the Vision Module.

- VISGEN.MNU

  Contains the menu pages for displaying and editing the following types of records in the Vision database:

  Picture
  Inspection
  Computed Point, Line, Circle, and Frame
  Frame Pattern
  Value Combination
  Prototype
  Template

  These are general operations that do not belong in the vision-tool or OCR menu files. Menu pages for vision operations added by customizers should be kept in separate files.

- VISINI.MNU

  Contains the menu pages for displaying and editing the Vision Initialization database. This database defines custom convolutions and morphological operations.

- VISLOG.MNU

  Contains the menu pages for displaying and setting up Data Logging operations.

- VISOCR.MNU

  Contains the menu pages for displaying and editing the OCR-related records in the Vision database.

- VISTOOLS.MNU

  Contains the menu pages for displaying and editing the following vision-tool records in the Vision database:

  Ruler
  Arc Ruler
  Window
  Point, Line, and Arc/Circle Finders
  Blob Finder
  Prototype Finder
  Correlation Window

- VISRES.MNU

  Contains menu pages for results and data plotting.

- VISUTIL.MNU

  Contains various general-purpose vision-related menu pages, such as the Live Video pop-up window.

- VISNEW.MNU

  Contains menu pages with choices of new vision operations.

- VSFRM.MNU

  Contains the menu pages for displaying and editing the Conditional Frame records in the Vision database.

- VIMAGEP.MNU

  Contains the menu pages for displaying and editing image processing operations (i.e., records of the Image Processing record type) in the Vision database.

- VISCAL.MNU

  Contains the menu pages for defining and performing camera calibrations in the Vision database.

- VISCAM.MNU

  Contains the menu pages for displaying and editing the Camera database.

Routines

A knowledge of the routines used in the Vision Module is not necessary unless you intend to customize the system.

The different kinds of routines are described below. Some routines need to be modified or created by system customizers. Other routines, called *standard* routines, are included in the AIM system for use as provided. Detailed descriptions of these routines are provided in Chapter 8.

> **NOTE:** All AIM routines are written in the Adept V^+ programming language.

- Standard editing support routines

  These routines support the creation and editing of record data from a menu page. This includes monitoring of changes in data values, and manipulation of graphic shapes using the mouse.

- Standard routines for use while executing records

  These routines are called from the routines that execute vision records. They may be useful when creating custom record types. (More information on these routines is provided later.)

- Standard runtime scheduler routines

  These routines are normally called by the application-specific runtime scheduler to control the execution of statements and vision records. (Statement routines are part of the VisionWare application module—see Chapter 5.)

- Standard graphics routines

  These routines provide high-level functionality when there is a need to display vision tools during editing or to display the results after execution.

- Record-type specific routines

  These routines provide support for specific record types. Routines already exist for the many built-in record types supplied with the Vision Module. For new record types, however, routines need to be written by the customizer, following the functional specifications for the routines given in Chapter 6.

Chapter 2
General Concepts

The Vision Module is designed as an integral part of AIM to provide a means for specifying and performing a wide variety of vision operations for inspection, measurement, and robot guidance. The threefold focus of the design is for easy and logical specification of operations, efficient execution of them, and natural direction of the results to other operations or to output signals. Understanding the Vision Module is best accomplished by keeping in mind these three main functional components: data, execution, and results. This chapter describes these elements and how they combine to perform the vision operations.

The Vision Module contains a fairly complete set of built-in vision operations for performing the vast majority of applications. However, customization is allowed and expected, and is achieved primarily by creating new types of vision operations. See Chapter 3 for more details.

2.1 Vision Operations and Vision Records

A vision operation is the basic functional unit in the Vision Module. It consists primarily of data (stored in the Vision database), an execution routine, and a specification of how the results may be used.

The “record type” is the key value (in the Vision database records) that distinguishes one type of vision operation from another. For example, the record type determines which execution routine is used for a specific vision operation and how the results of the operation may be used.

The record type is one of the data items in each record in the Vision database. Thus, a vision record provides all the information needed to perform a vision operation, and one can often use the terms “vision record” and “vision operation” interchangeably. For example, the vision operations “Line Finder”, “Point Finder”, and “Computed Circle” all have different record types.

The term “vision record” refers to the data needed for a vision operation and consequently to the editing and manipulation of that data. The term “vision operation” refers to the utilization of the information in the vision record—namely, for execution. For example, when editing a vision record, one would say that one selects the vision operations that will be used to compute the results.

2.2 Data

As mentioned above, the data for a vision operation is kept in a vision record. The data structure within the record is composed of fixed-use fields and variable-use fields. That is, some fields serve the same purpose for all records, while the use of other fields depends on the record type. When AIM is started up, all the numeric and string data in these records are copied into two global arrays called the “data arrays”. For speed and efficiency, these global arrays are used extensively, avoiding accesses to the actual database.

There is a special group of fields in the database used for keeping track of the "source records" of the record. Depending on the record type and evaluation method, these source records may have different purposes, but they always mean one very important thing to the Vision Module: that the records specified there must be executed prior to execution of the record itself. The source record names are linked automatically during editing and preruntime to the corresponding record numbers. These records are also called simply the "sources" for this record and for the vision operation it represents. For example, a "point-line distance" inspection record requires a point and a line. The point record and the line record are considered sources for the inspection record.

2.3 Execution

A vision operation is performed by "executing" a vision record. There is an execution routine for each record type. The execution routine uses the data in the "data arrays" to compute results. Pertinent numeric and string values are stored in global arrays called the "results arrays". In addition, the routine may accumulate statistics or draw graphics depicting the operation and its results.

When a sequence is started (that is, at preruntime), the statements in the sequence are scanned for the presence of arguments that are the names of records from the Vision database. These arguments represent vision operations whose results are presumably needed for the execution of the statement. Therefore, each of these vision operations will need to be performed at runtime. To do this, the statement routine will "evaluate" the named vision records.

> **NOTE:** Evaluation of a vision record consists of (1) evaluating all the source records for the record and then (2) executing the vision record itself. Note that this definition is recursive—that is, the evaluation process works its way down the tree of needed records, finds the ones that are needed first, executes them, and then works its way back up the tree. In this way, a record is executed only when all its source records have been evaluated. (The Vision Module contains the routine **vw.run.eval2( )** for evaluating vision records from statement routines.)

To prepare for this evaluation process, a list is created at preruntime that contains all the vision records needed for each statement argument. This list is also specially ordered to provide the most overlap of the Vision and V+ processing when possible. Then, when the standard routine mentioned above is called to evaluate a vision argument, it can execute the vision records listed with minimal overhead.

When a vision record is executed, an execution routine associated with the record type for the record is used. For custom record types, the routine name must be specified when the record type is defined.

2.4 Results

After a vision operation is performed (that is, a vision record is executed), there are usually results. These are stored in the global results arrays—**vw.res[,,]** and **$vw.res[,,]**. The stored results are available for use by other vision operations.

In addition, statistics may have been collected for any number of the values computed by a record. Inspection records automatically collect statistics for the result being tested (unless that option is disabled during editing). For any inspection record, the result being tested, the pass/fail status of the result, and their recent statistical histories (along with charts) are available for monitoring during runtime via the "Show/Vision Results" pull-down menu at the top of the screen.

For custom record types, a pair of standard routines can be called from the custom record-type routines to facilitate collecting the same kinds of statistics. The statistical information will then be available automatically for display in the same way as for the standard inspection operations. See the section “Accumulating Statistics” on page 45 for details on how to use this feature.

2.5 Classes

A standard format is defined for storage of some common types of results in the results array. For example, both the Line Finder and Computed Line vision operations produce a line as a result. Therefore, they both use the standard format for representing line results in the results array. In this way, the results of different operations can be used interchangeably as a source for other operations, such as computing a point.

When a vision operation produces data for a line and stores it in the results array (as described above), that vision operation is said to belong to the line “class”. Likewise, there are classes for points, circles, and vision frames.

When a record type is defined, the types of source records needed are specified by naming their classes. Then, when the user needs to select a source record, the Vision Module can provide a list of the existing records in the required class. If there are none, it can go straight to a new record page for that class.

For computing a point from two lines, the Computed Point vision operation needs, as sources, two LINEs. That is, it needs two members of the line class. In this document and on the menu pages, you will sometimes see the names of classes capitalized. In that case, they are being used as abbreviations. For example, “LINE” is short for “a member of the line class”. Likewise, “POINT” and “VISION FRAME” are commonly used to represent members of the point and vision-frame classes, respectively.

A vision operation often can belong to several classes. However, it must belong to at least one class in order to be used as a source for other operations.

2.6 Calibration

Calibration is the process that determines the exact scale and position of the camera image. By default, the Vision Module initializes all virtual cameras to have a one-to-one X-Y ratio, a scale factor of one millimeter per pixel, and a coordinate frame fixed at one corner of the camera image.

Calibration of the vision system is necessary in the following situations:

1. Measurements are to be reported in real-world units such as millimeters or inches. Otherwise, all measurements will be in pixels.
2. Positions are needed relative to a world coordinate frame. Otherwise, positions are relative to its local camera coordinate frame. (You must have a robot to establish the coordinate frame.)
3. Measurements are needed across multiple camera images.

The Vision Module provides a calibration procedure, similar to ADV_CAL (Advanced Camera Calibration) with enhanced functionality, that can be used without exiting AIM. The *VisionWare User’s Guide* describes the procedure fully.

If your application uses a motion device, it may need to be calibrated. This procedure is fully described in the *MotionWare User’s Guide.*

> **NOTE:** *VisionWare* with Motion is no longer a valid system configuration. Instead, use *MotionWare* with Vision.

If vision position information is needed in terms of the world coordinate system, you will need to calibrate the appropriate physical camera(s) with a robot (or motion system of some sort). This procedure also can be performed within AIM.

Chapter 3
Customization

Customization of the Vision Module consists primarily of the following activities:

- Adding new types of vision operations (that is, new record types in the Vision database), which the user can edit and execute.

  This chapter provides instructions on adding a new record type.

- Adding new statements to the Statement database.

  Adding new statements is a general capability of AIM and is not specific to vision. Thus, you should refer to the *AIM Customizer's Reference Guide* for detailed information on adding new statements. Some examples related to vision are presented in this manual. See Chapter 5 for information on the VisionWare application module.

This chapter contains brief descriptions of the routines that may be used or created during customization.

This chapter also contains many sections that are useful for reference when needed but may be confusing if included in the first reading of the manual. Therefore, if you are reading this chapter for the first time, be selective and skip sections that seem too detailed to be useful to you.

3.1 Database Identification Numbers

AIM routines refer to databases by their respective identification numbers. Table 3-1 lists all the databases unique to the Vision Module, their identification numbers, and the global variables that can be used to refer to the databases.

Table 3-1
Database Identification Numbers

Resource Name	Type Variable, Database Variable, Module File Ext.	Type, Number	Description
Camera	vc.ty vc.db[TASK( )] .vc	31	Defines the parameters and calibration for any cameras used by vision. Global database is vcamvw.db
Vision	vi.ty vi.db[TASK( )] .vi	30	Defines the vision processes used in inspections and robot guidance. No global database.

NOTE: Whenever possible, use the variables listed in Table 3-1 in place of explicit database numbers. Future AIM systems may use different numbers to refer to the databases, but the variable names will be retained with appropriate values. The only situation where you must use explicit database numbers is when defining new sequence statements. Refer to the *AIM Customizer's Reference Guide.*

3.2 Adding New Record Types

This section describes how to add a new record type to the Vision Module. We begin by describing the major components of a record type. Your needs, in terms of these components, will determine how you implement your new record type.

Why Do You Need a Custom Record Type?

You probably need a custom record type because you need some functionality that doesn't exist in the standard record types. Or, if it does exist, you may want to combine the functions of several record types into one. In either case, you need to clearly identify the functionality required *before* implementing the new record type.

VisionWare provides a great deal of flexibility and functionality. Be prepared to recognize functionality you *don't* need as you read this manual, and skip over those sections.

Basic Function and Components of a Record Type

The main function of a vision record is its execution, but the input data and output results are also key components. The record type provides a way of identifying a common purpose and format for using a vision record. That is, a record type defines, for every record of that type, the structure of the data, what happens at execution time, and the format of the results. Thus, there are three basic aspects or components of a record type: data, execution, and results.

For example, the "Line Finder" standard record type consists of the following three key elements (simplified a bit for illustration):

Data:	Picture to operate in Position of the Line Finder in the picture Parameters needed for the Line Finder
Execution:	Perform VFIND.LINE tool in designated picture
Results:	A LINE, defined by its angle and a point on the line Percent of edges found Maximum error distance of edges found from line Was the operator off the screen at all?

There can be many other supporting aspects to these three main elements, but for now we will concentrate on understanding the basics of a new record type.

How a Record Type Is Defined

Record types are defined in the Vision Module by the following:

- A unique identifying number (custom record types start at 100)
- A specific format for data usage within a database record

- An AIM menu page for editing database records
- A set of subroutines to be used for editing, execution, etc.
- A set of numeric and string descriptors defining various characteristics of the record type

Most of this information is set forth in a routine written by the system customizer, called the record-type definition routine. This and the other custom routines are fully defined in Chapter 6, but their basic functions are described in the section “Customization Routines” in this chapter.

Template and sample versions of these routines for some typical operations are presented in Appendixes C and D, with V+ code versions available in the public file VISTMPLS.V2. Most likely, one of these will be able to serve as a basis for developing your own record-type routines.

The details of the Vision database are presented before describing the actual routines.

3.3 Vision Camera Database

Table 3-2
Vision Camera Database

Field #, Variable	Field Name	Type, Size [Array Size]	Description
0 cc.name	name	name 15	A standard AIM name that uniquely identifies a vision operation. This name is referenced in sequence statements. (This field is typically not changed by custom routines.) (1)
1 cc.update	update date	date/time 4	The date when this record was last modified. This field is automatically set to the current date when the record is edited.
2 cc.device	device	byte 1	This field is not used by the Vision Module or by VisionWare. It is reserved for future use.
3 cc.page.name	menu page name	name 15 [2]	The name of the menu file, and the name of the record in the file, to use when displaying and editing this record. (This field is typically not accessed by custom routines.)
4 vc.desc	description	string 60	A comment field that contains a one-line description of the vision camera's setup.
5 vc.modes (vc.mode.num= Number of elements in the array)	modes	real 4 [16]	Available for use as general parameters for each record type. See Table 3-3 for variables used as indexes into the **vc.modes** array.
6 vc.cam.cal	cal array	real 4 [21]	The vision camera calibration array. See the *AdeptVision Reference Guide* for details on calibration arrays.
7 vc.pix.to.pmm	pixel-to-pmm array	real 4 [9]	Raw pixels to perspective millimeters. The vision system applies this transformation when returning results to the application program in millimeter coordinates.

Table 3-2
Vision Camera Database (Continued)

Field #, Variable	Field Name	Type, Size [Array Size]	Description
8 vc.pmm.to.pix	pmm-to-pixel array	real 4 [9]	Perspective millimeters to raw pixels. The vision system uses this transformation to convert user-specified millimeter coordinates (such as the start of a ruler) to pixels.
9 vc.to.cam	to.cam	transform 48	A calibration transform for a fixed-mount camera's vision reference frame or robot-mounted camera's vision reference frame.
10 vc.disk.loc vc.tool.offset	known.dot or tool.offset	transform 48	Part of the calibration transform. **vc.disk.loc**—Doubles as a known dot location. **vc.tool.offset**—Set to be the average tool offset.
11 vc.belt.name	belt record name	string 15	The name for the conveyor record. (1)
12 vc.belt.rec	[belt record]	integer 2	The number of a conveyor record in the Conveyor database corresponding to the name in the field "belt record name".
13 vc.loc1 (vc.loc1 = vc.away.loc = vc.nominal.loc)	location1	transform 48	Start of the motion block for a "lefty" configured robot. (5)
14	location1 strategy name	string 1	The name of the strategy routine or sequence. (2)
15	[location1]	byte 1	Start of a standard motion block for the motion to the basis location. (First field of motion block with no approach. Fields 15–25 are in the motion block.) (3)
16	location1 motion bits	byte 1	Part of the "location1" motion block. (4)
17	location1 speed	integer 2	Part of the "location1" motion block. (4)
18	location1 acceleration	byte 1	Part of the "location1" motion block. (4)

Table 3-2
Vision Camera Database (Continued)

Field #, Variable	Field Name	Type, Size [Array Size]	Description
19	location1 deceleration	byte 1	Part of the “location1” motion block. (4)
20	location1 rotational speed	byte 1	Part of the “location1” motion block. (4)
21	location1 profile	byte 1	Part of the “location1” motion block. (4)
22	[location1 sequence]	byte 1	Part of the “location1” motion block. (4)
23	location1 configuration	byte 1	Part of the “location1” motion block. (4)
24	location1 type bits	integer 2	Part of the “location1” motion block. (4)
25	[location1 frame]	integer 2	Part of the “location1” motion block. (4)
26 vc.loc2 (vc.loc2 = vc.nom.loc.rty= vc.start.loc= vc.actual.frame)	location2	transform 48	A transformation that defines the start point for this path segment for a “righty” configured robot. (5)
27	location2 strategy name	string 1	The name of the strategy routine or sequence. (2)
28	[location2]	byte 1	Start of a standard motion block for the motion to the basis location. (First field of motion block with no approach. Fields 28–38 are in the motion block.) (3)
29	location2 motion bits	byte 1	Part of the “location2” motion block. (4)
30	location2 speed	integer 2	Part of the “location2” motion block. (4)
31	location2 acceleration	byte 1	Part of the “location2” motion block. (4)
32	location2 deceleration	byte 1	Part of the “location2” motion block. (4)
33	location2 rotational speed	byte 1	Part of the “location2” motion block. (4)

Table 3-2
Vision Camera Database (Continued)

Field #, Variable	Field Name	Type, Size [Array Size]	Description
34	location2 profile	byte 1	Part of the “location2” motion block. (4)
35	[location2 sequence]	byte 1	Part of the “location2” motion block. (4)
36	location2 configuration	byte 1	Part of the “location2” motion block. (4)
37	location2 type bits	integer 2	Part of the “location2” motion block. (4)
38	[location2 frame]	integer 2	Part of the “location2” motion block. (4)
39 vc.scratch.loc	scratch loc	transform 48	A transformation that defines the scratch location start point for robot motions. (5)
40	scratch loc strategy name	string 1	The name of the strategy routine or sequence. (2)
41	[scratch loc]	byte 1	Start of a “scratch loc” motion block. (First field of “scratch” motion block with no approach. Fields 28–38 are in the “scratch” motion block.)(3)
42	scratch loc motion bits	byte 1	Part of the “scratch loc” motion block. (4)
43	scratch loc speed	integer 2	Part of the “scratch loc” motion block. (4)
44	scratch loc acceleration	byte 1	Part of the “scratch loc” motion block. (4)
45	scratch loc deceleration	byte 1	Part of the “scratch loc” motion block. (4)
46	scratch loc rotational speed	byte 1	Part of the “scratch loc” motion block. (4)
47	scratch loc profile	byte 1	Part of the “scratch loc” motion block. (4)
48	[scratch loc sequence]	byte 1	Part of the “scratch loc” motion block. (4)
49	scratch loc configuration	byte 1	Part of the “scratch loc” motion block. (4)

Table 3-2
Vision Camera Database (Continued)

Field #, Variable	Field Name	Type, Size [Array Size]	Description
50	scratch loc type bits	integer 1	Part of the “scratch loc” motion block. (4)
51	[scratch loc frame]	integer 2	Part of the “scratch loc” motion block. (4)

Notes:

1. Mark database as updated if this value is changed.
2. Field in motion block, not first; mark database as updated if this value is changed.
3. First field of motion block, no approach.
4. Field in motion block, not first.
5. Field is edited if defined during walk-thru training; basis location for robot motion block.

Table 3-3
Variables Used as Indexes Into the vc.modes Array

Variable	Index Number	Description
vc.md.vsys	0	Vision system number
vc.md.flags	1	Mode flags for camera calibration (see below). **Name** **Value** **Description** vc.flg.pitch ^H400 Sets vision Z-axis direction (camera/tool relationship). vc.flg.persp ^H800 Sets use of perspective calibration transformation.
vc.md.max.err	2	Max error when using basic calibration.

Note:

Fields 3 through 15 are reserved for future use.

3.4 Record Structure of the Vision Database

Each record in the Vision database defines a vision operation. Each record, regardless of record type, has the same field structure (see Table 3-4). However, unlike other AIM databases, some of the record fields have a “variable” usage. That is, the interpretation of those fields depends on the record type. For example, the Line Finder record type may use one of the elements of the “modes” array as the edge strength threshold, whereas the Picture record type may use the same “modes” element as the video gain.

All the record fields are listed and summarized in Table 3-4, in the order in which they occur within a record. The data in a record can be accessed from an application program by using the V+ variable names shown in Table 3-5. Alternate variables are shown Table 3-7.

Table 3-4
Record Definition for the Vision Database

Field #, Variable	Field Name	Type, Size [Array Size]	Description
0 cc.name	name	name 15	A standard AIM name that uniquely identifies a vision operation. This name is referenced in sequence statements. (This field is typically not changed by custom routines.) (1)
1 cc.update	update date	date/time 4	The date when this record was last modified. This field is automatically set to the current date when the record is edited. (3)
2 cc.device	device	byte 1	This field is not used by the Vision Module or by VisionWare. It is reserved for future use. (4)
3 cc.page.name	menu page name	name 15 [2]	The name of the menu file, and the name of the record in the file, to use when displaying and editing this record. (This field is typically not accessed by custom routines.) (3)
4 vi.rec.type	record type	byte 1	A unique number (in the range 100 to 255, inclusive) that identifies the type of record. (0 to 99 are reserved for Adept records.) This is specified when the record-type definition routine is called. It is not normally modified by custom routines. (2)
5 vi.eval.method	eval method	byte 1	A value (in the range 1 to 255, inclusive) used to indicate the specific evaluation method for a record when there is more than one method for the record type. (For example, this may indicate that a Computed Point is to be computed using the intersection of two LINEs, as opposed to being centered between two POINTs.) (5)
6 vi.modes (vi.mode.num= Number of mode values)	modes	real 4 [16]	Available for use as general parameters for each record type. See Table 3-5 for variables that can be used as indexes into the **vi.modes** array. (5)

Table 3-4
Record Definition for the Vision Database (Continued)

Field #, Variable	Field Name	Type, Size [Array Size]	Description
7 vi.shape	shape	real 4	If the record type is a “shape” type, this indicates what specific shape parameters will follow in the “shape description” field. For example, line rulers and arc rulers have different shapes. (5)
8 vi.shape.desc (vi.shape.num= Number of shape values)	shape description	real 4 [6]	If the record type is a “shape” type, this holds parameters that define the shape. Refer to Table 3-6 for examples (the specific items may vary with different record types and shapes). (6)
9 vi.flags	flags	byte 1	A bit field having bits 1 through 4 available for general use. Bit 5 is used to force an angle of 0 degrees for a normally rotatable tool. Bit 6 is used for the ☑ **Repeat** indicator. Bit 7 is used for the ☑ **TopLevel** indicator. Bit 8 is used for the ☑ **Show at runtime** indicator. (7)
10 vi.num.sources	num sources	byte 1	Number of sources for the “eval method” specified in the record. This is set automatically when the “eval method” is changed. It is determined using an array that is set up when each record type is defined. This count does not include source 0, which is reserved for a vision frame. (This field is normally managed by the Vision Module.) (2)
11 vi.src.recs	source rec	integer 2 [9]	Source record numbers determined by linking the source names in the “source rec name” array. The first element in the array (index 0) is always the vision frame source. (This field is normally managed completely by the Vision Module.) (2)

Table 3-4
Record Definition for the Vision Database (Continued)

Field #, Variable	Field Name	Type, Size [Array Size]	Description
12 vi.src.rec.name	source rec name	name 15 [9]	The names of the records that must be executed prior to this record being executed. (This field is normally managed completely by the Vision Module.) • The first element in the array (index 0) is always the name of the vision frame. • For "vision tool" record types, the second element (index 1) is reserved for a Picture record. • For "combination" record types, the second element (index 1) must be the top of the repeat tree for that record. • The uses of the other source-record references must be specified in the record-type definition routine. When defining a record type, you will indicate which classes of record types will be allowed in each array element, given a particular evaluation method. (Each class indicates the kind of results produced by a source record type.) (2)
13 vi.str.data (vi.str.num= Number of data strings)	string data	string 30 [2]	Multipurpose data strings (like the "modes" array) used as general parameters for each record type. (For example, the Prototype records store the prototype name in this field.) (5)

Notes:

1. Mark the database as updated if this value is changed. Meaning is the same for all records.
2. Meaning is the same for all records.
3. Same as Note 2, except use of the field is restricted to Adept routines.
4. Field is not used.
5. Meaning can depend on the record type.
6. Meaning is "fixed" (the same for all records) for some record types, and "variable" (can depend on the record type) for some record types.
7. Four bit flags are fixed; four bit flags are variable.

Table 3-5
Variables Used as Indexes Into the vi.modes Array

Variable Name	Interpretation
vi.md.0	Mode 0
vi.md.1	Mode 1
vi.md.2	Mode 2
vi.md.3	Mode 3
vi.md.4	Mode 4
vi.md.5	Mode 5
vi.md.6	Mode 6
vi.md.7	Mode 7
vi.md.8	Mode 8
vi.md.9	Mode 9
vi.md.10	Mode 10
vi.md.11	Mode 11
vi.md.12	Mode 12
vi.md.13	Mode 13
vi.md.14	Mode 14
vi.md.15	Mode 15

Table 3-6
Variables and Meanings for the Elements in the vi.shape.desc (Shape Description) Array

Variable Name	Index Number	Description
vi.shp.x	0	X coordinate of position (for example, arc center)
vi.shp.y	1	Y coordinate of position
vi.shp.dim1	2	Dimension 1 — A linear dimension (for example, width)
vi.shp.dim2	3	Dimension 2 — Another linear dimension (for example, length)
vi.shp.a0	4	Angle 1 — An angle (for example, starting angle of arc)
vi.shp.an	5	Angle 2 — Another angle (for example, ending angle of arc)

Table 3-7
Alternate V+ Variables for Vision Records

Variable Name	Alternate Name	Used For
vi.shape	vi.variety	Inspections (2nd eval method)
vi.shape.desc	vi.limits	Inspections
vi.shp.x	vi.lim.nom	Nominal value
vi.shp.y	vi.lim.min	Minimum value
vi.shp.dim1	vi.lim.max	Maximum value
vi.shp.dim2	vi.lim.lo	Low warning limit
vi.shp.a0	vi.lim.hi	High warning limit

3.5 Memory-Resident Data Structures

Although the permanent data storage for vision operations is in the Vision database, other data structures are kept in memory for speed and efficiency during editing and at runtime.

Data Arrays

Two of the most important of these data structures are the data arrays: **vw.data[,,]** and **$vw.data[,,]**. These arrays, which have the database number as their primary index and the physical record number as their secondary index, contain all the data from the records in the Vision database. In addition, the arrays contain some maintenance information used by the Vision Module and, optionally, some data computed uniquely for each record prior to editing or runtime.

For most record types, reading and setting of record data values are handled exclusively through these arrays. AIM handles all reading and writing of the actual database records. However, since the menu pages used for editing refer to a data value by its database field and index, you must know the correspondence between the database and the arrays. See “Correspondence Between Database and Data Arrays” on page 35.

Results Arrays

Two other key data structures used by vision operations are the results arrays: **vw.res[,,]** and **$vw.res[,,]**. These arrays, which also have the database number as their primary index and the physical record number as their secondary index, hold the results of executing a record. These results can then be used by other records for computing their own results.

If you want the results of your record type to be generally available for a specific use (for example, as a LINE), you need to put your results in the arrays in specific slots (for example, X, Y, angle, cosine, and sine as the first five values in **vw.res[,,]**). This makes it possible for your record type to be considered as a member of a particular “class” (the line class, for example). Classes are described in more detail later in this chapter.

Variables for Array Indexes

For each value in the data arrays, there is a standard variable name that can be used to specify the array index when initializing, editing, drawing, or executing your record type. For example, element **vw.data[vi.db[**TASK( )**],n,vs.src.1]** contains (for database record number "n") the record number for source 1. As another example, for records that are in the point class, the variables **vw.x** and **vw.y** can be used as the indexes into the results array for the X and Y coordinates, respectively, of the point.

The predefined variable names are naturally very general and terse. You are encouraged to define variables that are more descriptive, based on your particular usage of the array elements. (These variables are defined in the record-type definition routine.) For a complete list of the variables already defined for each of the standard record types, see Chapter 4.

3.6 Division of Effort

When customizing a general system, it is important to understand clearly which general capabilities are managed automatically and which specific actions and computations need to be managed with custom data and routines. This section explains where the various responsibilities lie.

AIM and the Vision Module always have primary control of the system. When operator input of some sort is made (mouse click, number entry, menu selection), the Vision Module will either handle it completely, preprocess it somewhat and pass it through a custom routine, or let it be completely managed by custom routines.

For example, editing actions that are fairly common or involve graphics (that is, where consistency is important) are controlled by the Vision Module. Management of runtime preparation and execution also is controlled by the Vision Module.

As you create a new record type, you are given the opportunity to do a great deal of customization in the form of custom routines you can write. Please note that many of these routines are optional and may not be needed for your record type. Also, some of these routines can operate in several different modes, some of which can be ignored.

The following is a list of the key functions automatically handled by the system. (Note, however, that there are often opportunities for special actions for specific record types.)

- Checking new record names (including source names) for validity.
- Linking source names to record numbers.
- Display and selection of valid source records.
- Vision frame and picture management.
- Creation and deletion of records.
- Creating / deleting / saving / loading prototypes and fonts.
- Drawing and editing tools and graphics. (The system manages all drawing, processing of mouse clicks, and dragging of handles. It also erases a graphic before a change and redraws it afterwards.)
- Execution order and task usage (overlap of motion, vision, and AIM).

The following list shows the functions and information that you are expected to provide, and actions that you can influence, for each custom record type.

- Initialization at AIM start-up

  Definition of custom record types and classes.

- Editing and menu-page management (optional)

  You provide a routine that will be called each time:

  A different record is selected for editing.

  The menu page is about to be redrawn.

  The menu page is about to be refreshed.

  A data value is changed.

  A significant window / mouse event happens (for example, mouse down on handle, delete record selected, etc.).

- Drawing graphics for editing (optional)

  You provide a routine that draws a graphic for editing based on the data in the data arrays.

- Execution routine

  You provide a routine that performs the desired actions or computations based on the data arrays and puts the results in the results arrays.

- Preruntime execution (optional)

  You provide a routine that is called.

- New record setup—initializing data values (optional)

  You provide a routine that is called when a new record is created. This routine assigns default data values to the data arrays. They are then used to initialize the new record.

The routines mentioned above are outlined briefly in the next section; full descriptions are presented in Chapter 6.

3.7 Customization Routines

The routines described here are to be written by the customizer, if needed, and given unique names. The names you assign are specified within the record-type definition routines. The appropriate routine will then be used for each record type during editing or execution.

> **NOTE:** The routine names used here (and throughout this manual) are intended to be generic names indicating the function of the routines. You must assign unique names to the routines you create.

A brief synopsis of each routine appears below; a more complete description is given in the following sections. For a complete description, however, you should refer to the "dictionary pages" in Chapter 6. For examples, see the routines in the file VFINDERS.V2, which contains the actual routines used for the *Line Finder, Point Finder,* and *Arc Finder* record types. (The definition

routines for these record types are in VFINDERS.OV2.) Also, see Appendix C for template routines and Appendix D for corresponding example routines.

Routine	Name	Use
Record-type definition	vrec.def	Define the record-type characteristics, including the names of the routines to be used when editing or executing records of the record type.
Execution	vrec.exec	Performs computations based on the data arrays, and puts the results in the results arrays.
Set-data	vrec.set.data (optional)	Called to set data values when a record is created, when it is initialized from the database, or at preruntime for execution efficiency.
Edit	vrec.edit (optional)	Called to handle menu-page and editing initialization and user actions. This routine is needed only for special handling of parameter editing.
Edit shape drawing	vrec.draw (optional)	Draws a shape using the data in the numeric data array. This routine is needed only if doing graphical editing of the shape parameters. (It is called around mouse moves to erase and draw the shape.)
Menu-page refresh	vrec.refresh (optional)	Called when the menu page is refreshed. (This routine should update any control variables or database values that are displayed by the menu page.)

Record-Type Definition Routine

When creating a new record type, the record-type definition routine should be written first, or in conjunction with the execution routine. Unless your record type is very simple, you probably will find that revisions will be made to this routine as the execution routine is written and as the menu page for editing is created.

This routine has output parameters that need to be filled with information describing the record type and with routine names to be used with the record type. The definition routine must do the following:

- Define descriptive variables to be used as indexes for the data and results arrays.
- Define a list of results that you would like to have accessible using the test-a-value method. You define a label and data type (real or Boolean) and they become automatically accessible from records such as inspections and value combinations.
- Fill in the “record-type definition” arrays. This includes the routine names and menu page names for use with the record type, and several numeric values indicating modes and methods of editing and execution.
- Fill in the “source classes” array. This defines what kinds of sources and how many sources there are for each evaluation method the record type may have.
- Add the record type to the classes that it is qualified to belong to (and that you want it in). Depending on how you order the results in the results array, your record type may be able to belong to several classes. You may even have created your own class(es) to use.

> **NOTE:** You do not need to specifically add any record types to the test-a-value class. This is handled automatically by the system.

- Define any other variables you may want to have for convenient or efficient editing or execution. For example, you may want to precompute tables for fast table look-up or define descriptive variables for referencing data values.

For more information on the definition routine, see the routines **vw.**.def( )** in the disk file VFINDERS.OV2. Also, see the template routines and examples in Appendixes C and D.

Execution Routine

This is the routine that actually performs the vision operation represented by the vision record. This routine is the most fundamental component of a record type since it actually performs the function of the record type. All the other routines and data definitions support this routine and serve to make the right data available for swift and efficient execution.

> **NOTE:** For "Information-only" record types the functions of this routine are performed by the "set-data" routine at preruntime, and an execution routine is not used. See the next section for more details.

The execution routine computes results based on the data in the data array and puts these results in the results array. The name you choose for this routine must be included in the record-type definition array initialized in your definition routine.

If the record type requires source records in order to function, they will have been already evaluated before the execution routine is invoked. These sources, however, are not guaranteed to have been successful. Therefore, the status values of these sources need to be checked and dealt with appropriately.

This routine must assign the "eval done" and "status" values for the record. These values are crucial to task coordination and successful operation of the Vision Module.

This routine also is responsible for displaying graphics when appropriate to represent the operation. Therefore, this routine is also called during editing before and after parameter changes so that the integrity of the graphics is maintained. Statistics can be accumulated by calling standard routines from the execution routine. Details on these aspects are on the dictionary page for **vrec.exec( )** on page 108. Also see "Accumulating Statistics" on page 45.

If the execution routine needs to change system switches or parameters, it generally can just change them and leave them with their new settings. However, some switches and parameters should be restored to their original settings before exiting the routine. Appendix F contains a full list of the switches and parameters, and how they should be treated.

For more information on the execution routine, see the dictionary page for **vrec.exec( )** on page 108, and the routines **vw.**.exec( )** in the disk file VFINDERS.V2. Also see the template and example routines in Appendixes C and D.

Set-Data Routine

The "set-data" routine is a multipurpose routine that fulfills three kinds of data-setting needs for a record type, as described below. The purpose of a specific call to this routine is indicated by a "mode" argument in the calling sequence.

This is an optional routine. If you use it, you must choose a name and include it in the record-type definition array initialized in your definition routine.

This routine is called in three different situations.

- mode 0
  When a record is created, this routine is used to initialize data values. If there are any default values (other than 0 or " ") that need to be assigned to the database elements of the data arrays, this is the place to assign them. For most record types, this is the only mode of operation for which this routine does anything.
- mode 1
  This routine can be used to perform "preruntime" calculations. That is, after all the records are linked at runtime but before execution of the sequence actually begins, this routine is called for each record that will be executed in the sequence. This is an efficient time to do any "fixed computations", which do not depend on source-record results that may vary with each cycle.
- mode 2
  The set-data routine is called just after the data array has been initialized (or updated) with the data from the database. This occurs, for example, during AIM start-up and at every redraw when the runtime scheduler is not active. The routine can be used to perform any data extrapolations or computations that are based solely on the data that is contained in the database. At the time the routine is called in this mode, the source records have been linked, but they are not necessarily evaluated or even complete.

"Information-only" record types do not have an execution routine. Thus, those record types rely completely on mode 1 or 2 of the set-data routine to compute the results for the record.

For more information on the set-data routine, see the dictionary page for **vrec.set.data( )** on page 115, and the routines **vw.**.set.data( )** in the disk file VCFEAT.V2. Also see the template and example routines in Appendixes C and D.

Edit Routine

This routine is a multipurpose editing management routine. It is optional, but as a practical matter it is required for all but simple record types. This routine is not needed if your records are edited only by simply changing values on the menu page that refer directly to the database fields. You need to use this routine if you want to click and drag a shape in the Vision window, or if you want to intercept and dynamically limit any values.

In order to handle the various editing activities, there are four situations in which this routine is called. (The routine has a "mode" argument that indicates the situation for each call.)

- mode –1
  Initial page display — This occurs when the record is first entered after editing another record. This situation rarely needs special code.
- mode 0
  Page redraw — This call is made when the page is redrawn—that is, after the **Redraw** key (**Shift**+**F6**) is pressed, a TAKE PICTURE is requested, or an auto-redraw menu-page item is changed, or after returning from a pop-up. Most initialization of editing variables is done in this situation. For example, this call would initialize the list of handles for shape editing.

  > **NOTE:** This call is *not* made if any source is not valid or the correct picture cannot be displayed.

- mode 1
  To set positions of editing handles — This occurs when a record has a "shape" to edit. This routine is called at redraw time to set the handle locations so that they can be drawn and checked for mouse hits. It is also called to locate the position handle for display while selecting source records.

  > **NOTE:** This call is *not* made if any source is not valid or the correct picture cannot be displayed.

- mode 2
  To handle editing events — This routine is notified of almost all editing events. It has the choice of ignoring some events, while others, such as mouse events, have to be processed to effect changes in the shape parameters. (This use of the edit routine is explained further in the section "Editing" in this chapter.)

  > **NOTE:** This call is *not* made if any source is not valid or the correct picture cannot be displayed.

After you choose a name for your edit routine, it must be included in the record-type definition array initialized in your record-type definition routine.

For more information on the edit routine, see the dictionary page for **vrec.edit( )** on page 103 and the example routines **vw.**.edit( )** in the disk file VCFEAT.V2.

Edit-Shape Draw Routine

This routine is used if there is a graphically displayable shape that the user manipulates to edit the data values of the record type. This routine does the drawing, but in standard situations, the Vision Module manages both when the drawing is completed and the display mode is used.

The graphics should depend only on the data arrays. The graphics should not depend on the results arrays since they may not be valid when this routine is called. All graphics must be done in complement mode, with either a "high-visibility" color or a "dim" color, depending on the display mode.

Sometimes a draw routine for another record type can be used for this routine—when the data arrays for your record type conform to those for the other record type and you want to draw the same thing. For example, the public routine **vw.tl.draw( )** draws a vision tool (without actually computing results) if certain data values (especially the shape parameters) are consistent with one of the standard vision tools. Also, the routines for drawing lines, points, circles, and vision frames, while editing the respective record types, are as follows:

vw.cc.draw( ) Draw a circle for editing a Computed Circle
vw.cl.draw( ) Draw a line for editing a Computed Line
vw.cp.draw( ) Draw a point for editing a Computed Point
vw.cf.draw( ) Draw a vision frame for editing a Computed Frame

After you write your draw routine, its name must be included in the record-type definition array initialized in your definition routine.

For more information on the draw routine, see the dictionary page for **vrec.draw( )** on page 101, and the example routines **vw.**.draw( )** in the disk file VCFEAT.V2.

Refresh Routine

This optional routine is responsible for maintaining the integrity of the values displayed on the menu page. This routine is used to update elements of the array **ai.ctl[ ]**, based on the data and results arrays.

The refresh routine is called whenever the menu page is about to be refreshed or redrawn. (In the case of a redraw, it is called after all the other redraw code—specifically the edit routine—has been executed.)

The Adept record types use this routine for updating control variables **ai.ctl[ ]** with results so that they can be displayed. If any results are to be displayed on the menu page, this routine is the only means to do that. If you wish to have only the first 16 results copied from the results array into **ai.ctl[ ]** (starting at index **cv.ve.results**), you can use the standard routine **vw.refresh( )** to do just that. This standard routine is used by almost all record types to move the results over to where they can be displayed.

Control variables are commonly used as key values for conditional records in the menu page. If you are using any control variables in this way, the values must be set by the refresh routine since this is the only custom routine that is guaranteed to be executed at every redraw of the menu page.

After you choose a name for this routine, it must be included in the record-type definition array initialized in your definition routine.

For more information on the refresh routine, see the dictionary pages for **vrec.refresh( )** on page 111 and **vw.refresh( )** on page 215.

3.8 Vision Operations Across Multiple Pictures

Sometimes it is necessary to use more than one picture record in the course of a vision operation. For example, you may need to measure the distance between objects that appear in two different pictures or you may need to compute a vision frame using features found in several different pictures, then cast vision tools in yet another picture. The Vision Module fully supports such operations, provided that certain geometric constraints on the camera positions (described below) are satisfied.

A “reference picture” record is associated with each record as it is evaluated. When a record has geometric-feature results (positions and / or orientations), they are expressed relative to the coordinate frame for the record’s reference picture. When a picture record is executed, the actual world-coordinate location of the picture coordinate frame is recorded. Then, when an operation involves features in multiple pictures, some of them are transformed so that all are relative to the same coordinate frame. Computation is then done as if all the features were found or computed in the same picture. The final results are represented relative to the reference picture for the record being executed.

> **NOTE:** In order for the results from one record to be reconciled with the results from a record with a different reference picture, the coordinate frames for the two reference pictures must have (essentially) coincident X-Y planes. Otherwise, an error will occur during walk-thru training. (The actual criteria are that the Z axes must be within 0.1 degree of being parallel, and the origin of each reference frame cannot be more than 0.05 millimeter from the X-Y plane of the other reference frame.) This is not an issue with nonrobot camera-to-camera calibrations.

For example, suppose we want to compute the distance between two holes that are at opposite ends of a large part. They are very small holes, and we want to find them as accurately as possible. We position two cameras, one over each hole, so that the holes appear with a diameter equal to about half of the field of view. We then create for each physical camera a picture and a camera record that define the camera and image parameters to use for calibration. Next, we create a calibration record for each physical camera. Then, we can set up vision operations to locate the holes and determine the point-to-point distance between them.

At execution time, a record that uses geometric features (points, lines, etc.) as sources needs to transform the results of all those sources whose reference pictures are not the same as that for the record under consideration. Consequently, the source records that have their results transformed must also be assigned the new reference picture, so that their results and reference picture are consistent. Therefore, you can see that even though an operation initially has its actual picture source as its reference picture, this may change several times during runtime as different records execute and use the results of the operation. Each record causes the reference picture for the operation to be changed to the reference picture for that record as the operation results are transformed to the coordinate frame of that reference picture.

If you create a custom record type that uses geometric features as sources, you will have to use the routine **vw.conv.frm( )** to check and, as required, convert the results of all the sources except source 1. (The Vision Module always chooses the reference picture for source 1 as the reference picture in which to compute results. For vision tools, remember, source 0 [the vision frame source] is automatically transformed, if necessary.)

The global variable **vw.multi.pics[vi.db[**TASK( )**]]** can be used to avoid checking the reference pictures for all the sources when you really have only one active picture record in the entire sequence. This variable will be set to a nonzero value if there really is more than one picture record required by the active statements in the sequence. It also will be set to nonzero during editing if the scheduler is not active, regardless of the sequence.

For an example of how to transform source-record results, see the execution routine for the Computed Line record type—that is, the routine **vw.cl.exec( )** in the disk file VCFEAT.V2.

3.9 Editing

The previous discussions regarding adding custom record types focused on the three basics: data, execution, and results. Your clear conception of these basics is certainly fundamental to putting together a working record type. In order to keep things simple at first, we postponed addressing the very important need for convenient editing of the data.

Usually, the basic capability of being able to edit the raw data is easy to provide and is completely sufficient. However, you may need to perform limit checking that cannot be handled by the standard menu-page limits. And you will certainly find it irresistible to add graphical editing when you have a shape to position on the screen.

The Vision Module monitors certain editing actions the user makes and passes them on to your custom edit routine as “events”. These events include changes to menu-page values, delete-record requests, mouse clicks and moves that are near handles, etc. For most parameter changes, the presence of an edit routine gives you a chance to intercept them and check limits or modify related data values based on the change. For mouse moves, having an edit routine provides the means for graphically editing the shapes. (More details on this are provided later.)

The top level for control of editing is always the AIM menu driver. It operates from the menu page that you design for the record type. In the following sections, we start by describing the basic menu page and how to create it. Then, we describe how you are notified of parameter changes and

mouse events, and what the edit routine is expected to do with them. And finally, we give a description of how to use Adept standard routines for graphical shape manipulation.

Record-Type Menu Page

There is a sample menu page in the file VISUTIL.MNU. This can be copied and modified to support any custom record type. So that visual uniformity is maintained with regard to standard information, you should always start with this sample menu page, or an existing menu page (from one of the menu page files listed in the section “Menu Summary” on page 3).

To access the sample menu page, perform:

Special ➡ Sample Menu

To edit the record-type sample menu page, perform:

Utilities ➡ Edit Menu ➡ File ➡ Switch File ➡ *enter “visutil.mnu”* ➡ Goto

Go ➡ Menu Pages ➡ sample_menu_pg ➡ Goto

The menu page is shown in Figure 3-1.

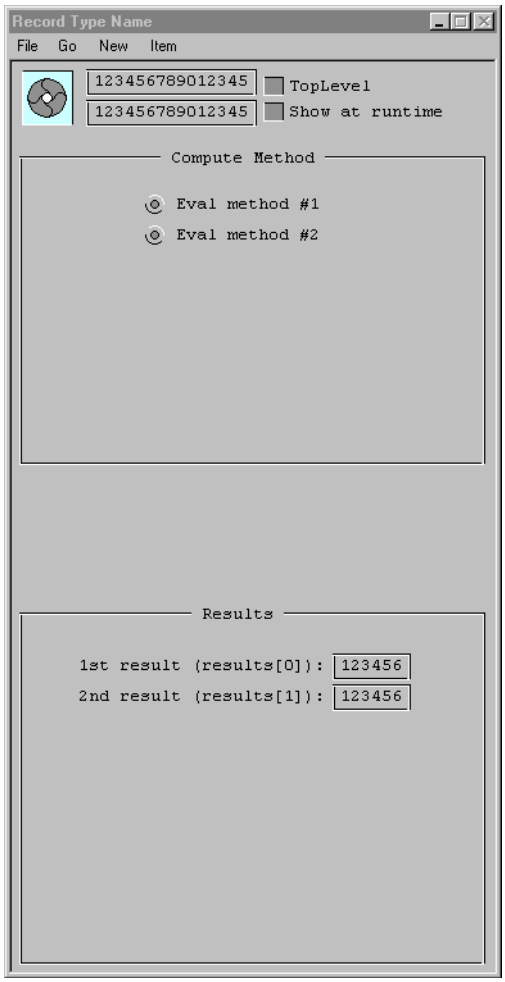

Figure 3-1
Record Type Sample Menu Page

Use the “File” pull-down selection to copy and modify the menu page.

> **NOTE:** Before continuing with this section, you may want to refer to the *AIM Customizer’s Reference Guide* and review the sections pertaining to creating and editing menu pages. In this manual you primarily need to be familiar with the basic functionality of the different spawn routines and with I/O command buffers.

If you explore the sample menu page, you will notice that there are several standard routines that are used in support of the various menu-page items. They are:

ve.page.mngr(arg)	Page spawn routine
ve.fld.chg(arg)	Value Check spawn routine
ve.warning.sign(arg)	Conditional Record spawn routine

The next three sections describe the functions of these routines and the meanings of their **arg** parameters as specified in the menu page.

The Standard Menu-Page Spawn Routine — ve.page.mngr(arg)

This routine is specified as the Page routine in the header record for a menu page. The routine controls redrawing of the page and intercepts all pertinent edit actions, such as record deletions and mouse clicks and drags. This routine also constantly makes sure that vision editing is initialized correctly for the current run state of the system.

The value of the **arg** parameter should be 1 if this routine is used as the Page routine for pop-ups, such as the "Tool Loc" pop-ups on many of the vision-tool menu pages. Otherwise, the **arg** parameter can be left blank or set to zero.

When doing shape editing, this routine automatically filters mouse actions to pick up only those that are close to a handle (within 20 pixels). The actions are then packaged into standard "events" and passed on to the edit routine for the record type. (These events are documented in the section "Edit Action Events" on page 60.) In addition, whenever the handles are moved, the editing graphic is automatically erased using the old parameters and redrawn using the new parameters.

The Standard Value-Check Spawn Routine — ve.fld.chg(arg)

This routine is used as the value-check routine for almost all writable fields. It intercepts changes to values that occur by clicking on buttons, dragging slide bars, or entering numbers on the menu page. Before these changes are actually performed, they are converted to standard "events" and passed to the edit routine (similar to the mouse events—see above). These events can then be accepted (or ignored), rejected (by return of an error code), or modified to perform a different change. In addition, receiving notice of each change can give you a chance to initialize or alter other related values.

When this routine is used as the value-check routine for source record names on a pop-up, the value of the **arg** parameter must have the least-significant bit set. This is so that when you double-click on the source name to GOTO it, the Vision Module knows it should exit the pop-up before redrawing with the new current record.

When doing shape editing, the editing graphic is automatically erased and redrawn before and after a parameter change. This is normally desired in order to have the graphic reflect the parameter changes. However, in cases where the erase and redraw are not necessary, you can set the value of **arg** such that the second bit is turned on. Consider the case of a menu page item that has "auto-redraw" turned on. Normally, this would cause the vision window to be completely erased and redrawn any time that item value is changed. Another case occurs when the item value does not affect the graphics or the results displayed on the menu page. In either case, updating of the graphic would be unnecessary, so the value of **arg** should have the second bit set.

To summarize, the typical values for the **arg** parameter are:

0 Any item that is *not* auto-redraw (for example, angle of Line Finder on the "Tool Loc" pop-up)

1 Source record name on pop-up, *not* auto-redraw (for example, vision frame of Line Finder on the "Tool Loc" pop-up)

2 Don't erase and redraw the graphics or results (for example, window-mode radio buttons)

3 Source record name on pop-up, auto-redraw

When creating new menu page items to control your database values, you should always use this routine as the "Check routine" with an appropriate value for the **arg** parameter, as described above.

A Standard Conditional-Record Spawn Routine — ve.warning.sign(arg)

This routine is used by all the menu pages for records that have source records. A warning-sign icon is displayed near the name of a source record whenever that source is not present or contains an error of some type (such as, one of its own sources is missing). This routine is used as the Conditional Record spawn routine for the conditional records that control display of these warning signs.

The value of the **arg** parameter must always be the number of the source that is to have its validity checked. (The vision frame, when used, is always source number 0.)

Warning Signs

Warning signs are used to indicate that there is some problem with a value. The standard "warning_sign" icon is conditionally displayed by using a conditional record with the same conditional section number. A conditional warning sign should *always* be used when a menu page displays the name of a source record. For source records, the routine **ve.warning.sign( )** (described above) can be used in the conditional record.

Display of the warning sign is a good technique for alerting the user that a value needs changing or attention of some sort.

Correspondence Between Database and Data Arrays

When writing your custom record-type routines, you will almost always refer to elements in the data arrays to access values in your database. However, the menu page must refer to database fields and indexes when specifying which values it will be controlling.

For your reference, Table 4-2 and Table 4-3 present the correspondence between elements in the data arrays and fields in the database records. Table 3-8 presents the correspondence between source names and fields in the database records. (These correspondences can also be seen in the definition routines in the file VISMOD.OV2.)

Using these tables, you should be able to easily determine what field and index to use when creating new menu-page items.

Refer to "Data Arrays" on page 62 for the names of variables used to access these data arrays.

Table 3-8
Correspondence Between Source Names and Record Fields

Description	V+ Variable for Database Field	Field Number	Index
Source names	vi.src.rec.name	12	
Ref frm name		12	0
Source 1 name		12	1
...			...
Source 8 name		12	8

Displaying Results and Other Non-Database Values

When a record is executed, the results are placed in the results array. However, since menu-page items can directly refer only to database values or control variables, the results must be copied to one or the other of these places before they can be displayed on the menu page. The standard refresh routine **vw.refresh( )** copies the first 16 results from the results array into the control-variable array (**ai.ctl[ ]**), starting at the element identified by the global symbol **cv.ve.results** (which equals 38). (Most Adept record types either use this standard routine as their refresh routine [naming it in the record-type definition routine] or call it from within their specific refresh routine.)

Thus, to display results, refer to the control-variable array elements listed in Table 3-9. Refer to section 4.4 on page 67 for an explanation of the **vw.res[,,]** array.

Table 3-9
Correspondence Between Results and Control-Variable Arrays

Element in vw.res[,,]	Element in ai.ctl[ ]	
	Symbolic Name	**Number**
vw.r.0 = vw.x	cv.ve.results	38
vw.y	cv.ve.results+1	39
vw.ang	cv.ve.results+2	40
vw.cos	cv.ve.results+3	41
vw.sin	cv.ve.results+4	42
...	...	...
vw.r.found	cv.ve.results+7	45
vw.r.clipped	cv.ve.results+8	46
vw.rad	cv.ve.results+9	47
...	...	...
vw.r.15	cv.ve.results+15	53

Auto-Refresh and Auto-Redraw

Auto-refresh and auto-redraw are two check box options for menu-page items. They should not be confused with each other since they do significantly different things.

You should set an item to “auto-redraw” if any change in the value should cause the menu page to be completely redrawn. A redraw *must* be done in order to reevaluate any conditional records. If the value in question will cause conditionals to change, and therefore affect the appearance of the menu page, the item should be set to “auto-redraw”. If a change in the value should cause reinitialization of the record data, “auto-redraw” is also appropriate. Otherwise, auto-redraw just repaints the page unnecessarily, slowing down operator interaction. For example, the different computation methods for a Computed Line record need to be set for auto-redraw since they cause different source-record descriptions to be displayed.

When a value is apt to be changed indirectly (for example, by mouse moves) and you would like the displayed value to stay up to date, that item should be set to “auto-refresh”. Any value that is

controlled by both a number-entry box and a slide bar (for example, the threshold selections on the dynamic binary windows) should have both the boxed item and the slide-bar item set to "auto-refresh", so that each item will track the value if it is changed by the other item.

> **NOTE:** Auto-refresh asserts only a reactionary aspect of the data field. It cannot affect other display items. It does *not* force a refresh of all the values on the screen. That is done at the time interval specified in the header of the menu page.

In summary, the "auto-redraw" option forces an action to take place, and the "auto-refresh" option is a reaction to other changes.

Pop-ups on Your Menu Page

To use a pop-up on your menu page, you need to design the pop-up and then you need to activate it. For most pop-ups, you can probably just copy the "Tool Loc" pop-up from one of the vision tools and change the references to suit your needs. Note that sometimes there are special values for the parameters to the Value Check routine and to the Page routine specified in the header. See the previous sections on those routines.

To activate the pop-up, you can do either of the following:

- Use a menu-spawn button that goes directly to the page.
- Use a spawn-routine button and call **mu.menu( )** with the page name from within a custom-written spawn routine.

  This may sometimes be necessary to set certain variables before the page pops up. In this case, you need to be careful that you don't pass back the **$cmd** value returned by **mu.menu( )** as the return argument for the spawn routine. For example, in the case when **mu.menu( )** returns the **$cmd** value **ky.exit**, returning that value would cause you to exit vision editing. The spawn routine should normally pass back a redraw command [$io.cmd.hdr+$INTB(ky.redraw)] or a null ($io.cmd.nop).

Normal Parameter Editing

When a parameter displayed on the menu page gets changed by either direct entry or a slide bar, the Vision Module (by means of the standard Value Check routine **ve.fld.chg( )**) packages this change as a standard "event" and passes it on to the edit routine for the record type. This gives you, the customizer, the opportunity to intercept these changes and check limits or modify related data values based on the changes.

If you let the event pass through unchanged, the expected change is made in the database and the corresponding data-array value is updated automatically. Alternatively, you may change the new value if there is a sensible replacement value, or you can reject the change by returning an AIM status code to be displayed to the user (such as **ec.badnum**, which would display "Illegal value" in a standard error pop-up).

> **NOTE:** If this is your first reading of this chapter, or if you do not need to do any special editing of parameters, you may want to skip the rest of this section.

The index into the data array for the parameter being changed is available as part of the event information. You also can use the standard routine **ve.param.chg( )** to actually effect the change in the data array if you wish. This routine also correctly updates absolute shape parameters when

relative shape parameters are changed, and it sets or clears bits when changes are made to the "flags" parameter.

> **NOTE:** Mouse events do not inherently address any particular parameter of an operation. Therefore, you would normally have to update the data array and the corresponding field in the database yourself. However, if the record type being edited has been designated as having a "shape" to edit, the shape parameters ("vs.x", "vs.y", etc.) in the data array and the database are updated automatically by the Vision Module.

When a parameter is changed, the record is executed once with the old parameter settings to allow any graphics to be erased exactly as they were drawn. Then, after the change has been made, the record is executed with the new parameter to draw the new graphic (if any) and to recompute the results.

Graphical Editing

The Vision Module supports graphical editing. This is enabled or disabled on a per-record-type basis by setting the "shape" attribute of the record-type definition arrays in the record-type definition routine, as follows:

```
def[vw.td.shape] = TRUE      ;Enable graphical editing
```

or

```
def[vw.td.shape] = FALSE     ;Disable graphical editing
```

The following sections describe the various support vehicles the Vision Module includes when this shape attribute is enabled.

> **NOTE:** If this is your first reading of this chapter, or if you do not need to do any graphical editing of shape parameters, you may want to skip this section.

Shape Parameters

When a record type has a "shape", the shape-description sections of the database and data array receive special attention. There are actually two sets of shape parameters in the data array: the relative shape parameters (which always track the database), and the absolute shape parameters (which give the position and orientation of the shape in the reference picture being used). This distinction is made because of the common situation in which the shape of a record needs to be defined relative to a vision frame formed by some other record. If the shape is not relative to another vision frame (that is, there is no vision frame named as source 0 on the menu page), the absolute and relative parameters are the same.

Table 3-10 lists the elements in the real data array that contain the shape parameters.

Table 3-10
Shape Parameters in Real Data Array

Relative	Absolute
data[vs.rel.x]	data[vs.x]
data[vs.rel.y]	data[vs.y]
data[vs.rel.dim1]	(not applicable)

Table 3-10
Shape Parameters in Real Data Array (Continued)

Relative	Absolute
data[vs.rel.dim2]	(not applicable)
data[vs.rel.a0]	data[vs.a0]
data[vs.rel.an]	data[vs.an]

Note that there are no corresponding absolute parameters for the dimensional shape parameters. There are, however, shorter alternative names for the dimension parameters that you can use. These shorter names fit the absolute names better.

```
vs.dx = vs.rel.dim1

vs.dy = vs.rel.dim2
```

When a relative shape parameter that is displayed on the menu page (from the database) is changed, both the absolute and relative parameters in the data array are automatically updated. Likewise, whenever an absolute shape parameter is changed by an edit event (like a mouse move), the relative shape parameters in the data array and the database are automatically updated.

Shape Graphics

When doing graphical editing, the graphics come from three places:

1. When the shape is not being dragged, the graphics displayed are generated by the *execution* routine.

   When a record executes, there is often a graphical way to display either the operation or the results, or both. Certainly, if vision tools are used from within the execution routine, the tool graphics can easily be displayed. When writing your execution routine, you are expected to write the code to display the appropriate graphics when the routine is run during editing.

2. The handles are drawn by the Vision Module, based on the data structure set up and updated by the *edit* routine.

   Your edit routine provides the information needed for the Vision Module to manage the handles. Whenever there is a change in the shape description, the edit routine is called to update the handle locations.

3. While the shape is being dragged using the mouse, the graphic is drawn by the edit-shape *draw* routine.

   Each record type that has a “shape” must have a draw routine. This routine displays an editing graphic based on the absolute shape parameters and other values in the data array. It should execute relatively quickly compared to the execution routine, especially for slow operations.

When a handle is clicked down on, the execution routine is called with the current position of the shape to erase the graphic. Then the draw routine is called to draw its version of the graphic. As the shape is dragged around the screen, the draw routine is constantly called to erase the graphic using the previous parameters and to redraw it using the new parameters. When the mouse button is released, the draw routine is called once again to erase the graphic. Then, the execution routine is called to draw the stationary graphic and compute new results. This procedure allows for swift editing and correct final results.

In addition, whenever any parameter is changed from the menu page, the record is executed using the old values (to erase) and reexecuted using the new values (to redraw). This is done to keep the graphics and results up to date with the data.

Editing Complex Shapes

If your record type wants to graphically edit a shape that has more than the six standard shape parameters, you will have to do some extra data maintenance on your own. You will naturally change the appropriate data-array value as part of handling mouse events. However, you must also write out the new value to the corresponding field in the database record. This is all that is needed if the extra parameter simply indicates an amount such as width or spacing.

If the extra parameters constitute a location or an angle, you need to keep track of both the relative and absolute versions of the parameter value, since the vision frame might come into play. (This is done automatically for the standard shape parameters.) Note, however, that only the relative version needs to be stored in the database. The absolute version should be kept in the "extended" data section of the data array, since it does not correspond to any of the database fields. When the edit routine is called with mode 0, the absolute version of the parameters should be calculated from the relative version so they relate properly to the other absolute parameters.

Shape Handles

The Vision Module manages which handles are drawn and when they are drawn. The record-type edit routine specifies the style of each handle and sets the positions for them to appear. The locations of the handles are also used to determine when a handle has been "hit" or clicked down on. Details on the data structure for handles can be found in the section "Handles for Shape Manipulation" on page 59 and in the dictionary page for the edit routine (see **vrec.edit( )** on page 103).

Whenever the edit shape is stationary, all the handles are drawn. If the user has clicked on and is dragging a handle, only that handle is displayed, and all the other handles are turned off temporarily. Also, when the user clicks on the image but misses all the handles, the handles are erased until the user releases the mouse button. This feature allows the user to see the shape unobscured by the handles.

When the edit routine is called upon to set the handle positions, it must specify them in absolute millimeter coordinates. To make this easy, we provide two routines that allow you to compute the location of the handle using Cartesian or polar coordinates relative to the x, y, and *angle* location of the shape. The routines are:

ve.setr.handle( ) Cartesian handle specification with relative angle
ve.setr.phandle( ) Polar coordinate specification with relative angle

We encourage the use of these routines. For an example, see the Line Finder edit routine **vw.fl.edit( )** in the file VFINDERS.V2.

Shape Editing Actions

The Vision Module (by means of the standard page routine) monitors mouse clicks in the Vision window. When a down-click is close enough (within 20 pixels) to a handle, that mouse event and all others until the next up-click are packaged into standard "events" and passed on to the edit routine. The edit routine then alters the shape parameters based on which handle is being dragged and the relative changes in the mouse position.

When a mouse event is passed to the edit routine, the information includes the index of the active handle and the (x,y) coordinates of the mouse. Although there are several ways to adjust the shape

based on this information, the following describes the method used for the standard Adept record types. There are useful standard support routines for this method.

When a down click comes in, save the location of the mouse and the value(s) of the parameter(s) that will be affected by mouse moves while attached to this handle. When subsequent mouse moves come in, compute relative changes to the parameter value(s) based on the relative change in the mouse position. (Often, at the down click, we also save the location of a reference point. We then use the change in the mouse location relative to the reference point as the basis for changing the parameter[s].)

This may seem a bit indirect, but it avoids many problems that arise when a 2-D mouse pointer is used to position handles that are not free to move just anywhere, but may be constrained by the geometry of the shape. For example, say you want to change the width of a window without rotating it. The width handle for a window is constrained to move only along a line. Using the reference-point scheme, the mouse may still control the handle while not necessarily having to stay right on top of it. Most importantly, editing works fairly intuitively.

There are several standard routines provided for altering shape parameters based on mouse events on certain handles. The principle is that you pass in the event, which has the mouse location, the parameter value that will be altered, and possibly some reference points. On the down click, the original values of all these are memorized in local variables. Then, when the mouse move occurs, the routine computes the appropriate new parameter value based on the new mouse location relative to the reference points. These routines are all described fully in Chapter 8, but we briefly describe them here. They are:

ve.mv.ang( )	For a single rotation or angle handle
ve.mv.arcpt( )	For one of three points that form an arc
ve.mv.dim( )	For dimension handles half their value away from the reference point (for example, width or height of a window)
ve.mv.pos( )	For position handles
ve.mv.rad( )	For radius handles
ve.mv.rot( )	For multiple rotation handles
ve.mv.sides( )	For moving one side (only) of a rectangle
ve.mv.rsides( )	For moving one side of a rotatable rectangle

We encourage use of these routines, since they are already debugged and almost any other implementation would be a duplication of code and effort. For an example of some of these routines in action, see the Line Finder record-type edit routine **vw.fl.edit( )** in the file VFINDERS.V2.

Other Editing Events

Parameter changes and mouse events comprise the vast majority of the editing actions that occur and, thus, have to be handled by the editing routine. However, there are a few other editing events you need to be aware of.

When a “delete record” event comes in, it means that the current record is about to be deleted. This may happen by the user specifically requesting to delete just the current record, or it may happen as a result of the entire database being deleted. Any large global arrays (especially string arrays) that have been used by the record should be deleted. For example, when prototype or font records are deleted, the prototypes and fonts associated with them are also deleted from vision memory. Also, if a record accumulates statistics, the statistics arrays should be deleted at this time, using the standard routine for that purpose.

The GOTO and SELECT events are passed in with an indication of which data value was current at the time. The GOTO event occurs when either a field is double-clicked on, or a field is highlighted (blue) and either the "Go/Goto" pull-down item is selected or the **Go To** (**F3**) function key is pressed. The SELECT event occurs if a field is highlighted and either the "Go/Select" pull-down item is chosen or the **Display** (**F5**) function key is pressed. (These events are currently ignored by all the standard record types.)

3.10 Repeat Records

A repeat record is one that has the potential of returning many instances of the same result. The standard record types that have this capability are listed in Table 3-11.

Table 3-11
Standard Record Types That Can Repeat

Record Type	Results That Are Repeated
Rulers	Multiple edge points along the ruler
Arc Rulers	Multiple edge points along the ruler
Blob Finders	Locations and features for multiple blobs
Prototype Finders	Locations for multiple proto-instances
Frame Patterns	Frame instances from the pattern of vision frames

You should note that the above list contains both vision-tool and computed-feature record types. Any (custom) record type can be made to be a repeat record type as long as it has the basic property of being able to produce multiple instances of the same result. The record type simply needs to set certain status flags and return certain error codes at the correct times.

Repeat-Enabled Flag

On the menu pages for most of the standard repeat-capable record types, there is a check box for enabling or disabling repeat mode for any particular record. There is a reserved bit in the flags byte of the vision records for this flag. The bit-mask variable for this bit is **vw.flg.repeat**. Therefore, to test if the current record is set to be a repeat record, use the following instruction:

```
IF data[vs.flags] BAND vw.flg.repeat THEN
```

Repeat-State Variable

There are several phases or states that a repeat record can be in during execution. This "repeat state" is recorded in the data array in the element "data[vs.more]". The possible states and their corresponding values are listed in Table 3-12.

Table 3-12
Descriptions of Repeat States

Value of data[vs.more]	Description of Repeat State
vw.stt.go	Not yet evaluated successfully. If the status value (data[vs.status]) is nonzero, evaluation was attempted, but there was a bad source record.

Table 3-12
Descriptions of Repeat States (Continued)

Value of data[vs.more]	Description of Repeat State
vw.stt.more[vi.db[TASK( )]]	All previous evaluations have been successful and there may still be more results to get.
vw.stt.mdone	The last evaluation was not successful. If the status value (data[vs.status]) is “ec.no.more”, the repeat record is simply exhausted (no more results). Otherwise, the record failed on the first try.

Rules of Operation

When a record is used as a repeat record, it has to set the variable **data[vs.more]** to the correct value at the correct time. This section details the rules for doing this.

Prior to execution of the record, the value of **data[vs.more]** is preset (by the Vision Module) to the value **vw.stt.go**. When the record is executed the first time, it checks the status of its source records first (this is done automatically for the vision frame and picture sources of a vision tool). If any source record is bad (nonzero status), that status should be returned and **data[vs.more]** should be left with the value **vw.stt.go**. If the sources are all okay, execution can continue.

Once sure that the source records are okay, the routine then needs to check the value of **data[vs.more]**. If it is equal to **vw.stt.more[vi.db[**TASK( )**]]**, the record is executing as a repeat request (that is, not the first time). It must then check to see if there are more results to return. If there is another instance of results available, they are simply assigned into the results array and execution completes successfully, leaving **data[vs.more]** alone (with the value **vw.stt.more[vi.db[**TASK( )**]]**). If there are no more results, the status value **data[vs.status]** should be set to **ec.no.more** and **data[vs.more]** should be set to **vw.stt.mdone**.

If the value of **data[vs.more]** is not **vw.stt.more[vi.db[**TASK( )**]]** at the start of execution of the record, the record must try to execute successfully a first time. If it fails, it should return the appropriate status code (that is, the same as if it were not a repeat record) and set **data[vs.more]** to **vw.stt.mdone**, which indicates there are no more results with which to repeat. If the record succeeds on its first time, **data[vs.more]** should be set to **vw.stt.more[vi.db[**TASK( )**]]**, indicating that there may be more results with which to repeat.

Example Pseudo-Code for Repeat Records

We now present two examples of how you might integrate the appropriate code into a custom record type. This may happen differently, depending on how you actually generate the multiple results. For example, the two standard record types, Rulers and Blob Finders, compute the multiple results in very different ways.

A Ruler record gets all the edge point locations at once, since this is the natural way that the VRULERI program instruction works. On subsequent repeat requests, it then simply computes the location coordinates of the next edge point and puts them in the POINT value slots of the results array.

A Blob Finder, on the other hand, gets the location and statistics for only the first blob on the first execution pass. Then, when each repeat request comes along, it executes another VLOCATE instruction to pull the data for the next blob from the vision queue. A Blob Finder knows that there are no more results available only if a VLOCATE fails.

Code such as the following can be used if all the results are computed during the first execution (as with Ruler records):

```
IF data[vs.flags] BAND vw.flg.repeat THEN
     IF data[vs.more] == vw.stt.more[vi.db[TASK()]] THEN
          IF <more results to return> THEN
               <compute and store new results in “results[]”>
               data[vs.status] = 0
          ELSE
               data[vs.more] = vw.stt.mdone
               data[vs.status] = ec.no.more
          END
          GOTO <end>
     END
     data[vs.more] = vw.stt.more[vi.db[TASK()]]
END
<normal record execution>
<store results in “results[]”>
<end>
```

Code such as the following can be used if more results are determined at each repeat request (as with Blob Finder records):

```
     IF data[vs.flags] BAND vw.flg.repeat THEN
          IF data[vs.more] == vw.stt.more[vi.db[TASK()]] GOTO 10
          data[vs.more] = vw.stt.more[vi.db[TASK()]]
     END
     <normal record execution - priming for getting results>
10   <get a result>

     IF <failure> THEN
          IF data[vs.more] == vw.stt.more[vi.db[TASK()]] THEN
               data[vs.more] = vw.stt.mdone
               data[vs.status] = ec.no.more
          ELSE
               data[vs.status] = <appropriate error status>
          END
          GOTO 20
     END
     data[vs.status] = 0
     <store results in “results[]”>
20   <end>
```

These examples have been included to show how the setting of **data[vs.more]** relates to the execution (and failure) of the record. By themselves, these examples are very incomplete templates—they should be used with the sample routines and examples provided later in this manual.

Using Repeat Records

Repeat records do not do any repeating themselves, but rather they have the capability of returning different information if they are executed repeatedly in a certain way. Therefore, there is always a “master repeater”, of sorts, that is repeatedly requesting the next instance of the results from the “slave” repeat record. This master repeater usually collects and combines the results in some useful way. In the Vision Module, there is a category of record types called “combination

records" that act as master repeaters, collecting the results from each repetition and combining them in useful ways.

Presently, there is only one standard combination record type: the Value Combination. This record type collects numeric values and combines them by computing statistics.

However, the general category of combination records could include such operations as combining points into a least-squares line or circle, or combining vision frames into a least-squares vision frame. Custom combination record types can be created using the instructions in Appendix E.

3.11 Accumulating Statistics

The Vision Module automatically accumulates statistics on the results of inspection records (if the user has not deselected the check box on the record's menu page). The "Vision Results" page displays the statistics and displays charts of them upon request. This same mechanism is available to custom record types.

To check the status of the check box, perform:

Show ➡ Vision Results

Select ☑ **Accum. stats** to enable the automatic accumulation feature.

In addition, the same inspection results can be automatically logged to a disk file or serial line. Since this feature is implemented as part of the statistics accumulation capability, some aspects of it are mentioned in this section, but more details are given in the next section.

If this is your first reading of this chapter, or if you do not need to accumulate statistics for your custom record type, you may want to skip this section.

Background

Statistics are accumulated in "bins". Bins are used as a memory-efficient means of supporting X-bar charts, R-charts, and P-charts. Each bin normally holds from 1 to 10,000 results (samples) for Boolean inspections, and 1 to 200 results for real-valued inspections. There is a separate bin for each different type of value to be accumulated for each inspection. A recent history of 50 bins is normally kept for each statistic. The bins are stored in the following arrays:

Array Name	Description
qc.cnt.ok[key,n]	Number of passed inspections in bin "n"
qc.cnt.fh[key,n]	Number of high failures in bin "n"
qc.cnt.hi[key,n]	Number passed with high warning in bin "n"
qc.cnt.lo[key,n]	Number passed with low warning in bin "n"
qc.sum[key,n]	Sum of the values in bin "n"
qc.sum.sq[key,n]	Sum of the squares of (value-nominal)
qc.min[key,n]	Minimum value in bin "n"
qc.max[key,n]	Maximum value in bin "n"

where “key” is a unique identifying number for each set of statistics. The key is provided when you initialize the statistics arrays, and it must be used to accumulate statistics at runtime.

> **NOTE:** The list of arrays above is only for your general information. You will never have to access them directly. Your custom record type accumulates statistics only via calls to standard routines.

Routines

The following two routines are used to accumulate statistics:

qc.set.acc.stat( )	Setup and maintenance
qc.accum.stats( )	Runtime accumulation

The routine **qc.set.acc.stat( )** allocates, changes, or deletes the arrays used for accumulating statistics. The routine **qc.accum.stats( )** is called at runtime to accumulate the statistics on a single result. See Chapter 8 for details on the calling sequences of these routines.

Programming Examples

In the custom record-type definition routine, you must define indexes into the data array for one or more keys. These indexes should be at and above the value **vs.usr.nums**. This marks the start of the section of the data array reserved for “user numbers”. For example, assume you want to accumulate statistics on two values: “Part width” and “Part height”. Then you need to define two slots in the data array, so you can store the keys there between initialization and accumulation. Here is what this might look like (in your definition routine) using the prefix “mon.” for your record type:

```
mon.key1 = vs.usr.nums ;Data-array index for part width
mon.key2 = mon.key1+1  ;  "    "    "     "  part height
```

In the set-data routine, you must call the setup routine to allocate and initialize the statistics arrays. This should be done only in the preruntime calculation mode (mode 1) of the set-data routine, and not at any other time.

Here is an example using some temporary descriptive variables. The program initializes the statistics arrays for both values. In return, it gets back two key numbers and stores them in the data array at **data[mon.key1]** and **data[mon.key2]**. Notice that these variables for the key values are initialized to zero before being used as input variables. This signals the routine **qc.set.acc.stat( )** to allocate new key numbers.

The last two parameters in the call of the setup routine pertain to the logging of results. In this example, we do not want data logging, and thus we specify zero for the logging mode and an empty label string. See the next section for a description on how to enable logging for a result.

> **NOTE:** The CALLs below are shown on two lines only because of the limitations imposed by the printed page. They each must be completed on a single line in an actual program.

```
bsize = 10           ;Bin size

lim[vi.lim.max] = 30 ;Maximum part width
lim[vi.lim.hi] = 28  ;High warning limit
lim[vi.lim.min] = 20 ;Minimum part width
lim[vi.lim.lo] = 22  ;Low warning limit
lim[vi.lim.nom] = 25 ;Nominal part width
```

```
data[mon.key1] = 0   ;Request a new key number
CALL qc.set.acc.stat(0, data[mon.key1], data[vs.p.rec], FALSE,
                                bsize, "Part height", lim[],0, "")

lim[vi.lim.max] = 80  ;Maximum part height
lim[vi.lim.hi] = 77   ;High warning limit
lim[vi.lim.min] = 72  ;Minimum part height
lim[vi.lim.lo] = 66   ;Low warning limit
lim[vi.lim.nom] = 64  ;Nominal part height
data[mon.key2] = 0   ;Request a new key number
CALL qc.set.acc.stat(0, data[mon.key2], data[vs.p.rec], FALSE,
                                bsize, "Part height", lim[],0, "")
```

If you have used a check box on your menu page to allow the user to optionally accumulate statistics on a record-by-record basis, you need to make the above code conditional on the setting of the check box. In the case where the user has turned off the accumulation of statistics, the keys need to be set to zero. For example, if your flag for allowing statistics is in **data[mon.accum.stats]**, you would do something like this:

```
IF data[mon.accum.stats] THEN        ;If statistics allowed...
     ; Use the initialization code from above here.
ELSE
     data[mon.key1] = 0 ;0 => no allocation
     data[mon.key2] = 0
END
```

In your edit routine, record deletions should be captured so that the memory allocated for the statistics arrays can be deleted as follows:

```
CASE mode OF
  VALUE -1:               ;Mode -1, first entry to menu page
  VALUE 0:                ;Mode 0, initialize (redraw)
     ...
  VALUE 1:                ;Mode 1, set handles
     ...
  VALUE 2:                ;Mode 2, process event
     CASE event[0] OF
       VALUE ky.cut.rec:  ;If deleting record, delete arrays
          CALL qc.set.acc.stat(2, data[mon.key1])
          CALL qc.set.acc.stat(2, data[mon.key2])
     ...
```

If you have allowed the user to control the parameters for statistics accumulation through the menu page, you need to set up the statistics arrays again when these parameters are changed. More specifically, if the user can turn on and off the accumulation of statistics (for example, via a check box), change the bin size, or change the user-specified control values (minimum, nominal, etc.), the edit routine should make a call to the statistics setup routine to delete or modify the statistics accumulation.

If statistics accumulation is being turned off, the statistics arrays need to be deleted. In this case, the same code used when the record is deleted can be used (see above).

If the bin size or the user-specified control values are changed, the setup routine needs to be called again—in a different mode with the new parameters—as follows:

```
CALL qc.set.acc.stat(1, data[mon.key1], ...)
CALL qc.set.acc.stat(1, data[mon.key2], ...)
```

Finally, in the execution routine, calls must be made to record the results of the evaluation. Using some descriptive local variables again, your code might look like this:

```
key1 = data[mon.key1]
key2 = data[mon.key2]
CALL qc.accum.stats(key1, qc.stats[key1,], width.ok, width, stt)
CALL qc.accum.stats(key2, qc.stats[key2,], height.ok, height, stt)
```

where **width.ok**, **width**, **height.ok**, and **height** are the particular results you are interested in analyzing. Note that you pass in both the value and the pass/fail status of the value. That is, if the width measurement passed the inspection, **width.ok** should be TRUE. Otherwise, it should be FALSE. Similarly, **height.ok** should reflect the result of the height measurement. The variables **width** and **height** should be set to the actual width and height measured, respectively. The return variable **stt** is set to a standard error code if an error occurs with the file being used for data logging (when applicable).

> **NOTE:** In the above examples, except for the routine names and the variable names starting with two-letter prefixes, we have used arbitrary variable names. You should not feel compelled to copy them verbatim.
>
> Also, these examples were done for accumulating statistics on two values per record. Obviously, if you had only one value on which to collect statistics, you would not need two calls to perform each operation.

3.12 Logging Results

Logging of results is a built-in function of the Vision Module that works in conjunction with the accumulation of statistics. Only results that are having statistics accumulated for them can be logged. The results can be logged by writing them to a disk file or outputting them to a serial line. There is a top-level pull-down under the "I/O" heading called "Log Results". This selection displays a pop-up window that allows you turn on (or off) logging and choose the destination of the logged results.

> **NOTE:** In a dual-vision system, there will be a different destination specification for each task. They must be different to avoid conflicts.

For each individual result being accumulated, logging can be enabled for all values, enabled just for values that fail, enabled for values that fail or pass with warnings, or disabled completely. In addition, since there may be multiple results being logged, each result can have a three-character label. The logging mode (on, off, etc.) and the label are established using the setup routine for accumulating statistics, **qc.set.acc.stat( )**.

Logging for Custom Record Types

The Inspection record type is the only standard record type that accumulates statistics, and thus it is the only standard record type that can log results. To set up logging for a custom record type, first set up the record for accumulating statistics on the result or results of interest. Then choose the logging mode (1 for all, –2 for only warnings and failures, or –1 for only failures) and a label (up to three characters) for each of those results. Include them as parameters in calls to the setup routine for statistics accumulation as follows:

```
CALL qc.set.acc.stat(0, ..., log.mode, $label)
```

If you look at the menu page for an inspection record, you will see that the user can alter the logging method and label individually for each inspection. This is also a good idea for any custom

records that use logging. To do this, use one of the mode parameters for the logging mode and one of the data strings (**$data[vs.str.1]** or **$data[vs.str.2]**) for the logging label.

Customizing the Logging Output Format

When a result is logged, it is written either to a disk file or to a user serial line. The data format is completely flexible, but it is initially set up to be a single string for each result logged. The actual formation and output of the data is performed in the routine **qc.trans.stats( )** located in the public file QCLOG.V2. This routine can be customized to formulate and output the data any way you want.

In this routine, the WRITE instruction is used to output to the correct destination. The global variable **qc.log.lun[**TASK( )**]** holds the value of the logical unit number associated with the user-specified disk file or serial line for the vision task being executed. Therefore, program lines of the form

```
WRITE (qc.log.lun[TASK()], 0) <data-line>
```

are used to output each consecutive data line. The data line (which is represented by "<data-line>" above) must be formatted in the standard manner for V+ output. This format is described in the *V+ Reference Guide* under the TYPE instruction. (The TYPE and WRITE instructions have identical styles for output formatting.)

The Default Logging Format

The default format for the data is

```
<label string>,<pass/fail indication>,<result value>
```

which is output with this format specification:

```
$label, ",", /I0, result, ",", $MID($ENCODE(/D,value),2,50)
```

That is, the label is first, followed immediately by a comma, then the integer "result" (the number of digits is flexible) and another comma—all with no spaces. The last number to be output is the "value"—in this general case it has undetermined format and precision. It could be an integer or a very small (or large) floating-point number that requires scientific notation. To be on the safe side (that is, to make sure the format specified can fully represent the number), we use the default format (/D). However, since "/D" format always outputs a leading space, we use the $MID function to strip off that space. (The value 50 above is simply an arbitrarily large number that is sure to include the entire formatted number string.)

In the default output routine, the following code is used, so that the "result" value is actually output as "1" for TRUE (as opposed to "–1", the V+ value for the special variable "TRUE"). This code also echoes the directive to zero the statistics collection by outputting a marker in the data log (that is, the string "$ZERO" followed by the label).

> **NOTE:** The second WRITE instruction below is shown on two lines here only because of the limits of the printed page. It must be completed on one line in the program.

```
num = -result
IF num < 0 THEN
     WRITE (qc.log.lun[TASK()], 0) "$ZERO ", $label, /N
ELSE
     WRITE (qc.log.lun[TASK()], 0) $label, ",", /I0, num, ",",
```

```
            $MID($ENCODE(/D,value),2,50), /N
END
```

Example Alternative Logging Formats

Here we consider some possible alternative formats for the data line, based on what may be some common specific needs. First, if you knew that the values being reported would never have a useful precision of more than one decimal place, the output instruction could look like this:

```
WRITE (qc.log.lun[TASK()], 0) $label, ",", /I0, num, ",", /F0.1, value, /N
```

If you wanted to have the data log file always present the data in neat columns, and you knew the value was always less than 1000 (and greater than 0) with a useful precision of 3 decimal places, the output line could look like this:

```
WRITE (qc.log.lun[TASK()], 0) $label, ",", /I0, num, ",", /F7.3, value, /N
```

If you wanted to make the output routine really straightforward, the code above could be rewritten as shown below. (The only drawback is the extra space in the output line, generated by the "/D" format.)

```
CASE result OF
    VALUE 1:                                ;Stats zeroed
         WRITE (qc.log.lun[TASK()], 0) "$ZERO ", $label, /N
    VALUE 0:                                ;Failed
         WRITE (qc.log.lun[TASK()], 0) $label, ",0,", /D, value, /N
    VALUE -1:                               ;Passed
         WRITE (qc.log.lun[TASK()], 0) $label, ",1,", /D, value, /N
    VALUE -2:                               ;Passed high
         WRITE (qc.log.lun[TASK()], 0) $label, ",2,", /D, value, /N
    VALUE -3:                               ;Passed low
         WRITE (qc.log.lun[TASK()], 0) $label, ",3,", /D, value, /N
END
```

> **NOTE:** For a description of the few global variables used in the data logging process, see "Support Variables for Logging Results" on page 84.

3.13 Results Page

The results page is displayed by selecting "Show / Vision Results" from the top-level pull-down menus. The routines to manage this display and perform all the calculations that accompany it are in the overlay file VISRES.OV2. This is a public file, so that the results page and the computations presented can be changed to meet the needs of each application. The charting page routines are also included in this overlay file.

3.14 Error Handling

During editing or runtime execution, you may need to or want to report errors. When a standard AIM status code is returned, it will be treated in a consistent way, based on the mode of operation of the system at the time.

During editing, errors can be generated either from the edit routine or from one of the runtime routines. If one of the editing routines returns an error as a response to a parameter being changed or some other undesirable edit action being attempted, this will be reported to the operator in a very obvious way. However, if an execution routine returns an error during editing, it is basically

ignored. Its occurrence will be evident, however, in the lack of results displayed on the menu page or the screen.

During runtime, errors can be generated by the preruntime mode of the set-data routine or by the execution routine. Any such error will stop the runtime and require a user response from the status window. The set-data routine has a return argument for error status. An error returned with this argument will be reported during the preruntime preparations. The execution routine does not have an error-status return argument. Instead, the status code is assigned to the **vs.status** element of the data array for the record being executed before marking the record as being "done". This status is then accessible to any subsequent records that desire to use the results of the record. Therefore, this element should be checked before attempting to access the results array for a record.

During the walk-thru training mode of runtime, the status of each executed record is checked as soon as it is executed, and the operator is notified. If the operator "proceeds" at this point, operation continues and the status code is unchanged, which is similar to what would happen if walk-thru training was not enabled. This normally leads to a subsequent record failing when it tries to make use of the first failed record.

Standard AIM status codes are the only valid error indicators allowed. The value zero always means okay. See the *AIM Customizer's Reference Guide* for a complete list of status codes. Each status-code value has an associated global constant, which can be assigned to error-return variables.

3.15 Creating a Custom Record Type

Record Type Creation

This section summarizes the steps you should follow when creating a custom record type. The order is not critical but is suggested to give you a progressive and orderly approach. (Note that it is common to move on to the next step before completely finishing a step, and to return later to the incomplete step when more information is available.)

1. Establish a clear idea of the purpose of this record (what the execution of it will do) and what information (data) is needed to do the job.

   Think about how you would like this information to be presented and edited (maybe visually). Key considerations are:

   a. Is there a shape to position on an image?

   b. Is this an "information-only" record type? (That is, one that is not executed at runtime.)

   c. Are there raw values, which result from executing this record, that you will want to test in an inspection? (As opposed to using for measurements, etc.)

   d. Will the record normally be used as an argument to sequence statements (that is, is it top level by default)?

   e. After execution, do you want some graphic representation of the results?

2. Determine what types of source records are needed. How many?

3. List the data items you need to define and store in the record.

4. List the data items that can be computed / extrapolated from the basic data, and therefore do not need to be stored (often there are none of these items). (These items are computed at pre-runtime [and during editing] to improve execution speed.)

5. Choose the class(es) to which this record type belongs. Does it produce a line, a vision frame, just a point? (A record can be in multiple classes.)
6. Write the record-type definition routine with help from the example.

   This routine is the best place for you to decide where each data item will appear in the data arrays (and, indirectly, in the database) and in the results array. Even if you will always refer to your data and results using the standard names for the indexes, you should document here which elements in the arrays are used for which values. There is no place more appropriate for that documentation.

   All the global variables unique to the record type should be defined here, since this routine will be executed at AIM start-up. (To save memory, the definition routine is deleted after it is executed. The global variables and their values will remain, but the code that assigned the variables their values will be gone.)
7. Write the execution routine. (This usually helps you refine the previous step).
8. Create the menu page(s) for editing the record. Put the menu-page names in the definition routine. (Creating a menu page for your vision operation will help you refine the previous steps.)
9. Using one of the example record types provided, write the set-data, edit, and draw routines.
10. Double check the correspondence between database field numbers referenced in the menu page and the data positions in the array **vw.data[„]**. (For tables detailing this correspondence, see “Correspondence Between Database and Data Arrays” on page 35.)
11. Install the record type following the procedures described in the next section.

3.16 Installation

Before installing your record type(s), decide whether or not to group any set of them together. If you have two or more that logically belong together, and you never expect to need to enable or disable them independently, then you should probably keep them all in one file group. For examples of grouped record types, see the “Finders” and “Compute Features” initialization records in VWRTINI; for a non-grouped one, see “Conditional Frame”.

For the sake of discussion here, we will call the initialization grouping of record types a “record type module”, whether there is one or several in a group. Each record type module has three files that use a common starting letter (“V”) and common base string (to be chosen by you and specified in the initialization database record).

Name	Contents	Header Routine Name
V<base>.OVR	Overlay routines for initialization.	v<base>.ovr
V<base>.SQU	Execution and editing routines.	c.v<base>
V<base>.MNU	Menu pages.	N/A

For a single record type module, you will specify the record type number and record type definition routine in the initialization record. The definition routine will be the only routine in the initialization overlay file.

For a multi-record type module, the initialization file contains all the record type definition routines for the record types, plus an additional short routine that returns a list of the record type numbers and definition routine names. It has the form:

```
.PROGRAM **.init.***(rec.types[], $def.rtns[], stt)

; ABSTRACT: This routine simply returns a list of the record type
; numbers and definition routines needed to initialize them.
;
; If this group/module of record types should not be used for some
; reason, then the status should be set to non-0.
;
; INPUT PARM.:  None
;
; OUTPUT PARM.: rec.types[] List of record type numbers.
;                           [0] is the number of record types.
;               $def.rtns[] List of record types definition routines.
;               stt         Standard AIM status code.
```

For an example of such a routine, see the file VFINDERS.OV2. In the initialization record, you will specify “0” as the record type number and give the name of the above routine as the definition routine.

To install a new record type:

1. Choose a simple 3-5 character base string, such as “OCR” or “SFRM”, to serve as the root of all the file names. All files names will start with “V” and be followed by this base string.
2. Place the definition routine(s) in an overlay file (.OVR) with the name V<base>.OVR. (Use the form Vxxx.OV2 and squeeze to Vxxx.OVR.)
3. Put the execution and editing support routines into their own .SQU file with the name V<base>.SQU. (Use the form Vxxx.V2 and squeeze to Vxxx.SQU.)
4. Place the menu pages in a file named V<base>.MNU.
5. Add a record-type initialization database record in the USERINI.DB file or other custom initialization database file. (We recommend that you COPY and PASTE an existing record-type initialization database record to reduce the work and maintain uniformity.) The steps are:
    a. Decide which initialization database file to put the record in.
    b. Perform **Special ➡ Edit Init Data**. Select the initialization database file to copy an example from and go to the record you wish to copy. (Select a single or multiple record type module similar to the one you are adding.)
    c. Perform **Edit ➡ Copy Record** to copy the record.
    d. Perform **Special ➡ Edit Init Data**. Select the initialization database to which you would like to add the record type module's initialization (probably USERINI.DB or USRRTINI.DB).
    e. Perform **Edit ➡ Paste Record** to paste the record.
    f. Type an appropriate name in the record name field.
    g. Edit the **Description** field as needed.
    h. Edit field **#B—**type the record type number (for a single-record type module) or 0 (for a multi-record type module)

i. Edit field **#$A**—type the base string for the module (in lowercase letters).

j. Edit field **#$B**—type the initialization routine name (in lowercase letters).

k. Edit field **#C**—type "0" to identify it as a non-Adept record type.

You are now done installing. To activate:

l. Perform **Setup ➡ Initialization Data**. Select the initialization database that should have the new record type page in it.

m. Select ☑**Enabled** and choose ☐**Press to make changes NOW**.

The new record type is now installed.

6. To test the new record type perform:

   Edit ➡ Vision ➡ Edit ➡ New Record and try creating a new record using the **New Record** page.

3.17 Example—The Line Finder

Using the general approach outlined in the previous section, we now go through the creation of a new record type—the Line Finder. The Line Finder already exists as a standard record type, and its routines are in the public file VFINDERS.V2. We will go through the thought process you would use to create these routines if they were not already written. You can refer to the routines to see how they are actually written.

There are several places below that refer to the routines in the public file VFINDERS.V2. The accompanying text elaborates on and explains the routines, and it is assumed that you are reading this section and those routines in a side-by-side manner.

1. Define the purpose of the operation and think about key information.

   The purpose of this record type is to find a line in an image using the VFIND.LINE instruction. Therefore, the key ingredients are a valid picture in which to operate and the parameters to the VFIND.LINE instruction.

   In addition, we would like to be able to use the operator relative to an arbitrary vision frame. However, since that situation is handled automatically by the Vision Module, we don't have to worry about it.

   The operator has a shape and dimensions that should be editable by the user via the mouse. The record should generate results that fit in the line class, so that it can be used as a source record for other records that need lines. However, since most statements do not accept a LINE as an argument, the record should not be top-level by default.

   There are a few results that users might want to test directly using the test-a-value inspection option—for example, the maximum error distance along the line. These will be defined in the definition routine, and you will need labels for them (up to 32 characters). Also, you will need to decide which of these results would be the default result to test if it were chosen as a test-a-value record.

2. What types of source records will be needed? How many?

   There is one source other than the vision frame, and that is a picture record. It is to be selected from among the picture class.

3. List the data items you need to define and store in the record.

In addition to the regular parameters to the VFIND.LINE instruction, we also should set the V.EDGE.STRENGTH parameter for the picture's virtual camera (Picture record) before performing the vision tool. Therefore, we need to store the mode (search direction), the effort level, the edge strength, and the shape parameters in the database.

4. List the data items that can be computed at preruntime.

   There are none for this record.

5. Choose which classes this record type will belong to.

   This record should be in the line, test-a-value, and vision-tool classes. (The vision-tool class exists only so that its member tools can be displayed by the Show pull-down menu.)

6. Write the record-type definition routine.

   We now know enough to write most of the record-type definition routine. (See the routine **vw.fl.def( )** in the file VFINDERS.OV2.) Notice how the parameters for mode, effort level, and edge strength were put in the general parameters section (called modes), and the indexes were given descriptive names for easier future reference (for example, "vs.eff" is more clear than "vs.md3").

   The record is defined to have only one source, from the picture class. Next, the indexes to be used for the results array are defined.

   > **NOTE:** This record type is defined as a vision tool (array element **def[vw.td.vtool]** is set to TRUE). This means it is expected to have a picture record as source 1. In return, many runtime chores common to vision tools will be done for you before the execution routine is called.

   Finally, the record is added to each of the classes to which it belongs: line, vision tool, and test-a-value.

7. Write the execution routine.

   Now that we know the indexes into the data array for all the needed information, we can write the execution routine. See the routine **vw.fl.exec( )** in the file VFINDERS.V2.

   There are several things missing here that would normally be done in an execution routine. In this case, they are not necessary because this is a vision-tool record type. First of all, the sources will have already been checked for success, so the execution routine can use the source results with confidence. Thus, the virtual camera for the vision tool is taken from the results of the picture (source 1). The shape parameters will have been converted from being relative to the vision frame (if any) to being absolute shape parameters in the coordinate frame of the picture. This means the shape parameters in the data array can be used directly to perform the VFIND.LINE. Also, the frame buffer for the required picture source has automatically been VSELECTed.

8. Create the menu page(s) for editing the record.

   Copy an existing menu page—probably another vision tool that already has a picture source and a "Tool Loc" pop-up, since you will probably need them on your menu page. Modify the menu page to look like the page "line_finder" in the file VISTOOLS.MNU. Put the name of the menu page in the definition array specified in the definition routine.

9. Write the set-data and draw routines.

   The set-data routine needs to set up the default values in the database and data array when a new record is created. See the routine **vw.fl.data( )**.

Also write the editing routine. See the routine **vw.fl.edit( )**.

Write the draw routine that will display the vision tool using the absolute shape parameters and other data values. Since vision tools have a "dry.run" feature, we can make use of this to draw exactly the shape that will appear at runtime (but without actually finding the line). For uniformity among the standard vision tools, one draw routine is used for all of them. (See the routine **vw.tl.draw( )** in the file VFINDERS.V2.) However, if this is a unique new custom tool, you will probably want to create a separate draw routine.

10. Double-check the correspondence between fields in the database and elements in the data array.

    This is a typical place for confusing errors to occur in the design of a record type. The menu page will refer to your parameters by database field and index, and to the results using indexes to the control-variable array (**ai.ctl[ ]**). But all your routines will refer to the same data using indexes into the data and results arrays. Refer to Table 3-9 and make sure that the menu page is correct and that you have not inadvertently made double use of any elements in the data arrays.

11. Refer to section 3.16 for additional steps that may be required for your application.

3.18 Adding Custom Classes

Classes are used to group records that have similar uses based on the information in their results arrays. Classes are also used to define a group of records that is a valid choice for a source record on some menu page.

If you design a record type that needs a source that does not conform to any of the classes currently defined, you may want to define your own custom class to prevent users from inadvertently choosing the wrong record.

Classes are defined by the standard routine **vw.mk.new.class( )**.

This routine needs to be called prior to the definition of any custom record types in the routine ***.mod.init( )** in your application module start-up file. See the sample code supplied in that routine. Also see the dictionary page for the routine **vw.mk.new.class( )** on page 208 for details on the calling sequence.

If all the record types of a certain class are guaranteed to be defined in one initialization file, the routine **vw.mk.new.class( )** can be placed in that file. See the routine **vw.init.ocr( )** in the public file VOCROVR.V2 for an example.

A class is defined by the following items:

Name	A name to be displayed by the Vision Module when it refers to the class (for example, when selecting records in the class).
Draw routine	A routine that graphically displays the results in the vision window. (The graphics are based solely on the information in the results array.)
"New record" menu page	A menu page to be displayed when a user wants to create a new record that belongs to this class.
Draw colors	Both a color to use when drawing the results as the high-lighted item on the screen, and a color to use when the results are displayed dimly.

For the “New record” menu page, one of two standard menu pages should be used — “new_rec” (the default) for single-record type classes, or “new_class_rec”, which presents a scrolling list of the record types in the class.

To customize your “New record” menu page, we recommend that you copy one of the existing “new record” pages and modify the selections to apply to the record types for the new class. When a record type is selected, it must set the record-type number in **ai.ctl[56]**, and the new name must be assigned to **$ai.ctl[33]**. Both of these array elements *must* be defined before the menu page is exited.

The draw routine is called when a record is used as a source for another record and when you are choosing among several records that belong to one class. Like all other graphics for the Vision Module, the routine should draw in complement mode. In addition, it must return the position to draw a “pick” handle when this graphic is used as a means of selecting records. See the dictionary page for **vclass.draw( )** on page 93 for details on writing this routine.

3.19 Test-a-Value Class

The “test-a-value” class allows access to single results of certain vision operations. This class is formed automatically. You need only define the results you want to make available for testing in the record-type definition routine. For each testable result, you define a string label and data type (real or Boolean). Inspection records and Value Combination records will then automatically be able to use records of that record type as a source, and select the value to test from a scrolling window (constructed using the result labels).

Results Filter Routine

If further sophistication is needed in making results conditionally available for testing, you can write a “results filter” routine and specify the name of the routine in **$def[vw.td.res.filt]** in the record-type definition routine. The filter routine is called with the physical record number and record type of the record in question. The routine returns a list of Boolean indicators corresponding to the list of results formed in the record-type definition routine. This list of Boolean indicators is used to determine whether each testable result is displayed in the scrolling window as an available value to test.

For example, a filter routine is used by the standard Window record type to make sure only valid results are allowed to be tested, given the particular mode of operation being used for the window. That is, if it is an “Average graylevel” window, one is not allowed to select “Number of edge pixels” as a result to test. See the routine **vrec.res.filt( )** on page 112 for more details.

Defining a Source Class as Test-a-Value

If you are building a custom record type and wish to have one of the source records be from the test-a-value class, there are a few special things you must do.

First, you need to reserve certain of your mode elements in the data array (modes 0, 14, and 15) for specific purposes as follows:

```
;     vs.indx.1 = vs.md0         ;Index to test in src’s results array
;     ...
;     vs.data.type = vs.md14     ;0 = real, 1 = Boolean, 2 = string
;     vs.res.num = vs.md15       ;Number of result to test
```

The lines above should appear in your record-type definition routine. The variables are already defined, so the lines should be commented out as shown. See the Value Combination record-type definition routine **vw.def.combv( )** as an example.

One of your sources, preferably source 1, needs to be defined as being from the test-a-value class. If it is source 1, and it is the only source for a particular evaluation method (shown as "eval.meth" below), the following lines would appear in your record-type definition routine:

```
src.classes[eval.meth,0] = 1
src.classes[eval.meth,1] = ve.tst.class
```

Second, on the menu page for your record type you need a menu spawn button that specifies the menu page "select_tst_val" (which is located in the file VISUTIL.MNU). When this menu page pops up, it displays a scrolling window of the results that are available to test. When the operator has chosen one and pressed the "OK" button, the menu page exits, having set the array elements **data[vs.indx.1]**, **data[vs.res.num]**, and **data[vs.data.type]** appropriately.

The menu page "select_tst_val" works only if the test-a-value source is "source 1" for your record type. However, this is just because the spawn routine for the scrolling window is called with the **arg** value 1. If you need to have the test-a-value source be other than source 1, you must copy the menu page and change the value of **arg** for the scrolling window spawn routine to correspond to the source number of the test-a-value source; and, of course, you must update the name of the menu page and filename specified for the menu spawn button.

> **NOTE:** Using a source other than 1 as a test-a-value source in a custom record type is not a tested feature, but it should work. For the most reliable results, use source 1.

One subtlety worth mentioning is that **data[vs.res.num]** is the index into the "results definition array" (that is, **res.def[,]** in the definition routine), *not* the actual results array (**vw.res[vi.db[**TASK( )**],prec,]**). The array element **data[vs.indx.1]** is the index into the actual results array.

In your execution routine, the value to test will be in the results array of the test-a-value source record, at the index given by **data[vs.indx.1]**.

There are other special things you may want to allow for when constructing your record-type menu page. If you are going to allow for selecting both real and Boolean data, you may want to use the value of **data[vs.data.type]** to determine conditional display of the values selected to test. See the Value Combination menu page for an example.

Also, you may wish to display the label for the value that has been selected to test. The best way to do this is to assign the label to one of the temporary string control variables, such as **$ai.ctl[112]**, from within the refresh routine for your record type. Assuming the context of the refresh routine, the appropriate label string can be obtained as follows:

```
src.1 = data[vs.src.1]                    ;Source 1 record number
res.num = data[vs.res.num]                ;Result to test from source 1
IF src.1 AND res.num THEN
     rec.type = vw.data[vi.db[TASK()],src.1,vs.rec.type]  ;Record type
     index = vw.td.results[rec.type,res.num,2]            ;Start of label
     len = vw.td.results[rec.type,res.num,3]              ;Length of label
     $ai.ctl[112] = $UNPACK($vw.typ.def[rec.type,],index,len)
END
```

Chapter 4
Data Structures

This chapter documents the various data structures that are used throughout the Vision Module. It may be necessary or convenient for a customizer to know about these structures.

4.1 Handles for Shape Manipulation

When a record type has a shape to edit graphically using the mouse, the shape is manipulated by clicking and dragging on red "handles". The graphical appearance and the drawing and erasing of these handles are managed by the Vision Module, but the customizer specifies the type of each handle and where it is to be drawn.

One of the arguments to the edit routine is a list of handle descriptors. That list is stored in a two-dimensional real array (which we call **list[,]**) in the form:

list[0,0]	Number of handles in the list
list[n,*]	Handle descriptor for the nth handle to monitor for mouse events
list[1,*] list[et.pos,*]	Handle 1 is always the position handle for the shape and **et.pos** has the value 1 so that it can be used as a symbol for that index

The descriptor for the nth handle has the following elements:

list[n,et.type]	Type of handle to draw
list[n,et.x]	X coordinate of handle
list[n,et.y]	Y coordinate of handle

The handle type indicates the graphical appearance the handle will have. If the type is negative, the handle is ignored when clicking and drawing. If the type is positive, it must be one of these values:

et.htyp.dim	Dimension handle: a solid box
et.htyp.ang	Rotation handle: a small bull's-eye
et.htyp.pos	Position handle: a solid box with cross hair

When the edit routine is called in mode 0, it initializes the list of handles by specifying how many there are and filling in the type values. Then, when the edit routine is called in mode 1, it sets the X and Y coordinates of each handle based on the values in the data array.

When the edit routine is called in mode 2, if a mouse event has occurred, the index passed in indicates which handle was clicked on or moved. The routine can then adjust the values in the data array based on the relative movement of the handle.

4.2 Edit Action Events

The edit routine is notified of certain editing events by means of an array (which we call **event[ ]**). The standard format for this array is

event[0]	Standard event code (for example, **ky.dbl.clk**)
event[1]	First data value
...	(the data values are different for each event)
event[n]	Nth data value

The possible events are listed in Table 4-1 along with their respective data structures.

Table 4-1
Data Structures for Edit Action Events

Element in event[ ]	**Value**	**Interpretation**
0	ky.but.down	Mouse button 2 depressed
	ky.but.move	Mouse moved while button 2 down
	ky.dbl.clk	Double click on button 2
1	2	(Value is always 2)
2	<X coordinate>	X position of mouse
3	<Y coordinate>	Y position of mouse
0	ky.but.up	Mouse button 2 released
1	2	(Value is always 2)
0	ky.field.chg	Database field about to be changed
1	<field>	Field number Index
2	<index>	Index (if field is an array)
3	<bit>	Bit number (if value is used as a bit field)
4	<value>	New value to set (0 or –1 if bit field)
5	<index in data[ ]>	**vs.*** index corresponding to <field>:<index>
6	<bit mask>	Bit mask for bit (if any)
0	–ky.field.chg	Database string field about to be changed ($str = <new string value>)
1	<field>	Field number
2	<index>	Index (if field is an array)

Table 4-1
Data Structures for Edit Action Events (Continued)

Element in event[ ]	Value	Interpretation
3	0	(Not used)
4	0	(Not used)
5	<index in $data[ ]>	**vs.*** index corresponding to <field>:<index>
6	0	(Not used)
0	ky.aictl.chg	Value in **ai.ctl[ ]** about to be changed
1	0	(Not used)
2	<index>	Index to **ai.ctl[ ]**
3	<bit>	Bit number (if value is used as a bit field)
4	<value>	New value to set (0 or –1 if bit field)
5	0	(Not used)
6	<bit mask>	Bit mask for bit (if any)
0	–ky.aictl.chg	Value in **$ai.ctl[ ]** about to be changed ($str = <new string value>)
1	0	(Not used)
2	<index>	Index to **$ai.ctl[ ]**
3	0	(Not used)
4	0	(Not used)
5	0	(Not used)
6	0	(Not used)
0	ky.goto ky.display	Double click or **Go To** (**F3**) while on value SELECT or **Display** (**F5**) while on value
1	<db>	Database number (vi.db), or 0 if **ai.ctl[ ]**,
2	<field>	Field number, or -1 if **$ai.ctl[ ]**
3	<index>	Index (if field is an array)
4	<bit>	Bit number (if value is used as a bit field)
5	<index in data[ ]>	**vs.*** index corresponding to <field>:<index> (0 if not a database field)

Table 4-1
Data Structures for Edit Action Events (Continued)

Element in event[ ]	Value	Interpretation
6	<bit mask>	Bit mask for bit (if any)
0	ky.cut.rec	Record is about to be deleted

Notes:

1. Items enclosed in angle brackets ("<...>") represent descriptions of the values that would be present.
2. The variable **$str** is an argument passed into the edit routine when there is an event regarding a string value.

4.3 Data Arrays

The data arrays **vw.data[,,]** and **$vw.data[,,]** are used to provide quicker and simpler access to the information in the Vision database. Each column of data in the data arrays (accessed using a physical record number for the left-hand index) contains numeric and string data needed to edit and execute a vision record. The following sections list the indexes that a customizer may use to access the elements of the array.

> **NOTE:** The **vi.*** variables described below are defined in the routine **vi.db.names( )**, and the **vs.*** variables are defined in the routine **vw.def.vw.data( )**. Both of these routines are contained in the file VISMOD.OV2.

Duplicates of the Database Record Values

As described previously, the data arrays contain all the data in the Vision database. Refer to Table 4-2 and Table 4-3 for a list of the data-array indexes that can be used to access the database field data.

Table 4-2
Correspondence Between Real Data Array and Record Fields

Element in vw.data[,,]	Description	V+ Variable for Database Field or Index	Field Number	Index
vs.rec.type	Record type	vi.rec.type	4	
vs.type	Evaluation method	vi.eval.method	5	
vs.modes	Start of modes array	vi.modes	6	
vs.md0	Mode 0	vi.md.0	6	0
...	...	...	...	...
vs.md15	Mode 15	vi.md.15	6	15

Table 4-2
Correspondence Between Real Data Array and Record Fields (Continued)

Element in vw.data[„]	Description	V+ Variable for Database Field or Index	Field Number	Index
vs.shp	Shape	vi.shape	7	
vs.shape.desc	Start of shape-desc. array	vi.shape.desc	8	
vs.rel.x	Relative X coordinate	vi.shp.x	8	0
vs.rel.y	Relative Y coordinate	vi.shp.y	8	1
vs.rel.dim1	A linear dimension	vi.shp.dim1	8	2
vs.rel.dim2	Another linear dimension	vi.shp.dim2	8	3
vs.rel.a0	A relative angle	vi.shp.a0	8	4
vs.rel.an	Another relative angle	vi.shp.an	8	5
vs.flags	Flags byte	vi.flags	9	
vs.num.src	Number of sources	vi.num.sources	10	
vs.src	Start of source-record numbers	vi.src.recs	11	
vs.ref.frm	Vision frame (source 0)	element 0	11	0
vs.src.1	Source 1	element 1	11	1
...	...	...	...	...
vs.src.8	Source 8	element 8	11	8

Table 4-3
Correspondence Between String Data Array and Record Fields

Element in $vw.data[„]	V+ Variable for Database Field	Field Number	Index
vs.name	cc.name	0	
vs.str.data	vi.str.data	13	
vs.str.1		13	0
vs.str.2		13	1

Some of the index variables listed in Table 4-2 also have aliases that are more descriptive or more convenient in some situations. They are listed in Table 4-4.

Table 4-4
Alternate Data-Array Index Variables

Variable	Alternate Name	Comment
vs.rel.dim1	vs.dim1	Relative and absolute dimensions are the same
vs.rel.dim2	vs.dim2	
vs.rel.dim1	vs.dx	Box-shaped things are common, so there are shorter names
vs.rel.dim2	vs.dy	
vs.a0	vs.ang	Used when no second angle

The database values are stored in the real and string data arrays starting at element 0. The last elements in the data arrays used for database data are identified by the variables **vs.last.db** and **vs.last.str.db**.

The physical record number is also stored in the real data array, in the element with index **vs.p.rec**.

Flags Byte

The use of the flags byte in the data array is split: the interpretations of the high four bits (the “fixed-use bits”) are set by Adept and apply to all record types; the low four bits are available for general use and can have different interpretations for each record type. The interpretations currently assigned to the fixed-use bits are listed in Table 4-5.

Table 4-5
Fixed-Use Bits in Flags Byte

Bit	Bit-mask	Bit-mask_variable	Interpretation
8	^H80	vw.flg.rn.dsp	Show at runtime
7	^H40	vw.flg.top.lvl	TopLevel node
6	^H20	vw.flg.repeat	Repeat
5	^H10	vw.flg.orthog	Fixed angle

Absolute Shape Parameters

These values are the absolute shape parameters for the position and orientation of an editing shape in its reference picture. The values are updated automatically if the relative values (above) are edited directly via the menu page. When the user is performing mouse editing, the values are modified by the record-type editing routines (and the relative shape parameters automatically get updated).

Table 4-6 lists the variables that can be used as indexes to access these values in the real data array.

Table 4-6
Data-Array Index Variables for Absolute Shape Parameters

Variable	Description of Array Element
vs.x	Absolute X coordinate
vs.y	Absolute Y coordinate
vs.a0	Absolute angle
vs.an	Another absolute angle

Maintenance and Status Information

The real data array contains various values that are used for administration of the system. Table 4-7 lists the variables that can be used as array indexes to access those values. The table also lists variables that are used to represent status values.

Table 4-7
Data-Array Index Variables for Maintenance and Status Information

Variable	Description of Array Element
vs.ref.pic	Picture record in whose coordinate frame the results are stored (valid only if the record is "done" [that is, the evaluation state is **vw.stt.done[ ]**]).
vs.editing	TRUE if graphical editing is allowed. This element needs to be set by the record-type editing routine to indicate that editing is okay given the current state of the data values in the record.
vs.eval vw.stt.no.ref vw.stt.go vw.stt.done[ ]	Evaluation state of this record. This indicates the "completion" state—the possible element values are: Not referenced; not evaluated On evaluation list, ready to evaluate Evaluation is complete
vs.status	Status result of the evaluation (if it is done)
vs.more vw.stt.go vw.stt.mdone vw.stt.more[ ]	"Repeat" state of this record—indicates whether the record has not yet been executed, is exhausted or failed on the first try, or is ripe for repeating. The possible array-element values are: Not executed yet Done, repeat record exhausted More results available, can repeat successfully
vs.rpt.rec	When appropriate, the number of the repeat record that is associated with the record.
vs.ei.list	Number of the evaluation list created for this record. These lists are built for arguments in statements and for sources of Value Combination records.

Table 4-7
Data-Array Index Variables for Maintenance and Status Information (Continued)

Variable	Description of Array Element
vs.tree.done	Used to mark records that have been parsed already in recursive routines. This is a rolling number, like **data[vs.eval]**. The possible values are the same as those for **data[vs.eval]** (see above).
vs.vcam	Virtual camera for vision tools to use when setting their switches and parameters, and for passing to the vision instructions.

Variable-Data Sections

There are elements for general use at the end of each data array. These elements can be used for data that need to be stored on a per-record basis. Table 4-8 lists the variables that can be used as the indexes for the first element of variable data in each array.

Table 4-8
Data-Array Variables for Variable Data

Variable	Description of Array Element
vs.usr.nums	First item of variable data in real array
vs.usr.strings	First item of variable data in string array

String Data Array and Record Fields

Table 4-9 lists elements in **$vw.data[,,]** and their corresponding database fields.

Table 4-9
Correspondence Between String Data Array and Record Fields

Element in $vw.data[,,]	V+ Variable for Database Field	Field Number	Index
vs.name	cc.name	0	
vs.str.data	vi.str.data	13	
vs.str.1		13	0
vs.str.2		13	1

Vision Tool Record Types

The vision tool record types shown in Table 4-10 are found in the array element:

```
vw.data[vi.db[TASK()],prec,vs.rec.type]
```

Table 4-10
Vision Tool Record Types

Tool Name	Variable	Value
Arc Finder	vw.farc	13
Arc Ruler	vw.arul	9
Blob Finder	vw.blob	14
Computed Circle	vw.ccir	6
Computed Frame	vw.cfrm	7
Computed Line	vw.clin	5
Computed Point	vw.cpt	4
Conditional Frame	vw.sfrm	24
Correlation Finder	vw.corr	21
Correlation Template	vw.tmpl	22
Frame Pattern	vw.patt	20
Image Processing	vw.imgp	23
Inspection	vw.ins	1
Line Finder	vw.flin	12
OCR	vw.ocr	15
OCR Font	vw.font	16
Picture	vw.vpic	2
Point Finder	vw.fpt	11
Prototype Finder	vw.proto	18
Prototype Recognition	vw.prof	17
Prototype Template	vw.tmpl	22
Ruler	vw.rul	8
Value Combination	vw.combv	19
Window	vw.win	10

4.4 Results Formats for Standard Record Types

The following sections show the locations in the results arrays for each of the standard record types. In general, if you need to use one of these results in your execution routine, one of the source records for your record type must be defined to have the correct class. That is, the record

type that produces the results you are interested in must belong to that class. See the description of the record-type definition routine on page 26.

If you are using the results from source 2 of your record, the record number will be in the element **data[vs.src+2]** or, equivalently, **data[vs.src.2]** (where the array **data[ ]** is the data array for your record, which is passed in to all execution routines).

Assuming the current record number has been assigned to the (local) variable "src.2", the results are in the one-dimension array **vw.res[vi.db[**TASK( )**],src.2,]**. The specific results needed are at various positions in this array, depending on the record type of the source record. However, the results for a particular record may not be valid. To check this, make sure that the status value is zero in the data array for the source record (**vw.data[vi.db[**TASK( )**],src.2,vs.status]**).

The following sections show where each result is for the standard record types provided with the Vision Module. Each section presents the global variables that can be used as indexes into the results array. (The global variables **vw.r.**∗ are defined in the routine **vw.def.vw.res( )**, which is in the file VISMOD.OV2. The "alternate" variables listed are defined in the respective record-type definition routines for the standard record types.)

In general, an operation could place string results in the string array **$vw.res[,,]**. Currently, the only standard vision operation to use this feature is the OCR-Field type.

Inspection Record

Table 4-11 lists the variables that can be used to access the results from an inspection.

Table 4-11
Results-Array Index Variables for Inspection Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.r.value	Numeric result of inspection
vw.r.1	vw.r.dev.nom	Deviation from nominal value
vw.r.2	vw.r.result	Pass/fail indication
vw.r.3	vw.r.warn.hi	High warning indication
vw.r.4	vw.r.warn.lo	Low warning indication

Notice that the results indicating warnings do not specify pass or fail status. These indications are given whether or not the inspection failed. That is, they can be combined with the pass/fail indication **vw.r.result** to determine if the inspection failed low, passed with a low warning, passed with a high warning, or failed high. Once the results are accumulated into statistics, however, the warning counts are only for those results that passed but exceeded the warning limits.

Picture Record

Table 4-12 lists the variables that can be used to access the results from a picture record.

Table 4-12
Results-Array Index Variables for Picture Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.r.vcam	Virtual camera number to use
vw.r.1	vw.r.vis.sys	Vision system to use
vw.r.2	vw.r.frm.buf	Frame buffer picture is in
vw.r.3	vw.r.aoi	Number of AOI used (0 for none)

Camera Record

Table 4-13 lists the variables that can be used to access the results from a camera record.

Table 4-13
Results-Array Index Variables for Camera Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.r.vcam	Number of virtual camera that received the calibration

Computed-Point Record

Table 4-14 lists the variables that can be used to access the results from a computed-point record.

Table 4-14
Results-Array Index Variables for Computed-Point Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of point
vw.r.1	vw.y	Y coordinate of point
vw.r.2	vw.ang	Angle (always 0)
vw.r.3	vw.cos	Cosine of angle (always 1)
vw.r.4	vw.sin	Sine of angle (always 0)

Computed-Line Record

Table 4-15 lists the variables that can be used to access the results from a computed-line record.

Table 4-15
Results-Array Index Variables for Computed-Line Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of point on line
vw.r.1	vw.y	Y coordinate of point on line
vw.r.2	vw.ang	Angle of line
vw.r.3	vw.cos	Cosine of angle above
vw.r.4	vw.sin	Sine of angle above

Computed-Circle Record

Table 4-16 lists the variables that can be used to access the results from a computed-circle record.

Table 4-16
Results-Array Index Variables for Computed-Circle Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of center of circle
vw.r.1	vw.y	Y coordinate of center of circle
vw.r.2	vw.ang	Angle (always 0)
vw.r.3	vw.cos	Cosine of angle above (always 1)
vw.r.4	vw.sin	Sine of angle above (always 0)
vw.r.5		(Not used)
vw.r.6		(Not used)
vw.r.7		(Not used)
vw.r.8		(Not used)
vw.r.9	vw.rad	Radius of circle

Computed-Frame Record

Table 4-17 lists the variables that can be used to access the results from a computed-frame record.

Table 4-17
Results-Array Index Variables for Computed-Frame Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of origin

Table 4-17
Results-Array Index Variables for Computed-Frame Record (Continued)

Variable	Alternate Name	Description of Element
vw.r.1	vw.y	Y coordinate of origin
vw.r.2	vw.ang	Angle of X-axis
vw.r.3	vw.cos	Cosine of angle above
vw.r.4	vw.sin	Sine of angle above

Ruler Record

Table 4-18 lists the variables that can be used to access the results from a ruler record.

Table 4-18
Results-Array Index Variables for Ruler Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of nth edge point
vw.r.1	vw.y	Y coordinate of nth edge point
vw.r.2	vw.ang	Angle (always 0)
vw.r.3	vw.cos	Cosine of angle above (always 1)
vw.r.4	vw.sin	Sine of angle above (always 0)
vw.r.5	vw.r.1st.last	Distance from first to last edge
vw.r.6	vw.r.rpt.nth	Number of the edge point reported
vw.r.7	vw.r.edge.cnt	Number of edges found (edges start at 9; go to count+8)
vw.r.8	vw.r.clipped	Ruler-off-screen indicator
vw.r.9	vw.r.1st.dist	Distance to first edge

Arc-Ruler Record

Table 4-19 lists the variables that can be used to access the results from an arc-ruler record.

Table 4-19
Results-Array Index Variables for Arc-Ruler Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of first edge point
vw.r.1	vw.y	Y coordinate of first edge point
vw.r.2	vw.ang	Angle of first edge
vw.r.3	vw.cos	Cosine of angle above

Table 4-19
Results-Array Index Variables for Arc-Ruler Record (Continued)

Variable	Alternate Name	Description of Element
vw.r.4	vw.sin	Sine of angle above
vw.r.5	vw.r.1st.last	Distance from first to last edge
vw.r.6	vw.r.rpt.nth	Number of the edge point reported
vw.r.7	vw.r.edge.cnt	Number of edges found (edges start at 9; go to count+8)
vw.r.8	vw.r.clipped	Ruler-off-screen indicator
vw.r.9	vw.r.1st.dist	Distance to first edge

Window Record

Table 4-20 lists the variables that can be used to access the results from a window record. This record type does not use any common definitions for results indexes. It uses the order of the results returned from the VWINDOWI instruction.

Table 4-20
Results-Array Index Variables for Window Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.r.win.clip	Window-operator-off-screen indicator
vw.r.1		(Not used)
vw.r.2		(Not used)
vw.r.3	vw.r.total	Total number of pixels in window
vw.r.4	vw.r.whitep	(Mode 0) Number of white pixels in binary image
vw.r.4	vw.r.avggl	(Mode 1) Average gray level
vw.r.4	vw.r.edgep	(Mode 5) Number of edge pixels
vw.r.5	vw.r.mingl	Minimum gray level in window
vw.r.6	vw.r.maxgl	Maximum gray level in window
vw.r.7	vw.r.objp (*)	Number of object pixels (above threshold; outside dual thresholds)
vw.r.8	vw.r.bkgdp (*)	Number of background pixels (below threshold; inside dual thresholds)
vw.r.9	vw.r.stdev	Standard deviation of gray levels
(*) Indicated item depends on the setting of V.BACKLIGHT.		

Point-Finder Record

Table 4-21 lists the variables that can be used to access the results from a point-finder record.

Table 4-21
Results-Array Index Variables for Point-Finder Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of point
vw.r.1	vw.y	Y coordinate of point
vw.r.2	vw.ang	Angle (of vision frame, if relative)
vw.r.3	vw.cos	Cosine of angle above
vw.r.4	vw.sin	Sine of angle above
vw.r.5		(Not used)
vw.r.6		(Not used)
vw.r.7	vw.r.found	Point-found indicator
vw.r.8	vw.r.clipped	Point-Finder-off-screen indicator

Line-Finder Record

Table 4-22 lists the variables that can be used to access the results from a line-finder record.

Table 4-22
Results-Array Index Variables for Line-Finder Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of point on line
vw.r.1	vw.y	Y coordinate of point on line
vw.r.2	vw.ang	Angle of line found
vw.r.3	vw.cos	Cosine of angle above
vw.r.4	vw.sin	Sine of angle above
vw.r.5		(Not used)
vw.r.6		(Not used)
vw.r.7	vw.r.found	Line-found indicator
vw.r.8	vw.r.clipped	Line-Finder-off-screen indicator
vw.r.9		(Not used)
vw.r.10	vw.r.pctfnd	Percent of edges found along line
vw.r.11	vw.r.maxdst	Maximum error distance for line-fit
vw.r.12	vw.r.maxd1	Maximum error distance, light side

Table 4-22
Results-Array Index Variables for Line-Finder Record (Continued)

Variable	Alternate Name	Description of Element
vw.r.13	vw.r.maxd2	Maximum error distance, dark side
vw.r.14	vw.r.pctfilt	Percent of edge points filtered out

Arc/Circle-Finder Record

Table 4-23 lists the variables that can be used to access the results from an arc/circle-finder record.

Table 4-23
Results-Array Index Variables for Arc/Circle-Finder Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of circle center
vw.r.1	vw.y	Y coordinate of circle center
vw.r.2	vw.ang	Angle (of vision frame, if relative)
vw.r.3	vw.cos	Cosine of angle above
vw.r.4	vw.sin	Sine of angle above
vw.r.5		(Not used)
vw.r.6		(Not used)
vw.r.7	vw.r.found	Arc-found indicator
vw.r.8	vw.r.clipped	Arc-Finder-off-screen indicator
vw.r.9	vw.rad	Radius of circle found
vw.r.10	vw.r.pctfnd	Percent of edges found along arc
vw.r.11	vw.r.maxdst	Maximum error distance for arc-fit
vw.r.12	vw.r.maxd1	Maximum error distance on inside
vw.r.13	vw.r.maxd2	Maximum error distance on outside
vw.r.14	vw.r.pctfilt	Percent of edge points filtered out

Blob-Finder Record

Table 4-24 lists the variables that can be used to access the results from a blob-finder record.

Table 4-24
Results-Array Index Variables for Blob-Finder Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of largest blob found
vw.r.1	vw.y	Y coordinate of largest blob found

Table 4-24
Results-Array Index Variables for Blob-Finder Record (Continued)

Variable	Alternate Name	Description of Element
vw.r.2	vw.ang	Angle (depends on execution mode)
vw.r.3	vw.cos	Cosine of angle above
vw.r.4	vw.sin	Sine of angle above
vw.r.5	vw.r.rad1	Maximum radius or major ellipse radius
vw.r.6	vw.r.rad2	Minimum radius or minor ellipse radius
vw.r.7	vw.r.found	Blob-found indicator
vw.r.8	vw.r.clipped	(Not used)
vw.r.9	vw.r.area	Area of largest blob found
vw.r.10	vw.r.holearea	Area of holes in largest blob
vw.r.11	vw.r.numholes	Number of holes in blob
vw.r.12	vw.r.perimeter	Perimeter of blob
vw.r.13	vw.r.totarea	Total area

OCR-Field Record

OCR-Field records return both string and numeric results. The string result—the verified or recognized text—is in element 0 of the string results array. There is no alternate indexing variable for that element.

Table 4-25 lists the variables that can be used to access the numeric results from an OCR-Field record.

Table 4-25
Numeric Results-Array Index Variables for OCR-Field Record

Variable	Alternate Name	Description of Element
vw.r.0		(Not used)
vw.r.1		(Not used)
vw.r.2		(Not used)
vw.r.3		(Not used)
vw.r.4		(Not used)
vw.r.5	vw.r.num.chrs	Number of characters found/returned
vw.r.6	vw.r.avg.score	Average score
vw.r.7	vw.r.min.score	Minimum score
vw.r.8	vw.r.all.1st	Each character was a 1st choice

Table 4-25
Numeric Results-Array Index Variables for OCR-Field Record (Continued)

Variable	Alternate Name	Description of Element
vw.r.9	vw.r.all.1or2	Each character was 1st or 2nd choice

Font Record

There are no results for a Font record, which is an information-only record. All the information is contained in the **data** array. Table 4-26 lists the variables that can be used to access the information from a Font record.

Table 4-26
Data-Array Index Variables for Font Record

Variable	Alternate Name	Description of Element
vs.md0	vs.font	Font number

Proto-Finder Record

Table 4-27 lists the variables that can be used to access the results from a proto-finder record.

Table 4-27
Results-Array Index Variables for Proto-Finder Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of prototype
vw.r.1	vw.y	Y coordinate of prototype
vw.r.2	vw.ang	Angle of proto instance found
vw.r.3	vw.cos	Cosine of angle above
vw.r.4	vw.sin	Sine of angle above
vw.r.5	vw.ver.percent	Percent verified
vw.r.6		(Not used)
vw.r.7	vw.r.found	Blob-found indicator

Prototype Record

There are no results for a prototype record, which is an information-only record. All the information is contained in the **data** array. Table 4-28 lists the variables that can be used to access the information from a prototype record.

Table 4-28
Data-Array Index Variables for Prototype Record

Variable	Alternate Name	Description of Element
vs.str.1	vs.pname	Name of the prototype (and the record)

Value-Combination Record

Table 4-29 lists the variables that can be used to access the results from a value-combination record.

Table 4-29
Results-Array Index Variables for Value-Combination Record

Variable	Alternate Name	Description of Element
If real values are collected:		
vw.r.0	vw.r.co.avg	Average of the values collected
vw.r.1	vw.r.co.min	Minimum value collected
vw.r.2	vw.r.co.max	Maximum value collected
vw.r.3	vw.r.co.std	Standard deviation of values
vw.r.4		(Not used)
vw.r.5	vw.r.co.cnt	Number of values collected
If Boolean values are collected:		
vw.r.0	vw.r.co.good	Number of TRUE Boolean values
vw.r.1	vw.r.co.bad	Number of FALSE Boolean values
vw.r.2	vw.r.co.and	All results ANDed together
vw.r.3	vw.r.co.or	All results ORed together
vw.r.4		(Not used)
vw.r.5	vw.r.co.cnt	Number of values collected

Frame-Pattern Record

Table 4-30 lists the variables that can be used to access the results from a frame-pattern record.

Table 4-30
Results-Array Index Variables for Frame-Pattern Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of origin
vw.r.1	vw.y	Y coordinate of origin
vw.r.2	vw.ang	Angle of X-axis
vw.r.3	vw.cos	Cosine of angle above
vw.r.4	vw.sin	Sine of angle above
vw.r.5	vw.r.rpt.mth	Number of row, if grid pattern (always 1 if not a grid)

Table 4-30
Results-Array Index Variables for Frame-Pattern Record (Continued)

Variable	Alternate Name	Description of Element
vw.r.6	vw.r.rpt.nth	Number of current frame result (in the row, if a grid)

Correlation Window

Table 4-31 lists the variables that can be used to access the results from a Correlation Window record.

Table 4-31
Results-Array Index Variables for Correlation Window Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of match location
vw.r.1	vw.y	Y coordinate of match location
vw.r.2	vw.ang	Angle (of vision frame, if relative)
vw.r.3	vw.cos	Cosine of angle above
vw.r.4	vw.sin	Sine of angle above
vw.r.5	vw.r.ver.pct	Percent verified (match value)
vw.r.6		(Not used)
vw.r.7	vw.r.found	Positive correlation indicator

Template Record

Table 4-32 lists the variables that can be used to access the results from a Template record. Table 4-33 lists the variables that can be used to access important information in the data array.

Table 4-32
Results-Array Index Variables for Template Record

Variable	Alternate Name	Description of Element
vw.r.0		Width of template in pixels
vw.r.1		Height of template in pixels

Table 4-33
Data-Array Index Variables for Template Record

Variable	Alternate Name	Description of Element
vs.md0	vs.tmpl	Template number

Conditional Frame Record

A Conditional Frame record type has been added. This allows a frame offset to be conditionally applied to a source frame, depending on the results of up to four different inspection records. Table 4-34 lists the variables that can be used to access the results from a frame-pattern record.

Table 4-34
Results-Array Index Variables for Conditional Frame Record

Variable	Alternate Name	Description of Element
vw.r.0	vw.x	X coordinate of origin
vw.r.1	vw.y	Y coordinate of origin
vw.r.2	vw.ang	Angle of X-axis
vw.r.3	vw.cos	Cosine of above
vw.r.4	vw.sin	Sine of above
vw.r.5		Not used
vw.r.6		Not used
vw.r.7	frm.ok	Reference frame is invalid
vw.r.8	vis1.ok	Inspection 1 source is valid and passed
vw.r.9	vis2.ok	Inspection 2 source is valid and passed
vw.r.10	vis3.ok	Inspection 3 source is valid and passed
vw.r.11	all.ok	The frame and all inspections are okay
vw.r.12	off.ok	Frame offset is used
vw.r.13	res.ok	Smart-frame result is PASS

Image Processing Record

An Image Processing record type has been added. This allows you to perform general image processing operations on pictures and then use the results as the picture record for a vision tool or another image processing record. The results-array index variables match those defined for the Picture record type. See Table 4-12 for the results-array index variables.

This new record type supports:

- Convolutions (can specify number of passes)
- Morphological operations (can specify number of passes)
- Edge-detection / threshold operations
- Simple binary thresholding
- Image addition and subtraction
- Image copy

In all cases, the resulting image may be placed back in the same buffer (the normal case) or in a new buffer (maintaining the integrity of the original image). Additionally, the size of the area

processed can be inherited from one of the source images or specified using the click and drag pointer.

When specifying the area of interest for processing on top of previously processed images (several compound image operations), it is currently the user's responsibility to keep the boundaries within the valid area of the source images. Generally, use the "inherit AOI" mode for any compound operations.

Specific virtual frame buffers can always be used when desired.

4.5 Support Variables for Editing

When the menu page for a vision record is redrawn, the variables listed in Table 4-35 are set for use while editing the record. Remember, though, that the values of these variables are valid only during editing, and only for the record currently being edited.

Table 4-35
Variables for Editing a Record

Variable	Interpretation
ve.cur.p.rec	Physical record number of the record being edited.
ve.cur.rec	Logical record number of the record being edited.
ve.rec.type	Record type of the record being edited. (This is the same value as **vw.data[vi.db[**TASK( )**],ve.cur.p.rec,vs.rec.type]**.)
ve.type	Evaluation method of the record being edited. (This is the same value as **vw.data[vi.db[**TASK( )**],ve.cur.p.rec,vs.type]**.)
ve.src.class[ ]	List of classes that the sources must be for the record being edited, given the current value of the evaluation method (**ve.rec.type**). This array is indexed by source number (for example, if the first source is supposed to be a point, **ve.src.class[1]** will equal **ve.pt.class**).
vw.image.lock	True if "Image Lock" has been checked on the "Image" pull-down menu in the Vision window. This should be checked by editing and menu spawn routines that may take pictures. If it is true, pictures should *not* be taken.
vw.show.edges	True if "Show edge points" has been checked on the "Options" pull-down menu in the Vision window. This should be used to conditionally enable the V.SHOW.EDGES for custom vision tools that execute point, line, or arc finders. Remember that V.SHOW.EDGES is normally assumed to be FALSE, so if you set it you must also turn it off.
$ve.edit	Name of the edit routine for the record type of the current record.
$ve.draw	Name of the edit-shape draw routine for the record type of the current record.
$ve.set.data	Name of the set-data routine for the record type of the current record.
$ve.refresh	Name of the refresh routine for the record type of the current record.

The variables listed in Table 4-36 are assigned values based on the calibration for the virtual camera currently being displayed. (This virtual camera is normally from the picture record associated with the first source for the current record.)

Table 4-36
Variables for Calibration Data

Variable	Interpretation
ve.mm.ppixx	Number of millimeters per pixel in the X direction for the image being displayed.
ve.mm.ppixy	Number of millimeters per pixel in the Y direction for the image being displayed.
et.mm.ppixx	Same as **ve.mm.ppixx**, except this should be used for positioning and sizing vision-tool graphics.
et.mm.ppixy	Same as **ve.mm.ppixy**, except this should be used for positioning and sizing vision-tool graphics. Use of this variable is particularly important when overlaying graphics on half-frame images. In this case, the X, Y, DX, and DY parameters of the G∗ graphics instructions are doubled. However, if the **et.mm.**∗ variables are used for converting from pixels to millimeters, the DX and DY values should turn out okay.
et.min.x.sc	Millimeter value at the left side of the screen.
et.max.x.sc	Millimeter value at the right side of the screen.
et.min.y.sc	Millimeter value at the bottom of the screen.
et.max.y.sc	Millimeter value at the top of the screen.

The variables listed in Table 4-37 are limits to the position coordinates and extent of vision tools. These variables are currently set to the millimeter values that correspond to the range –1000 pixels to +1000 pixels in both the X and Y directions.

Table 4-37
Variables for Tool-Position Limits

Variable	Interpretation
et.min.x.tl	Minimum X extent for vision tools
et.max.x.tl	Maximum X extent for vision tools
et.min.y.tl	Minimum Y extent for vision tools
et.max.y.tl	Maximum Y extent for vision tools

4.6 Class Data Structures

The classes are defined by a few arrays that contain the numeric and string data needed to support their use. Each array is indexed by the class number that is returned from the class-definition

routine **vw.mk.new.class( )**. The class numbers for the standard classes are assigned to the variables listed in Table 4-38.

Table 4-38
Variables for Class Numbers

Variable	Interpretation
ve.cir.class	Class number for the CIRCLE class
ve.font.class	Class number for the FONT class
ve.frm.class	Class number for the VISION FRAME class
ve.ins.class	Class number for the INSPECTION class
ve.lin.class	Class number for the LINE class
ve.ocr.class	Class number for the OCR FIELD class
ve.pic.class	Class number for the PICTURE class
ve.proto.class	Class number for the PROTOTYPE class
ve.pt.class	Class number for the POINT class
ve.tst.class	Class number for the TEST-A-VALUE class
ve.win.class	Class number for the WINDOW class
ve.tmpl.class	Class number for the TEMPLATE class

The names of all the class number variables, descriptions of all the class data structures, as well as the actual initialization of the standard classes, can be found in the routine **ve.init.classes( )** in the public file VISMOD.OV2.

4.7 Support Variables for Execution and Runtime

Table 4-39 describes some variables that are assigned by standard record types, and by internal runtime-management routines.

Table 4-39
Variables for Execution and Runtime

Variable	Interpretation
vw.cur.buf[vw.vis.sys[vi.db[TASK( )]]]	Buffer number for the image currently VSELECTed.
vw.cur.pic[vi.db[TASK( )]]	Record number for the picture record whose image buffer is currently VSELECTed. When **vw.run.disp[ ]** (see below) is nonzero, this is also the picture displayed.
vw.v.cam	Virtual camera number for the image currently VSELECTed. When **vw.run.disp[ ]** (see below) is nonzero, this is also the picture being displayed.

Table 4-39
Variables for Execution and Runtime (Continued)

Variable	Interpretation
vw.multi.pics[vi.db[TASK( )]]	TRUE if there is more than one picture record required by the active statements to be executed at runtime. (This variable is always TRUE during editing.) This is used to speed up the runtime in cases when there is only one picture to be taken in each cycle. It is checked by the execution routines before going to the bother of looping through the source records to find if any are in the wrong coordinate system.
vw.run.disp[vi.db[TASK( )]]	Used by execution routines to determine whether or not graphics should be displayed, and to what extent. There are three graphics states indicated by this variable: 0 No graphics allowed. –1 Only built-in vision-tool graphics are allowed. 1 Any graphics are allowed if the correct picture is displayed. For vision tools, the correct picture is automatically VDISPLAYed before the tool is executed.
vw.runtime.disp	This real variable defines the state of the “runtime graphics” switch. It is set to TRUE if the switch is ON. Otherwise, it is set to FALSE.
vw.vdisp.mode	VDISPLAY mode currently selected. This should be either 1 for grayscale, or 2 for binary.
vw.cancel[TASK( )]	Global variable that can be used to stop (and prematurely advance to completion) the evaluation of a statement argument. Specifically, it stops the wait loop for digital I/O signals during picture evaluation. If this variable is set by a custom record type, the current statement argument is aborted with an error.

4.8 Control-Variable Indexes

There are many variables defined at AIM start-up that are used throughout the Vision Module as indexes in the control-variable arrays **ai.ctl[ ]** and **$ai.ctl[ ]**. These index variables have names with the prefixes **cv.** and **cs.** Their definitions can be found in the routine **ve.def.ai.vals( )** in the file VISMOD.OV2. Please refer to this routine for documentation on these variables.

4.9 Support Variables for Logging Results

Table 4-40 describes some variables that are used in the management of the data-logging process.

Table 4-40
Variables for Logging Results

Variable	Interpretation
cv.log.res	Index into the array **ai.ctl[ ]** for the flag that indicates whether or not logging is active. (The flag is TRUE if logging is enabled, FALSE if logging is disabled.)
cv.log.flush	Index into the array **ai.ctl[ ]** for the number of seconds to let pass between periodically closing and opening the log file. The default value is –1, and means never do it.
cs.log.file	Index into the array **$ai.ctl[ ]** for the name of the log file, or a string containing the number of the serial line.
qc.log.lun[TASK( )]	Logical unit number used for logging, or 0 if logging is not enabled.
$qc.log.file[TASK( )]	Name of log file currently opened. (Copied from **$ai.ctl[cs.log.file]** when logging is started.)

4.10 Miscellaneous Global Variables

In addition to the global variables already mentioned in this chapter and throughout the manual, there are assorted others used in support of a wide range of activities. These variables (which have name prefixes **et.**, **ve.**, **vf.**, and **vw.**) are defined in the routines **vi.def.vals( )** and **ve.def.ed.vals( )** in the file VISMOD.OV2. Please refer to these routines for documentation on these variables.

4.11 Data Structures for Defining Record Types

Table 4-41 describes the data structures that are used for defining record types.

Table 4-41
Data Structures for Record-Type Definitions

Array	Contents
vw.typ.def[,]	Numeric values used for defining basic characteristics of a record type, such as whether or not it is a vision tool, etc. The subarray **vw.typ.def[rec.type,]** is for the specified record type. This subarray is passed to the record-type definition routine as **def[ ]**.(*)

Table 4-41
Data Structures for Record-Type Definitions (Continued)

Array	Contents
$vw.typ.def[,]	String values used for specifying the name of the record type, as well as all the menu-page names, routine names, and filenames needed for operation of the record type within the context of the AIM Vision Module. The packed-string subarray **$vw.typ.def[rec.type,]** is for the specified record type. However, unlike the treatment of **vw.typ.def[,]**, this subarray is not passed directly to the record-type definition routine. For the convenience of the programmer, the normal string array **$def[ ]** is passed, and the packing is handled automatically by the Vision Module.(*)
vw.src.classes[,,]	Numeric values defining the number and type of source records for each record type. The two-dimensional subarray **vw.src.classes[rec.type,,]** is for the specified record type. This subarray is passed to the record-type definition routine as **src.classes[,]**.(*)
vw.td.results[,,]	Numeric values that define the testable results for each record type. The subarray **vw.td.results[rec.type,,]** is for the specified record type. This subarray is passed to the record-type definition routine as **res.def[,]**.(*)
(*) A detailed description of the contents of this subarray can be found in the dictionary page for the routine **vrec.def( )** on page 96.	

Chapter 5
VisionWare Module

VisionWare is an AIM application module for vision inspection and measurement. In AIM, an application module is comprised of the following components:

- Statements available for use in sequences
- Database information for access by the statements
- A runtime scheduler that manages the execution of sequences

The standard VisionWare statements are described in the *VisionWare User's Guide*. More details are available in Chapter 7, which describes the statement routines. The procedure for adding statements is described in the basic AIM documentation, but specific information on how to get vision records executed is presented later in this chapter.

5.1 Preruntime

"Preruntime" is defined as the time following linking but preceding the period when any statements are executed and the sequence starts running. Preruntime is used for several purposes in VisionWare. The most significant are:

- Sequence step information is extracted so that there will be no database calls at runtime for the standard statements (see below).
- The evaluation lists are built for each vision argument in the sequence. See the dictionary page for **vw.build.module( )** on page 188.
- Evaluation lists are built for records specified in **vw.cu.elists[,]**.
- Several important runtime globals are determined (for example, **vw.multi.pics[vi.db[**TASK( )**]]**), and certain improper runtime conditions are detected.
- Preruntime routines for statements and records are executed.

All these activities are initiated from the application-specific preruntime routine **rn.sched.start( )** in the private file VWRES.SQU. If there are other custom preruntime activities you would like to add, they should be included in the routine **cu.sched.start( )** in the public file CUSTOM.V2.

Preruntime Routines for Statements

Each statement may have a preruntime routine and a runtime routine. The preruntime routine should handle all the activities that need to be done only once, at the start of execution. The runtime routine is for those things that need to be done for every cycle.

The name of each preruntime statement routine must be the same as the corresponding statement, with a **pr.** prefix added. The name of each runtime statement routine must be the same as the name of the statement. For example, for the INSPECT statement the preruntime routine is **pr.inspect( )**,

and the runtime routine is **inspect( )**. See the file VWRUN.V2 for examples on using this feature; see Chapter 7 for descriptions of these routines.

There must *always* be a runtime statement routine for each statement, or else an error will be generated. Therefore, you must create a "dummy" statement routine. To prevent the dummy routine from being called, disable the sequence step before exiting the preruntime routine. This is now done by setting the **args[0]** value to 0 (formerly –1 for AIM version 2.x).

5.2 Runtime

The runtime scheduler for VisionWare is very general and fits almost any application. The important thing to remember about the operation of the VisionWare scheduler is that at the start of each cycle, the "done" state of all records in the database is changed to "not done". This means that all pictures will be retaken, and all records will be reevaluated, every cycle.

> **NOTE:** The "done" states of all records are not actually reset by looping through all the records in the database. Instead, for efficiency, the "done" state variable **vw.stt.done[ ]** is incremented. That way, all records that were previously marked as done will have the wrong "done" value. This incrementing process wraps around to zero at approximately 16 million cycles.

If logging of results is enabled and active, a timer is checked to see if auto-flush is needed. This checking is done once per cycle.

The VisionWare runtime scheduler includes a special timer that keeps track of the running time (excluding pauses). The scheduler outputs the total time to the status window at the conclusion of the runtime.

5.3 Adding Statements That Use Vision Records

To create a new statement that uses vision, you must perform at least the following steps:

1. Use a vision record as one of the arguments to the statement. (The Vision database type number is 30.)
2. In the statement routine, convert the logical record number of the argument into a physical record number.
3. Check the record type of the record for validity.
4. From the statement routine, call the routine **vw.run.eval2( )** with the physical record number for the record.

If there are multiple vision-record arguments, multiple calls must be made to **vw.run.eval2( )**. Only records that are arguments to active statements (that is, statements that are not commented out) in the current sequence can be used as arguments to the routine **vw.run.eval2( )**. That is because this routine relies on an evaluation list being present for the record being passed in. Evaluation lists are built for all the vision record arguments in active statements when the "Start" button is pressed.

For details on the calling sequence for **vw.run.eval2( )**, see the dictionary page in Chapter 8; see the routine "inspect" in the file VWRUN.V2 for an example of a statement routine that uses vision records.

5.4 Using Repeat Trees in Statements

If you prefer writing custom statement routines to creating custom record types, you may want to use the repeat-tree concept (normally employed by combination records) in a statement. To do this, the vision record used as an argument to the statement must be the top of a repeat tree. Then the statement routine controls the process of repeating the tree.

In the standard VisionWare runtime scheduler, the routine **vw.new.eval( )** is called at the top of each sequence. This means that all records are cleared (declared "not done") and will be re-executed each cycle. This includes pictures. This discussion assumes that you will be using this standard VisionWare runtime scheduler without any alterations.

The statement routine must first evaluate the tree for the vision argument as it would in any other VisionWare statement (such as the INSPECT statement). If this succeeds, the statement routine repeatedly clears and evaluates the repeating section of the tree until the repeat record is exhausted. After each tree is evaluated, some custom operation would most likely be done to accumulate or save away the results of that instance. (Otherwise, they will be written over by the next iteration!)

Here is some pseudocode that shows what this might look like:

```
rec = <physical record number of the top-level record>

ei = vw.data[vi.db[TASK()],rec,vs.ei.list]       ;Eval list number for src 1
rpt.rec = vw.data[vi.db[TASK()],rec,vs.rpt.rec] ;Initial repeat record

CALL vw.run.eval2(mode, rec, resp, error)        ;In Normal VisionWare mode
                                                 :(mode 0)

<react to the user responses and errors as necessary>
IF error GOTO <error exit>

<wait for "rec" to be done>

DO
     IF vw.data[vi.db[TASK()],rec,vs.status] THEN ;Error in tree
          status = vw.data[vi.db[TASK()],rec,vs.status]
          GOTO <error exit>
     ELSE                                        ;Good tree, record result
          <save current result, or combine current result with
                previous ones on the fly>
     END
     CALL vw.clear.rec(rpt.rec)                  ;Clear all rpt rec
                                                 ;dependents
     CALL vw.eval.list(ei)                       ;Evaluate the repeat tree
     WHILE vw.data[vi.db[TASK()],rec,vs.eval] <>
                                vw.stt.done[vi.db[TASK()]] DO
          RELEASE                                ;Wait for other tasks
                                                 ;to do job
     END
UNTIL vw.data[vi.db[TASK()],rpt.rec,vs.more] <>
                      vw.stt.more[vi.db[TASK()]] ;Until no more

<further action based on combined results...>
```

The code above is very similar to what a combination record does. The main difference is that combination records will already have had the tree evaluated the initial time, whereas statement routines have to do the initial evaluation themselves. See Appendix E for details on writing custom combination record types.

Chapter 6
Examples of Custom Routines

This chapter describes the functions and calling sequences of routines that must be written by a system customizer. For these routines, the actual names of the routines are established by the system customizer.

Commented V+ source code is provided with the AIM Vision Module to exemplify some of these routines. The example routines may be used by a system customizer as a basis for creating new routines.

> **CAUTION:** In general, the calling sequences and the interpretations of program parameters must be preserved exactly as described in this chapter. This restriction is required to maintain compatibility with calls by other routines in the AIM system.

The descriptions of the routines are presented in alphabetical order, with each routine starting on a separate page. The "dictionary page" for each routine contains the following sections, as applicable:

Program Parameters

The format of the call to each routine is established within the AIM system and cannot be changed by the system customizer. To be compatible with subroutine calls to the routine, the first line of the routine *must* have the format shown in this section.

> **NOTE:** The routine name, and the variable names used for the routine parameters, are for explanation purposes only. Your custom routine can use any (unique) routine name and any variable names you want.
>
> If the .PROGRAM line would normally extend off the page, it is split and continued on the next line. These split lines must be merged if the statement is typed into an actual program.

Function

This is a brief statement of the function of the routine.

Usage Considerations

This section is used to point out any special considerations associated with use of the routine.

Name

This represents the customizer-defined name of the routine. This name must exactly match the name specified elsewhere in the AIM system to refer to this routine.

As with all V^+ program names, this name must: be unique; begin with a letter; be one to fifteen characters long; and consist of only letters, numbers, and period (“.”) and underscore (“_”) characters.

Input Parameter

Each input program parameter is described in detail.

Output Parameter

Each output program parameter is described in detail.

Details

A description of the routine and its use is given.

Related Routine

Other AIM routines, which are related to the function of the current routine, are listed.

Program Parameters

```
.PROGRAM vclass.draw(data[], $data[], res[], $res[],
                                class, dmode, handle, hndl[])
```

Function

Display a representation of the results of a vision operation, appropriate for the class indicated.

Usage Considerations

The routine **vclass.draw( )** is *not* provided with the Vision Module. This documentation describes the calling sequence and functionality for a class-specific "draw" routine, which must be written by the system customizer.

There can be as many "draw" routines as desired. The actual names for such routines are established by the system customizer, but the calling sequence must be as described here.

To specify the "draw" routine for a particular class, the routine must be named in the call to **vw.mk.new.class( )** that defines the class.

The input parameters should *not* be modified by the routine.

Name

vclass.draw — This represents the name of the draw routine. This must exactly match the name specified in the call to the routine **vw.mk.new.class( )** that defines the class.

Input Parameters

data[ ] — An array of data for one record (from **vw.data[,,]**)

$data[ ] — An array of data for one record (from **$vw.data[,,]**)

res[ ] — An array of results for one record (from **vw.res[,,]**)

$res[ ] — An array of results for one record (from **$vw.res[,,]**)

class — Real variable that receives the number of the class that the results should be made to resemble. For example, a Computed Frame can be displayed as a POINT by simply showing the origin. The class number is the value returned by the routine **vw.mk.new.class( )**. Typical standard class number values are:

ve.pt.class	Point class
ve.lin.class	Line class
ve.cir.class	Circle class
ve.frm.class	Vision-frame class

A complete list of constants to use for standard class numbers can be found in the section titled "Class Data Structures" on page 81.

dmode — Real variable that receives the display mode to use when drawing. The possible values are:

ve.dm.nop	No outline drawn
ve.dm.dim	Draw subtly (dim)
ve.dm.high	Draw obviously (highlighted)

handle — Real variable that receives a signal indicating whether or not the routine should return the location of a handle to use for visually selecting the displayed record from among several others. A TRUE (nonzero) value means yes, return a handle. The value FALSE (zero) means no, do not return a handle.

Output Parameter

hndl[ ] — Array of real values describing a handle (returned only if the input parameter **handle** is TRUE). This array has the same format as a handle in the list of handles for graphical editing.

hndl[et.type]	=	et.htype.pos
hndl[et.x]	=	X coordinate for select handle
hndl[et.y]	=	Y coordinate for select handle

Details

Previously, a parameter named **p.rec** was required and used to index into the **vw.data[„]**, **$vw.data[„]**, **vw.res[„]**, and **$vw.res[„]** arrays. This is no longer needed, as the pertinent column of data is passed directly.

This routine displays the results of a record in a certain way. It can be assumed that, if everything has been set up correctly by the customizer, the only records for which this routine will be called are those whose record type allows them to be members of the specified class.

This routine can then assume the results of the given physical record are formatted in such a way that they fit the specified class. Thus, the graphics can be displayed using the results found in the subarray **vw.res[vi.db[**TASK( )**],p.rec,]**.

The display mode for the graphics instructions should always be complement (2). The color to use is dictated by the array **ve.clr[,]**. This array is initialized with the parameters passed to the routine **vw.mk.new.class( )**. The color to use is **ve.clr[class,dmode]**.

As with the edit drawing routines, the V+ graphics instructions (for example, DARC) should be used with the D.SCALE.MODE system parameter set to 3. Unless you change it, the D.SCALE.MODE parameter will always be 3 when this routine is called. This allows the routine to deal strictly in millimeters, which is the unit of measure for the results.

When a handle position is requested, you need to compute one from the geometry of the display graphics. Alternatively, if the record has a shape that is normally maneuvered at edit time, the record-type edit routine (in “mode” 1 with “index” 1) returns a list of one handle—the position handle.

For “vision tool” records, the graphical shape used to position the tool in the picture is automatically displayed along with the results to help further visually identify the record. Therefore, you need not recreate any portion of this shape. Also, the position handle returned can be on this edit shape, if convenient.

The VisionWare Module includes some completed draw routines—see the routines listed below.

Related Routines

vw.draw.feat
vw.draw.vtool
vw.mk.new.class

Program Parameters

```
.PROGRAM vrec.def(rec.type, def[], $def[],
                  src.classes[,], res.def[,], $res.labels[])
```

Function

This type of routine is called by the Vision Module to define the data structures for a record type, including custom globals such as useful variables for indexing or assigning values to the data or results arrays.

Usage Considerations

The routine **vrec.def( )** is *not* provided with the Vision Module. This documentation describes the calling sequence and functionality for a custom record-type "definition" routine, which must be written by the system customizer.

There can be as many record-type definition routines as desired. The actual names for such routines are established by the system customizer, but the calling sequence must be as described here.

This type of routine is to be called only by Adept routines. To specify this as the record-type definition routine for a new record type, call the routine **vw.typ.def.rtn( )** from the routine ∗**.mod.init( )**, which is located in the start-up overlay file for your AIM application module. (For VisionWare, the routine is **vw.mod.init( )** in the file VWMOD.OV2.)

The input parameters should *not* be modified by the routine.

Name

vrec.def	This represents the name of the definition routine. This must exactly match the name specified in the call to **vw.typ.def.rtn( )** that defines the record type.

Input Parameter

rec.type	Real variable that receives the number of the record type to define. This is generally used only when calling the routine that adds a record type to a class (see Details).

Output Parameters

def[ ]	Array of real values that describes the record type. This array needs to be filled in with the appropriate values for the record type specified. This data goes directly into the subarray **vw.typ.def[rec.type,]** (see Details for specific contents).
$def[ ]	Array of string values that includes names for menu pages, files, routines, and icons needed for the operation of the record type. These strings get packed into the subarray **$vw.typ.def[rec.type,]** (see Details for specific contents).
src.classes[,]	Two-dimensional array of real values that describes the number and classes of the sources needed for each of the evaluation methods this record type can have. This data goes into the subarray **vw.src.classes[rec.type,,]** (see Details).

res.def[,] Two-dimensional array of real values that describes the results from the results array that will be available to test via the test-a-value feature. This array needs to be filled in with the appropriate values for the record type specified. This data goes directly into the subarray **vw.td.results[rec.type,,]**. (See Details for specific contents.) Although this array must be present in the calling sequence, it may be ignored if there are no results that need to be accessible via test-a-value.

$res.labels[ ] Array of string values that are the names for the results defined in the **res.def[,]** array above. These strings are packed in **$vw.typ.def[rec.type,]**. (See Details for specific contents.) Although this array must be present in the calling sequence, it may be ignored if there are no results defined in the array **res.def[,]**.

Details

This routine performs two important functions. One is to define a record type to the Vision Module. The other is to document completely the data, routines, icons, files, menu pages, etc., that are involved with editing and executing a record type. In addition, the routine documents how the data and results arrays are used to store important information.

The routine should have the sections listed below. The order is not critical, but the order shown is used in the sample routines provided with the Vision Module.

- Describe how each element in the data array **vw.data[vi.db[**TASK( )**],rec.type,]** will be used (or not used). If needed, define new global variables to use as descriptive indexes for the data array.
- Fill in the array **src.classes[,]** as described below.
- Describe how the results array will be used. If needed, define new global variables to be used in connection with the results.
- Fill in the array **def[]** as described below.
- Fill in the array **$def[]** as described below.
- Fill in the array **res.def[,]** as described below.
- Fill in the array **$res.labels[]** as described below.
- Add the record type to the appropriate class(es).

The array **def[]** contains numerical information critical to support of the record type by the Vision Module. The following references to items in the array are shown with variables for the indexes. These variables should also be used when your routine assigns values into the array.

def[vw.td.shape] A Boolean value denoting how the shape parameters in the database and data arrays are to be used. If TRUE, they are expected to be used in the standard manner (that is, x, y, dim1, dim2, ang0, angn). Consequently, the Vision Module can manage the vision frame (source 0) and the absolute version of the shape parameters. See Chapter 3 for more information.

def[vw.td.icon] Index of an icon in an icon array. This is used in conjunction with the icon name stored in the string array, as described below.

def[vw.td.custom] TRUE for a custom (non-Adept) record type. FALSE for a standard record type.

def[vw.td.class] When results need to be drawn and the class has not been specified, this is the default class whose draw routine is to be used to display the results graphically. Zero indicates that the record-type indexed draw routine should be used.

def[vw.td.flags] Index variable used for various bit flags. The only one currently in use is defined as **vw.flg.clean**, used by the Window and Image Processing records. When this bit is set, it indicates that the execution graphics do not contain results-dependent items. This means that when a shape tool is clicked on for dragging, it will not have to fully execute the tool just to erase it before going to dry.run mode for the dragging.

def[vw.td.vtool] If this attribute is TRUE, some aspects of your record type must follow certain guidelines, and consequently the Vision Module can assume some common vision-tool chores. For vision-tool records, you must have a picture-class record for source 1.

At preruntime, an AOI is allocated and VDEF.AOI is performed using the relative shape parameters for the vision tool record.

The following runtime chores are done automatically for vision tools:

- The status of the picture source (source 1) is checked. If nonzero, the vision tool fails with the error code of that source.
- Sets the vision system for this record.
- If the shape of the vision tool is relative to a vision frame (source 0), the status of that record is checked also. If the status is nonzero, the vision tool fails with the error code of that source.
- If the shape of the vision tool is relative to a vision frame in a different picture, the results of the vision frame are transformed to be in the coordinate frame for the correct picture.
- The absolute shape parameters in the data array are computed from the relative shape parameters and the vision frame (if there is one). (The absolute shape parameters can be used directly as arguments to vision instructions, since they are relative to the coordinate frame for the picture.)
- If the correct frame buffer (the one the picture was last grabbed into) is not selected, that buffer is VSELECTed.
- If editing or walk-thru training is enabled, the correct picture is always VDISPLAYed, so that the graphics are correct.
- Performs a VDEF.TRANS using the reference frame record, if any.

def[vw.td.info] TRUE if this is an “information-only” record type. This means it does not have an execution routine.

def[vw.td.def.tst] For record types that are in the test-a-value class, this is the index into the results definition array (**res.def[,]**) for the value that comes up as

the default result to test when the record is chosen as a test-a-value source record.

def[vw.td.combo] TRUE if this is a "combination" record type. That means this record has at least one source, and that source one is the top of a "repeat tree" that should have at least one unused repeat record in it. See the section "Repeat Records" on page 42 for details on repeat records and their use.

The array **$def[ ]** contains string data that are key to support of the record type by the Vision Module. The following references to items in the array are shown with variables for the indexes. These variables should also be used when your routine assigns values into the array.

$def[vw.td.exec] Name of the record-type execution routine. See **vrec.exec( )** on page 108 for more information.

$def[vw.td.name] Name for the record type.

$def[vw.td.pg.file] Name of the file that contains the menu pages (see below).

$def[vw.td.pg.name] Name of the menu page for display and editing of the records of this type. (The menu page must be in the file named by **$def[vw.td.pg.file]**.)

$def[vw.td.res.filt] Name of optional routine for filtering that makes the results definition array available for testing. This is used only if there are results defined in the array **res.def[,]**. When a record is being used as a test-a-value source record, this routine is called to determine which results are valid and should be displayed in the scrolling window used when selecting the value to test. See **vrec.res.filt( )** on page 112 for more information.

$def[vw.td.data] Name of the set-data routine for the record type. See **vrec.set.data( )** on page 115 for more information.

$def[vw.td.draw] Name of the editing draw routine for the record type. See **vrec.draw( )** on page 101 for more information.

$def[vw.td.edit] Name of the edit routine for the record type. See **vrec.edit( )** on page 103 for more information.

$def[vw.td.refresh] Name of the refresh routine for the record type. See **vrec.refresh( )** on page 111 for more information.

$def[vw.td.ic.name] Name of the icon to use when displaying records of this type in the tree displays.

The "source classes" array parameter defines the class of records allowed for each of the sources of a record type. Within one record type, different evaluation methods can have different source requirements, so this array is first indexed by evaluation method, then by source number. Since source number 0 is always the same class (vision-frame class), the element with index zero is used to store the number of sources needed for each evaluation method. Thus, the array format is as follows (where "eval.meth.1" and "eval.meth.2" represent any two evaluation methods):

```
src.classes[eval.meth.1,0]   = <number of sources>
src.classes[eval.meth.1,1]   = <class for source 1>
```

```
src.classes[eval.meth.1,2]   = <class for source 2>
        ...                          ...
src.classes[eval.meth.1,n]   = <class for source n>
src.classes[eval.meth.2,0]   = <number of sources>
src.classes[eval.meth.2,1]   = <class for source 1>
src.classes[eval.meth.2,2]   = <class for source 2
        ...                          ...
src.classes[eval.meth.2,n]   = <class for source n>
(and so forth, for each evaluation method)
```

The "results definition" array parameter (**res.def[ ]**) defines which results out of the "results" array (**vw.res[vi.db[**TASK( )**],p.rec,]**) will be available for testing via the "test-a-value" feature. The "results labels" array (**$res.labels[]**) provides a label (with up to 32 characters) for each of the results defined in the results definition array. Specifically, the two arrays are to be filled as follows:

```
res.def[0,0]     = <number of testable results>

res.def[1,0]     = <index into results array for result 1>
res.def[1,1]     = <data type of result 1>
                   ;0 = Real value, 1= Boolean value
res.def[1,2]     = <reserved—do not use>
res.def[1,3]     = <reserved—do not use>
$res.labels[1]   = <up to 32-character label for result 1>

res.def[2,0]     = <index into results array for result 2>
res.def[2,1]     = <data type of result 2>
res.def[2,2]     = <reserved—do not use>
res.def[2,3]     = <reserved—do not use>
$res.labels[2]   = <up to 32-character label for result 2>

(and so forth, for each testable result)
```

There must not be any "holes" in the list. That is, if there are four testable results, **res.def[0,0]** should equal 4, and the entries in **res.def[,]** and **$res.labels[ ]** should be in elements 1 through 4 consecutively. For example, putting them at elements 1, 2, 4, and 5 would *not* be valid. See almost any routine in the public file VCFEAT.OV2, specifically **vw.cl.def( )**, for examples of how to fill in these arrays.

Related Routines

vw.add.to.class
vw.cl.def (in the file VCFEAT.OV2)
vw.typ.def.rtn

Program Parameters

```
.PROGRAM vrec.draw(data[], $data[], dmode)
```

Function

Draw the graphical editing shape for a record type.

Usage Considerations

The routine **vrec.draw( )** is *not* provided with the Vision Module. This documentation describes the calling sequence and functionality for a record-type "draw" routine, which must be written by the system customizer.

There can be as many record-type draw routines as desired. The actual names for such routines are established by the system customizer, but the calling sequence must be as described here.

This type of routine is to be called only by Adept routines. To specify the draw routine for a particular record type, the draw routine must be named in the definition routine for that record type (see **vrec.def( )** on page 96).

The input parameters should *not* be modified by the routine.

Name

vrec.draw	This represents the name of the draw routine. This must exactly match the name specified in the definition routine for the record type.

Input Parameters

data[ ]	Array of real values containing data for a specific vision record.
$data[ ]	Array of strings containing data for a specific vision record.
dmode	Real variable that receives the display mode to use when drawing. The possible values are: ve.dm.dim Draw subtly (dimly) ve.dm.high Draw obviously (highlighted) ve.dm.nop No outline drawn The specific choice of colors is up to you, but there should be a distinct contrast between the "dim" version and the "highlighted" version.

Output Parameter

None.

Details

This routine draws the graphical editing shape for a record type. This routine is used when the shape is being dragged around the screen. This is also the routine used to draw a stationary shape when live video is present and the record can not be evaluated.

The absolute shape parameters are in millimeters, so it is most convenient to use the graphics instructions (GLINE, GARC, etc.) in GTRANS mode 1 (vision-frame-relative coordinates). This graphics mode is the default in the Vision module routines. If you need absolute pixel graphics

(GTRANS mode 0) or choose to change the graphics mode for any reason, then you must set it back to mode 1 before exiting the routine.

To draw objects (such as tick-marks) that you want to be a fixed pixel size, you should calculate the corresponding millimeter dimensions using the values in **vw.x.scale[vw.v.cam]** and **vw.y.scale[vw.v.cam]**. (**vw.v.cam** is always the virtual camera for the picture currently being displayed.) These array elements contain the millimeters-per-pixel scale factors for the X and Y directions, respectively.

There are several standard graphics routines that can be used in place of this routine, or that can be called from within this routine.

Related Routines

ve.draw.arrow
ve.draw.circle
ve.draw.frame
ve.draw.line
ve.draw.point
ve.line.arrows
vrec.def
vw.cc.draw
vw.cf.draw
vw.cl.draw
vw.cp.draw
vw.tl.draw (in the file VDRAW.SQU)

Program Parameters

```
.PROGRAM vrec.edit(mode, data[], $data[], event[],
                           $str, list[,], index, status)
```

Function

Manage all the editing functions for a record type.

Usage Considerations

The routine **vrec.edit( )** is *not* provided with the Vision Module. This documentation describes the calling sequence and functionality for a record-type "edit" routine, which must be written by the system customizer.

There can be as many record-type edit routines as desired. The actual names for such routines are established by the system customizer, but the calling sequence must be as described here.

This type of routine is to be called only by Adept routines. To specify the edit routine for a particular record type, the edit routine must be named in the definition routine for that record type (see **vrec.def( )** on page 96).

The input-only parameters should *not* be modified by the routine.

Name

vrec.edit — This represents the name of the edit routine. This must exactly match the name specified in the definition routine for the record type.

Input Parameters

mode — Real variable that receives a code for the situation in which this routine is being called. This code dictates the responsibilities and opportunities this routine has. Briefly, the different modes of operation are:

–1	Initial menu page display
0	Initialization for editing
1	Set positions of editing handles
2	An editing event has occurred

data[ ] — Array of real values containing data for a specific vision record (from **vw.data[,,]**)

$data[ ] — Array of strings containing data for a specific vision record (from **$vw.data[,,]**)

event[ ] — Array of up to seven real values that describes an editing action by the operator. The basic structure of the event array is as follows:

event[0]	Standard event code (e.g., **ky.goto**)
event[1]	Data values describing the event
...	(the specific values are
event[n]	different for each event)

The possible values for “event[0]” are:

event[0]	Description of Event
ky.aictl.chg	**ai.ctl[ ]** element about to be changed
–ky.aictl.chg	**$ai.ctl[ ]** element about to be changed
ky.but.down	Mouse button 2 depressed
ky.but.move	Mouse moved while button 2 down
ky.but.up	Mouse button 2 released
ky.cut.rec	Record is about to be deleted
ky.dbl.clk	Double click mouse button 2
ky.display	SELECT or **Display** (F5) while on value
ky.field.chg	Real database field about to be changed
–ky.field.chg	String database field to be changed
ky.goto	Double click or **Go To** (F3) while on value

See “Edit Action Events” on page 60 for descriptions of the structures of **event[ ]** for the possible events.

$str — String variable that receives the new string value if a string parameter or control variable is being changed.

list[,] — Array of real values containing a list of handle descriptors for the edit handles. This is an input for modes 1 and 2, but not for modes –1 or 0. Element **list[0,0]** is the number of handles in the list. The primary index is the handle number, and each subarray describes one handle, as follows:

list[N,et.type]	Type (style / shape) for handle N
list[N,et.x]	X coordinate for handle N
list[N,et.y]	Y coordinate for handle N

The possible values for the type of handle are:

et.htyp.pos	Position handle (box with cross hair)
et.htyp.ang	Angular handle (little bull’s-eye)
et.htyp.dim	Dimension handle (simple box)

If the handle type is negative, the Vision Module ignores the handle when checking for mouse hits, drawing all handles, or testing whether all the handles are within the bounds of the Vision window.

index — Real variable that receives the (left-hand) index into the array **list[,]** for the handle of interest. The interpretation of this value depends on the value of the “mode” parameter (see above), as described below.

In mode 0, for initializing the list of handles:

1	Initialize only the position handle
–1	Initialize all handles

In mode 1, for setting the position of handles:

1	Set (x,y) location of only position handle
–1	Set (x,y) locations for all handles

In mode 2, for processing editing events:

0	The event is not for an editing handle
>0	Index of handle being edited (mouse event)

Output Parameters

data[ ]	Same as input, except that some values may be changed.
$data[ ]	Same as input, except that some values may be changed.
event[ ]	Same as input, except that **event[4]** may have a new value. For parameter changes, **event[4]** of the input event is the proposed new value for the parameter. After this routine returns, the value of **event[4]** (whether modified or not) is assigned into the intended database field, or element of **ai.ctl[ ]** or **$ai.ctl[ ]**, as if it were the value typed in.
$str	For a change to a string parameter, this may be changed to indicate the new value that should be assigned into the intended database field, or element of **$ai.ctl[ ]**, in place of the original value of **$str**.
list[,]	Array of real values containing a list of handle descriptors for the edit handles. This is an output parameter only for mode 0. In mode 0, the number of handles and the types of the handles are established. See the description of the handle data structure above.
status	Real variable that returns a value indicating whether or not the operation was successful, and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

This routine manages all the editing functions for a particular record type. The main functions are initialization; setting the positions of click-and-drag handles; and making changes to the record data in response to user actions, such as changing a value in the menu page or mouse events in the Vision window.

> **NOTE:** Technically, this is an optional routine for each record type. If there is no graphical editing shape to be manipulated, and no complicated interrelated parameters, chances are very good that this routine is not needed at all.

The following paragraphs describe the processing to be done by this routine for its different modes of operation.

Processing for "mode" –1—Prepare for display of menu page:

When called with this mode, the record being edited has just been selected for editing. The menu page for this record is about be displayed. This mode can be used to perform unique assignments to globals that should not happen every time the menu page is redrawn.

Processing for "mode" 0—Initialize for editing:

When called in this mode, the menu page is about to be redrawn, the sources for the current record are all linked and have been successfully evaluated, and the correct picture is being displayed.

> **NOTE:** This mode is *not* called for every redraw of the page, only when the source records have been successful and the correct picture is being displayed.

If doing graphical editing (using a "shape"), several things must be done at this time.

1. Set **data[vs.editing]** to indicate the state of graphical editing.

   If this element is set to –1, the normal support of shape manipulation is enabled. That is, the draw routine is used to display the shape while it is being dragged, and the execution routine is used to display the shape when it is sitting still.

   If this element is set to 1, the Vision Module should perform all the editing without using the execution routine. That is, the draw routine is used at all times for displaying the shape.

2. Initialize the list of handles, with the number of handles and the type of each handle. See the description above of the data structure for the list.

   The position of each handle should *not* be set at this time, since that is the job of this routine in mode 1.

   The position handle is always handle number 1, and when the "index" parameter is 1, this is to be the only handle in the list. You should always use type "et.htyp.pos" for the position handle and not for any other handle, since to do so may cause confusion.

3. Initialize any global or local variables to be used in support of editing.

   In particular, if you wish to do any limit checking during parameter changes in mode-2 operation of this routine, the maximum and minimum limits should be set here, in mode 0. There is a standard routine (ve.set.limits) for setting typical limits on the position and dimension elements of the absolute shape parameters. It sets them in the global arrays **et.min[]** and **et.max[]**. These arrays are used by another standard routine **ve.tl.upd.chk( )**, which can be called from mode-2 operation of this routine.

Processing for "mode" 1 — Set handle locations:

This mode is used only if there is a shape to edit and a mode-0 call of this routine returned a nonzero value in **data[vs.editing]**. The handle locations are necessary for the Vision Module to draw the handles, as well as for checking the proximity of mouse events.

This routine must assign the absolute (x,y) locations for the handles in the list. That is, the locations are defined relative to the camera coordinate frame. The values are stored as follows:

```
list[1,et.x]     Absolute X coordinate of handle 1
list[1,et.y]     Absolute Y coordinate of handle 1
   ...           ...
```

list[N,et.x]	Absolute X coordinate of handle N
list[N,et.y]	Absolute Y coordinate of handle N

Or, if it is easier to compute relative locations, you can use one of the following programs:

ve.set.handle	Set handles using relative Cartesian coordinates
ve.set.phandle	Set handles using relative polar coordinates

For examples of edit routine, see **vw.fl.edit( )** in the file VFINDERS.V2 and **vw.ft.edit( )** in the file VCFEAT.V2.

An edit routine can also be used to change the position of a shape-record during runtime (on the fly). A customizer may want to do this for nonvision shape records (for vision tools, this is handled automatically). This is done by modifying the relative value in the **vw.data[,,]** array (vs.rel.x, etc.), by:

```
CALL ve.set.aoi(1,data[vs.aoi.num],data[])
```

where **data** represents the column of **vw.data[vi.db[**TASK( )**],prec,]** for the record of interest.

Processing for "mode" 2—Responding to edit event:

The Vision Module monitors certain editing actions the user makes and passes them on to this routine as "events" in the array **event[ ]**. Also, if there is a graphic for this record, it is erased before this routine is called, and it is redrawn after this routine is called.

If handles and their positions are established (through calls to this routine in modes 0 and 1), the Vision Module monitors the mouse events that happen on or near these handles. If a handle is "hit" using the middle mouse button, the event is passed through and the "index" parameter is set to the appropriate index in **list[,]** for the handle.

If there are no handles for editing, there are no required duties for this mode. Then it is merely a mechanism for notifying the customizer that certain events have occurred.

If handles have been established, this mode needs to change the absolute shape description in **data[ ]**, based on the mouse movements on the handles.

For vision tools, the global arrays **et.min[ ]** and **et.max[ ]** can be considered after changes have been made to the absolute shape parameters. If these global arrays have been initialized with minimum and maximum limits (for example, using the routine **ve.set.limits( )**), the routine **ve.tl.upd.chk( )** can be used to check that the shape parameters of the vision tool are within the prescribed limits. If a handle is being dragged, it is not allowed to go outside the Vision window. That is, if an attempt is made to drag a handle out of the Vision window, the handle will separate from the cursor and be left behind. These checks are consistent with those for all the standard vision tools, such as a Line Finder.

Related Routines

ve.fl.action	ve.fl.init
ve.fl.update	ve.ft.action
ve.ft.init	ve.ft.update
ve.set.handle	ve.set.limits
ve.set.phandle	ve.tl.upd.chk
vrec.def	vw.fl.edit
vw.ft.edit	

Program Parameters

```
.PROGRAM vrec.exec(data[], results[], vwdata[,], vwres[,])
```

Function

Execute a vision record.

Usage Considerations

The routine **vrec.exec( )** is *not* provided with the Vision Module. This documentation describes the calling sequence and functionality for a record-type "execution" routine, which must be written by the system customizer.

There can be as many record-type execution routines as desired. The actual names for such routines are established by the system customizer, but the calling sequence must be as described here.

This type of routine is to be called only by Adept routines. To specify the execution routine for a particular record type, the execution routine must be named in the definition routine for that record type (see **vrec.def( )** on page 96).

This routine is not used for information-only record types. In that case, the element **$def[vw.td.exec]** should be assigned an empty string in the record-type definition routine.

Name

vrec.exec	This represents the name of the execution routine. This must exactly match the name specified in the definition routine for the record type.

Input Parameters

data[ ]	Array of real values containing data for a specific vision record.
vwdata[,]	Two dimensional sub-array of **vw.data[„]** for the current Vision database (**vi.db[**TASK( )**]**).
vwres[,]	Two dimensional sub-array of **vw.data[„]** for the current Vision database (**vi.db[**TASK( )**]**).

Output Parameters

results[ ]	Array of real values to return the results of executing this record.
vwres[,]	Two dimensional sub-array of **vw.data[„]** for the current Vision database (**vi.db[**TASK( )**]**).

Details

There are two global arrays that could be considered additional input and output parameters. The string data array could be considered an additional input, and the string results array could be considered an additional output. If needed, these arrays can be accessed as follows:

```
$vw.data[vi.db[TASK()],data[vs.p.rec],element_of_interest]
$vw.res[vi.db[TASK()],data[vs.p.rec],element_of_interest]
```

The basic purpose of this routine is to compute results for the record and put them in the results array. However, there are a few things that need to be done to maintain consistent operation of the Vision Module.

1. When this routine is called, all of the source records indicated in the data array have been evaluated, but their success is not guaranteed. Therefore, you must test the status value of each of the sources and respond appropriately. Normally, if one of the sources has failed, you would carry the status for that source over to the current record and return. (For vision tools, this is automatically done for the picture and vision-frame source records.)

2. You need to determine whether there are multiple pictures in the sequence, and, if so, transform all the source results into the same coordinate frame before computing results. The routine **vw.conv.frm( )** performs this conversion. Obviously, this is needed only if your computations involve position and orientation information, such as computing a vision frame. (For vision tools, this is automatically done for the vision-frame source record.)

3. If you have a picture source record, you need to make sure that its frame buffer is the one currently selected. If not, it needs to be VSELECTed.

   Also, if unlimited graphics are allowed (that is, **vw.run.disp[ ]** is greater than zero), you should VDISPLAY the camera for that picture, so that any graphics you draw will scale correctly. (For vision tools, all this is done automatically.)

4. If setting any switches or parameters, or issuing any vision instructions (these conditions are always true for vision tools), you need to assign the display mode and virtual camera to use, as follows:

```
virt.cqm = data[vs.vcam]         ;Virtual camera
disp.mode = vw.dmode[TASK()]     ;Display mode
```

After performing those steps, you can compute the results as appropriate. For vision tools, this involves executing a vision instruction. For purely computational records, this involves accessing the results arrays of various source records.

> **NOTE:** It is very important that you arrange the results in the results array such that they conform to the class(es) of which you have made this record type a member (in the definition routine).

After computing the results, if you wish to accumulate statistics about any particular aspect of the final results (or even for intermediate results), that would be done by calling the routine **qc.accum.stats( )**. See the description of **qc.accum.stats( )** on page 137 for details.

If there is an appropriate graphical way of displaying the operation being performed, or some aspect of the results, it should be drawn by this routine. However, certain conditions restrict when graphics are allowed. Graphics should never be displayed if the global variable **vw.run.disp[ ]** is zero. This should be checked before execution of any code that prepares for graphics output, since in the non-graphics case, that incurs the least overhead.

In addition, graphics (other than those performed by the system as part of vision instructions) should be performed only when **vw.run.disp[ ]** is greater than zero. This indicates that all graphics are okay. This is the case during normal editing and walk-thru training.

Furthermore, for nonvision tools, you need to check that the reference picture for the results is the same as the picture currently displayed. This check would be coded as

```
IF (data[vs.ref.pic] == vw.cur.pic[vi.db[TASK( )]]) THEN
```

followed by the graphics code.

When done with everything, this routine must set the following two important elements in the data array. They are crucial to task coordination and successful operation of the Vision Module. They should be set as shown below, but only after all the results have been computed and stored in the results array.

```
data[vs.status] = <AIM status code>            ;(0 if successful)
data[vs.eval] = vw.stt.done[vi.db[TASK( )]]    ;Signal that it is done
```

In summary, the tasks that need to be performed by this routine vary from record to record, but there are two fairly common cases. One is for computation records, such as a Computed Line. The other is for vision tools, such as a Line Finder. The tasks needed for each are summarized below. Tasks in brackets ("[...]") are optional. Tasks in parentheses are taken care of automatically by the Vision Module.

Computation records:

Check the status of sources
Convert the source results if necessary
Perform the operation
[Accumulate statistics]
[Draw operation graphics]

Vision tools:

(Check status of picture and vision-frame sources)
(Transform vision frame results, if needed)
(Select the correct frame buffer, if needed)
(VDISPLAY the correct camera if **vw.run.disp[ ]** > 0)
Assign display mode
Assign virtual camera
Perform the operation
[Add the result to accumulated statistics]
[Draw result graphics]

Related Routines

vw.cl.exec (in the file VCFEAT.V2)
vw.conv.frm
vw.fl.exec (in the file VFINDERS.V2)
vrec.def

Program Parameters

```
.PROGRAM vrec.refresh(data[], results[])
```

Function

Keep menu page display values up to date.

Usage Considerations

The routine **vrec.refresh( )** is provided with the Vision Module. This documentation describes the calling sequence and functionality for a record-type "refresh" routine, which must be written by the system customizer.

There can be as many record-type refresh routines as desired. The actual names for such routines are established by the system customizer, but the calling sequence must be as described here.

This type of routine is to be called only by Adept routines. To specify the refresh routine for a particular record type, the refresh routine must be named in the definition routine for that record type (see **vrec.def( )** on page 96).

The input parameters should *not* be modified by the routine.

Name

vrec.refresh	This represents the name of the refresh routine. This must exactly match the name specified in the definition routine for the record type.

Input Parameters

data[ ]	Array of real values containing data for a specific vision record.
results[ ]	Array of real values containing the results of executing this record.

Output Parameter

None.

Details

This routine is used to update the elements in the global array **ai.ctl[ ]**, based on the data and results arrays.

This routine is called whenever the menu page is about to be refreshed or redrawn. (In the case of redraw, the routine is called after the call to the edit routine in mode 0.)

The Adept tools use this routine for updating the array **ai.ctl[**] with results so they can be displayed. This routine provides the only way to display results on the menu page.

If you wish to have only the first 16 results copied from the results array into **ai.ctl[ ]** (starting at element **cv.ve.results**), you can use the routine **vw.refresh( )** to do that. That routine is used by almost all record types to move the results over to where they can be displayed.

Related Routine

vw.refresh

Program Parameters

```
.PROGRAM vrec.res.filt(p.rec, rec.type, ok[])
```

Function

Determine which of the results in the results definition array are valid to choose as results to test.

Usage Considerations

The routine **vrec.res.filt( )** is *not* provided with the Vision Module. This documentation describes the calling sequence and functionality for a record-type "results filter" routine, which must be written by the system customizer.

This routine is ignored if there are no testable results as defined by the record-type definition routine for **rec.type**. It is, therefore, for use only with record types in the test-a-value class.

There can be as many record-type results filter routines as desired. The actual names for such routines are established by the system customizer, but the calling sequence must be as described here.

This type of routine is to be called only by Adept routines. To specify the results filter routine for a particular record type, the results filter routine must be named in the definition routine for that record type (see **vrec.def( )** on page 96).

The input-only parameters should *not* be modified by the routine.

Name

vrec.res.filt	This represents the name of the results filter routine. This must exactly match the name specified in the definition routine for the record type, assigned in **$def[vw.td.res.filt]**.

Input Parameters

p.rec	Real variable specifying the **physical** record number for the vision operation.
rec.type	Real variable that receives the number of the record type for the vision operation.
ok[ ]	Array of real values initialized with the default values for the output array of the same name. Element **ok[0]** is initialized with the number of results in the list.

Output Parameter

ok[ ]	Array of real values to return a list of Boolean indicators, one for each result in the results definition array defined in the record type. For example, if **ok[3]** is TRUE, the third result (**res.def[3,*]**) is valid for selecting a value to test.

Details

You should note that this is an optional routine. If, after reading the information below, you decide there is no need for this routine, an empty string should be specified as the name for this routine in

the record-type definition routine. That is, the following line should appear in the definition routine:

```
$def[vw.td.res.filt] = " "  ;No filter routine
```

This routine is called when the operator is selecting a value to test from a test-a-value source record. At that time, a popup is displayed with a scrolling window showing the possible values to test for the source record. For some record types, not all the results that are possible to compute are computed for every mode of operation the record type has. In those cases, it is necessary to exclude (that is, "filter out") those results that are not valid, given the current configuration of a particular record.

For example, the Window record can compute the number of edge pixels in one mode and the average graylevel in another mode. However, it cannot compute both at the same time. So, when an Inspection record is using an edge-counting window as a source record, the operator should *not* be allowed to select "average graylevel" as a result of that record to test. If that were done, the wrong value would be returned and inspections would be confused. Therefore, for such record types, a results filter routine can be written.

Let's consider a detailed example. Suppose we have a custom Window record that is similar to the standard one, but has been enhanced to include automatic local threshold determination. It can operate in two modes, counting white pixels (using an automatically chosen binary threshold) or counting edge pixels (using an automatically chosen edge threshold). However, it can return only one of these results at a time. The record-type definition routine would have the following code in it regarding the results (using the prefix "auto"):

```
; Use of data[]:
;           ...
;          vs.type                    ;Eval method: 1=>binary, 2=>edge
;           ...
; Use of vw.res[,,]:
;
           auto.whitep = vw.r.0       ;Number of white pixels
           auto.edgep = vw.r.1        ;Number of edge pixels
;          vw.r.2 -thru- vw.r.15      ;(not used)

; Results available for testing:
           res.def[1,0] = auto.whitep ;Index into results array
           res.def[1,1] = 0           ;0=>Real value, 1=>Boolean
           $res.labels[1] = "Number of white pixels"

           res.def[2,0] = auto.edgep  ;Index into results array
           res.def[2,1] = 0           ;0=>Real value, 1=>Boolean
           $res.labels[2] = "Number of edge pixels"

           res.def[0,0] = 2           ;Two results available

Then the results filter routine would basically do the following:
           CASE vw.data[vi.db[TASK()],p.rec,vs.type] OF
                VALUE 1:
                     ok[1] = TRUE    ;White pixels counted
                     ok[2] = FALSE   ;Edge-pixel count not available
                VALUE 2:
                     ok[1] = FALSE   ;White-pixel count not available
                     ok[2] = TRUE    ;Edge pixels counted
           END
```

See the template routine ∗**.cmp.res.filt( )** for the computational record type in Appendix C.

Notice that the filter routine is not defined, or if it is defined but does nothing, all the results will be made available for testing. Also, because of the initialization of the array **ok[ ]** done by the Vision Module, you really need to set certain results indicators to FALSE when appropriate—since they will default to TRUE otherwise.

Related Routine

vrec.def

Program Parameters

```
.PROGRAM vrec.set.data(mode, data[], $data[], status)
```

Function

Set values in the data arrays in three key situations: initialization of new records, after loading, and before runtime.

Usage Considerations

The routine **vrec.set.data( )** is *not* provided with the Vision Module. This documentation describes the calling sequence and functionality for a record-type "set-data" routine, which must be written by the system customizer.

There can be as many record-type set-data routines as desired. The actual names for such routines are established by the system customizer, but the calling sequence must be as described here.

This type of routine is to be called only by Adept routines. To specify the set-data routine for a particular record type, the set-data routine must be named in the definition routine for that record type (see **vrec.def( )** on page 96).

The input-only parameters should *not* be modified by the routine.

Name

vrec.set.data	This represents the name of the set-data routine. This must exactly match the name specified in the definition routine for the record type.

Input Parameters

mode	Real variable that receives a code for the situation in which this routine is being called. The different modes of operation are: 0 Initialize database data section with defaults 1 Preruntime computations 2 Data extension based on database values
data[ ]	Array of real values containing data for a specific vision record.
$data[ ]	Array of strings containing data for a specific vision record.

Output Parameters

data[ ]	Array of real values containing data for a specific vision record.
$data[ ]	Array of strings containing data for a specific vision record.
status	Real variable that returns a value indicating whether or not the operation was successful, and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

You should note that this is an optional routine. If, after reading the information below, you decide there is no need for this routine, an empty string should be specified as the name for this routine in the record-type definition routine. That is, the following line should appear in the definition routine:

```
$def[vw.td.data] = ""       ;No set-data routine
```

This routine operates in three modes, for the three different situations in which it is called.

When this routine is called with "mode" set to 0, a new record has just been created. The data arrays have just been initialized—mostly with zeros and empty strings. This routine provides a way to modify this initialization. After this routine is called and the data array values have been changed to the appropriate initial values, the Vision Module sets the number of sources (**data[vs.num.src]**) to the correct value for the evaluation method (given in **data[vs.type]**). Then the data array values are copied into their corresponding spots in the database.

> **NOTE:** For mode 0, values assigned into data-array elements that do not correspond to database fields are ignored.

Two data array values are initialized to other than zero before calling this routine. The eval method (**data[vs.type]**) is initialized to 1, and the "show at runtime" bit is set to the value in **data[vs.flags]**. If other values are required, simply change them. These values are assumed to be the most common default values. Note that if other bits need to be set in the element **data[vs.flags]**, they would need to be ORed in to preserve the initialization of the "show at runtime" bit.

For this routine (but no others), there are entries in the string data array for the source names. They start at the element with index **vs.src.names**. For example, the name for source 1 could be assigned to the element **$data[vs.src.names+1]**.

When this routine is called with "mode" set to 1, the routine should perform all the computations for this record type that do *not* depend on source records being complete. This will speed up the runtime, since this routine is called only once (in this mode), at the start of sequence execution, that is, when you click on the "Start" button.

For information-only record types, this routine takes the place of an execution routine. In this case, all calculations and error checking should take place in this routine.

This routine is called with "mode" set to 2 each time the data is copied out of the database into the data arrays. This mode is used mainly for the sake of editing. If there are any data array values that need to be set but are not stored in the database, they can be set here.

Related Routines

ve.tl.set.up
vrec.def
vw.cl.data
vw.fl.data

Chapter 7
VisionWare Statement Routines

This chapter describes the functions and calling sequences of the statement routines provided in the VisionWare Module. Application software written by a system customizer may call these routines.

Source code for these routines is provided with the VisionWare Module. Thus, a system customizer may modify them.

> **NOTE:** In general, AIM routines should not be modified in any way that changes the calling sequence or the interpretations of the program parameters.
>
> This restriction is required to maintain compatibility with calls by other AIM routines for which source code is not available.

The descriptions of the statement routines are presented in alphabetical order, with each routine starting on a separate page. The dictionary page for each routine contains the following sections, as applicable:

Statement Syntax

This section shows the statement syntax.

Function

This is a brief statement of the function of the routine.

Usage Consideration

This section is used to point out any special considerations associated with the use of the routine.

Calling Sequence

The format of a V+ CALL instruction for the routine is shown.

> **NOTE:** The variable names used for the routine parameters are for explanation purposes only. Your application program can use any variable names that you want when calling the routine.

Input Parameters

Each of the input parameters in the calling sequence is described in detail. For parameters that have a restriction of their acceptable values, the restriction is specified.

Output Parameters

Each of the output parameters in the calling sequence is described in detail.

Global Variables

Global variables accessed by the routine are described in this section.

Details

A complete description of the routine and its use is provided here.

Related Routines

Other AIM routines, related to the function of the current routine, are listed here.

> **NOTE:** Some of the routines listed may be documented in the reference guide for a different portion of your AIM system.

Statement Syntax

```
AUTO_BRIGHTNESS WITH --vision-- {AT_FREQUENCY --constant--}
  {OK_SIGNAL--output--}
```

Function

This routine is called from the runtime scheduler when it encounters an AUTO_BRIGHTNESS statement.

Usage Consideration

This routine may change the PARMETER V.OFFSET[cam] for one of the virtual cameras. It may also increase **vw.ab.next.time**.

Calling Sequence

```
CALL auto_brightness(args[], error)
```

Input Parameter

args[ ]	Real array containing the arguments for this statement. The individual elements are described below: [1] Inspection record that must be at the top of an Inspection — Window — [...] — Picture tree, where the Window computes the average graylevel, and the Inspection record tests the average graylevel against valid limits. [2] Nth_cycle indicator (defaults to 1). [3] Number of the output signal (hardware or software) to access to indicate the result. The value zero indicates no output.

Output Parameter

error	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard operator error response code values.

Global Variables

vw.precs[TASK( ), logical.rec]	List of physical record numbers.
vi.db[TASK( )]	Vision database for this task.
vw.data[vi.db[TASK( )],phys.rec,]	Real array containing the data for each record in the Vision database.
vw.res[vi.db[TASK( )],phys.rec,]	Results for each record.
vw.ab.next.time	Counter for how often to check and adjust the brightness.

Details

The Inspection record given must be testing the "Average Graylevel" result from the Window record. The preruntime routine for this statement (**pr.auto_brightn( )**) will check for this and return an error if it does not meet this condition.

An evaluation list was built at preruntime for each vision record in the sequence. Then, the **pr.auto_brightn( )** routine is called to prepare each AUTO_BRIGHTNESS statement. This will check to make sure the argument is correct, and put its physical record number in the logical-to-physical array.

The graylevel windows result is compared to the nominal value in the inspection record (this is done by the inspection record) and the deviation from nominal is used to adjust the video offset parameter in the picture called by the window record.

In addition, the high and low limits in the inspection record are used to provide a fail-safe check. If they are exceeded, the OK_SIGNAL is turned off. Or, if the inspection record returns an error, the OK_SIGNAL is turned off. Otherwise, it is asserted.

> **NOTE:** Usually, the **data[ ]** value for the offset is changed for the picture record, and the PARAMETER value is changed by the picture record at the next evaluation. However, if there is just one picture in the sequence with a preallocated virtual camera, this routine changes the system parameter directly since it would not have been changed by the picture (it was done at preruntime for the preallocated virtual camera).

Related Routine

pr.auto_brightn

Statement Syntax

```
INSPECT OPERATION --vision-- {& --vision--
    {& --vision-- {& --vision-- {& --vision--
    {& --vision-- {& --vision-- {& --vision--}}}}}}}
    {OK_SIGNAL --output--}
```

Function

Statement routine for the INSPECT statement that optionally (based on the state of a digital input signal) executes one or more vision inspection records, then signals on a digital output the results of the inspections.

Usage Consideration

This routine must be called from the runtime scheduler when it encounters an INSPECT statement.

Calling Sequence

```
CALL inspect (args[], error)
```

Input Parameter

args[ ]	Real array containing the arguments for this statement. The individual elements are described below: [0] Statement ID number. [1] Not used (formerly was the IF_SIGNAL argument). [2] - [9] Inspection record names. One is required. [10] Number of the output signal (hardware or software) to access to indicate the result of the inspection(s). The value zero indicates no output.

Output Parameter

error	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard operator error response code values.

Global Variables

vw.precs[TASK( ), logical.rec]	Real array containing the list of physical record numbers.
vi.db[TASK( )]	Real array containing the Vision database for this task.
vw.data[vi.db[TASK( )],phys.rec,]	Real array containing the data for each record in the Vision database.
vw.res[vi.db[TASK( )],phys.rec,]	Real array containing the results for each record.

Details

This routine executes each of the vision inspection records in sequence. If one of the inspections fails, the remaining inspections are not executed. Otherwise, they are all executed. If you would

like *all* the inspection records to be performed regardless of success and then have the output signal be set only if all succeed, use the INSPECT_LIST statement.

Each inspection is executed after first executing all the sources for the record that have not yet been executed. If any of those sources have sources of their own that have not yet been executed, they are done first, and so on, recursively, until the main inspection record can be executed.

If the number of the digital output signal is nonzero, the signal is asserted after all of the given inspections have been executed. If one of the inspections fails, any remaining inspections in the list are skipped and the opposite sense of the output signal is asserted. The sign of the signal number establishes whether the signal uses positive or negative logic.

An evaluation list was built at preruntime for each vision record in the sequence. Then, the **pr.inspect( )** routine is called to prepare each inspect statement. This routine checks to make sure each argument is an inspection record and puts its physical record number in the logical-to-physical array.

If the OK_SIGNAL is given, it is asserted to reflect the results of the inspection(s).

This statement may have multiple inspection arguments. If an argument is left blank, the rest are ignored.

Related Routines

inspect_list
pr.inspect
pr.inspect_list

Statement Syntax

```
INSPECT_LIST OPERATION --vision-- {& --vision--
    {& --vision-- {& --vision-- {& --vision--
    {& --vision-- {& --vision-- {& --vision--}}}}}}}
    {OK_SIGNAL --output--}
```

Function

Statement routine for the INSPECT_LIST statement that optionally (based on the state of a digital input signal) executes one or more vision inspection records, then signals on a digital output the results of the inspections. (This is nearly identical to the INSPECT statement—see the Details section below.)

Usage Consideration

This routine is called from the runtime scheduler when it encounters an INSPECT_LIST statement.

Calling Sequence

```
CALL inspect_list(args[], error)
```

Input Parameter

args[ ]	Real array containing the arguments for this statement. The individual elements are described below: [0] Statement ID number. [1] Not used (formerly was the IF_SIGNAL argument). [2...9] Inspection record names. One is required. [10] Number of the output signal (hardware or software) to access to indicate the result of the inspection(s). The value zero indicates no output.

Output Parameter

error	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard operator error response code values.

Global Variables

vw.precs[TASK( ), logical.rec]	Real array containing the list of physical record numbers.
vi.db[TASK( )]	Real array containing the Vision database for this task.
vw.data[vi.db[TASK( )],phys.rec,]	Real array containing the data for each record in the Vision database.
vw.res[vi.db[TASK( )],phys.rec,]	Real array containing the results for each record.

Details

The preruntime statement routine that accompanies this runtime routine simply calls the preruntime routine for the INSPECT statement.

This routine executes each of the vision inspection records in sequence. If one of the inspections fails, the INSPECT_LIST routine continues and performs the remaining inspections listed in the statement. (The INSPECT routine immediately skips to the output signal if it encounters a failed inspection.) The same signal state is output at the end of this statement routine, but this routine at least attempts to execute each of the inspections listed in the statement.

Each inspection is executed after first executing all the sources for the record that have not yet been executed. If any of those sources have sources of their own that have not yet been executed, they are done first, and so on, recursively, until the main inspection record can be executed.

If the number of the digital output signal is nonzero, the signal is asserted after all of the given inspections have been executed. If one of the inspections fails, any remaining inspections in the list are skipped and the opposite sense of the output signal is asserted. The sign of the signal number establishes whether the signal uses positive or negative logic.

An evaluation list was built at preruntime for each vision record in the sequence. Next, the **pr.inspect( )** routine is called to prepare each inspect statement. This routine checks to make sure each argument is an inspection record and puts its physical record number in the logical-to-physical array.

If the OK_SIGNAL is given, it is asserted to reflect the results of the inspection(s).

> **NOTE:** This statement may have multiple inspection arguments. If an argument is left blank, then the rest are ignored. Unlike the INSPECT statement, this statement evaluates *every one* of the arguments even if previous ones fail. It is identical to the INSPECT statement except for a "GOTO 90" statement.

Related Routines

inspect
pr.inspect
pr.inspect_list

Statement Syntax

```
OCR_OUTPUT FROM --vision-- {& --vision-- {& --vision--
     {& --vision-- {& --vision-- {& --vision--
     {& --vision-- {& --vision-- }}}}}}}
```

Function

Statement routine for the OCR_OUTPUT statement that executes one or more OCR-Field records and then outputs the string results from those records.

Usage Consideration

This routine must be called from a runtime task.

Calling Sequence

```
CALL ocr_output (args[], error)
```

Input Parameter

args[ ]	Real array containing the arguments for this statement. The individual elements are described below: [0] Statement ID number. [1] - [8] Logical record numbers of the OCR-Field records to execute. One is required.

Output Parameter

error	Real variable that receives a value indicating whether or not the statement was successful and what action should be taken by the calling routine. See the standard operator error response code values.

Global Variables

vw.precs[TASK( ), logical.rec]	List of physical record numbers.
vi.db[TASK( )]	Vision database for this task.
vw.data[vi.db[TASK( )],phys.rec,]	Real array containing the data for each record in the Vision database.
vw.res[vi.db[TASK( )],phys.rec,]	Results for each record.

Details

This routine takes string results from OCR-Field records and outputs them to the data-logging disk file or serial line. Data logging must be enabled, and a serial line or disk file must have been specified.

The evaluation list for each OCR-Field record is executed. If the top-level OCR-Field record is successful, its string result is output through the output port set up for data logging.

There is a related preruntime routine **pr.ocr_output( )**. It checks that each argument is the correct type of record.

Related Routine

pr.ocr_output

Statement Syntax

```
PICTURE --vision--
```

Function

This routine is called from the runtime scheduler when it encounters a PICTURE statement.

Calling Sequence

```
CALL picture(args[], error)
```

Input Parameter

args[ ]	Real array containing the arguments for this statement. The individual element is described below: [1] The picture record.

Output Parameter

error	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard operator error response code values.

Global Variables

vw.precs[TASK( ), logical.rec]	List of physical record numbers.
vi.db[TASK( )]	Vision database for this task.
vw.data[vi.db[TASK( )],phys.rec,]	Real array containing the data for each record in the Vision database.
vw.res[vi.db[TASK( )],phys.rec,]	Results for each record.

Details

This statement simply calls for the evaluation of a picture record. This is useful, and sometimes necessary, to force the ordering of pictures, allowing the scheduler to set up things for ping-pong (overlapped) picture taking. If pictures appear in a "conditional" situation in the sequence, then ping-ponging (picture pretaking) is not possible.

> **NOTE:** The order of the pictures in the sequence *must* be fixed and guaranteed in order to use ping-pong picture taking.

An evaluation list was built at preruntime for each vision record in the sequence. Then, the **pr.picture( )** routine is called to prepare each PICTURE statement. This routine checks to make sure each argument is a picture record and places its physical record number in the logical-to-physical array.

Related Routine

pr.picture

Calling Sequence

```
CALL pr.auto_brightn(args[], step, fail, error)
```

Function

Preruntime statement routine for the AUTO_BRIGHTNESS statement.

Usage Considerations

vw.precs[,] is changed.

vw.ab.next.time is initialized to 1.

Input Parameters

args[ ]	Real array containing the arguments for this statement. The individual elements are described below: [0] Statement ID number. [1] Window inspection record. [2] Number of the output signal (hardware or software) to access to indicate the result. The value zero indicates no output.
step	Real variable containing the sequence step number for this statement. This will need to be used to process errors as an argument to **rn.error( )** (see the *AIM Customizer's Reference Guide*).

Output Parameters

args[ ]	If args[0]=0, the AUTO_BRIGHTNESS statement is disabled.
fail	TRUE if there were any problems.
error	Standard AIM error response code.

Global Variables

vw.precs[TASK( ), logical.rec]	List of physical record numbers.
vw.ab.next.time	Counter for how often to check and adjust the brightness.

Details

This routine will prefetch the physical record number for each argument and make sure it has an entry in the logical-to-physical mapping array.

It will also check the record type for each argument to make sure that it is in the inspection class and that it inspects a window record for average graylevel.

CAUTION: This is a runtime routine.

It is performed after linking as one of the first steps in runtime. Errors must be handled by calling **rn.error( )**. Pop-ups are not allowed.

Related Routine

auto_brightness

Calling Sequence

```
CALL pr.inspect (args[], step, fail, error)
```

Function

Preruntime statement routine for the INSPECT statement.

Usage Consideration

This routine is called automatically at preruntime if the routine **pr.prep.module( )** is called from the application-dependent routine **rn.sched.start( )** in the file VWRES.SQU.

Input Parameters

args[ ]	Real array containing the arguments for this statement. The individual elements are described below: [0] Statement ID number. [1] Not used (used to be IF_SIGNAL). [2] - [9] Logical record numbers of the inspection records to execute. [10] Number of the output signal (hardware or software) to access to indicate the result of the inspection(s). The value zero indicates no output.
step	Real variable containing the sequence step number for this statement. This will need to be used to process errors as an argument to **rn.error( )** (see the *AIM Customizer's Reference Guide*).

Output Parameters

args[ ]	If args[0]=0, the INSPECT statement is disabled.
fail	TRUE if there were any problems.
error	Real variable that receives a Boolean value indicating whether or not the statement is okay to run. See the standard AIM error response code values.

Global Variables

vw.precs[TASK( ), logical.rec]	List of physical record numbers.
vi.db[TASK( )]	Vision database for this task.
vw.data[vi.db[TASK( )],phys.rec,]	Real array containing the data for each record in the Vision database.

Details

This routine is performed after linking as one of the first steps in runtime. It is designed to make the routine **inspect( )** run as fast as possible at runtime.

Each of the inspection record arguments is specified in the **args[]** array as a logical record number. This routine converts each logical record number to a physical record number and makes an entry in the global array **vw.precs[l.rec]**. That provides a fast way to get the physical record number for each of the inspections in the argument list.

Next, the routine checks that each of the records specified (in **args[2]** through **args[9]**) is actually a member of the inspect class. It also verifies that an evaluation list was successfully created for each argument during the list building process.

If either of the above conditions is not satisfied, an error is generated. Errors must be handled by calling **rn.error( )**. Pop-ups are not allowed.

Related Routines

inspect
inspect_list
pr.inspect_list

Calling Sequence

```
CALL pr.inspect_list (args[], step, error)
```

Function

Preruntime statement routine for the INSPECT_LIST statement.

Usage Consideration

This routine is called automatically at preruntime if the routine **pr.prep.module( )** is called from the application-dependent routine **rn.sched.start( )** in the file VWRES.SQU.

Input Parameters

args[ ]	Real array containing the arguments for this statement. The individual elements are described below: [0] Statement ID number. [1] Not used (used to be IF_SIGNAL). [2] - [9] Logical record numbers of the inspection records to execute. [10] Number of the output signal (hardware or software) to access to indicate the result of the inspection(s). The value zero indicates no output.
step	Real variable containing the sequence step number for this statement. This will need to be used to process errors as an argument to **rn.error( )** (see the *AIM Customizer's Reference Guide*).

Output Parameters

args[ ]	If args[0]=0, the INSPECT_LIST statement is disabled.
error	Standard AIM error response code.

Global Variables

vw.data[vi.db[TASK( )],phys.rec,]	Real array containing the data for each record in the Vision database.

Details

This routine simply calls the routine **pr.inspect( )**, the preruntime routine for the INSPECT statement. The preruntime preparation is identical for both statements.

Related Routines

pr.inspect
inspect_list

Calling Sequence

```
CALL pr.ocr_output (args[], step, fail, error)
```

Function

Preruntime statement routine for the OCR_OUTPUT statement.

Usage Consideration

This routine is called automatically at preruntime if the routine **pr.prep.module( )** is called from the application-dependent routine **rn.sched.start( )** in the file VWRES.SQU.

vw.precs[,] is changed.

Input Parameters

args[ ]	Real array containing the arguments for this statement. The individual elements are described below: [0] Statement ID number. [1] - [8] Logical record numbers of the OCR-Field records to execute. One is required.
step	Real variable containing the sequence step number for this statement. This will need to be used to process errors as an argument to **rn.error( )** (see the *AIM Customizer's Reference Guide*).

Output Parameters

args[ ]	If args[0]=0, the OCR_OUTPUT statement is disabled.
fail	TRUE if there were any problems.
error	Real variable that receives a Boolean value indicating whether or not the statement is okay to run. See the standard AIM error response code values.

Global Variables

vw.data[vi.db[TASK( )],phys.rec,]	Real array containing the data for each record in the Vision database.
vw.precs[TASK( ), logical.rec]	List of physical record numbers.

Details

This routine is designed to make the routine **ocr_output( )** run as fast as possible at runtime.

First, if the OCR option is not installed in the system, an error occurs and the statement is disabled from running.

Each of the OCR-Field record arguments is specified in the **args[ ]** array as a logical record number. This routine converts each logical record number to a physical record number and makes an entry in the global array **vw.precs[l.rec]**. This provides a fast way to get the physical record number for each of the inspections in the argument list.

Next, the routine checks that each of the records specified (in **args[1]** through **args[8]**) is actually a member of the OCR class. (Currently, only the OCR-Field record type is in the OCR class.) This routine also verifies that an evaluation list was created successfully for each argument during the list building process.

This routine checks that data logging is enabled, since the statement is almost useless if it cannot output string data.

If any of the above checks are not satisfied, an error is generated. Errors must be handled by calling **rn.error( )**. Pop-ups are not allowed.

Related Routine

ocr_output

Calling Sequence

```
CALL pr.picture(args[], step, fail, error)
```

Function

Preruntime statement routine for the PICTURE statement.

This routine is called automatically at preruntime if the routine **pr.prep.module( )** is called from the application-dependent routine **rn.sched.start( )** in the file VWRES.SQU.

Input Parameters

args[ ]	Real array containing the arguments for this statement. The individual elements are described below: [0] Statement ID number. [1] Picture record number (logical).
step	Real variable containing the sequence step number for this statement. This will need to be used to process errors as an argument to **rn.error( )** (see the *AIM Customizer's Reference Guide*).

Output Parameters

args[ ]	If args[0]=0, the PICTURE statement is disabled.
fail	TRUE if there were any problems.
error	Standard AIM error response code.

Global Variables

vw.precs[TASK( ), logical.rec]	List of physical record numbers.
vi.db[TASK( )]	Vision database for this task.
vw.data[vi.db[TASK( )],phys.rec,]	Real array containing the data for each record in the Vision database.

Details

The **pr.picture( )** routine is called to prepare each PICTURE statement. It verifies that each argument is a picture record and places its physical record number in the logical-to-physical array.

It is performed after linking as one of the first steps in runtime. Errors must be handled by calling **rn.error( )**. Pop-ups are not allowed.

Related Routine

picture

Calling Sequence

```
CALL vw.pr.error(error, resp, code, step, db, lrec)
```

Function

This routine constructs a descriptive string for outputting a preruntime error.

Usage Considerations

The final output should look like:

```
*Invalid vision record* Step: 4, Db: vision, Record: insp1
```

Input Parameters

These are the same as the input parameters for the routine **rn.error( )** (see the *AIM Customizer's Reference Guide*), except for:

step	The sequence step being executed when the error occurred.

Output Parameter

error	Standard operator error response code.

Details

This routine simply calls the runtime routine **rn.error( )**.

Related Routine

rn.error

Chapter 8
Descriptions of Vision Module Routines

This chapter describes the functions and calling sequences of routines provided in the AIM Vision Module. These routines may be called by application software written by a system customizer when modifying or creating schedulers, statements, or primitives.

Commented V+ source code for some of these routines is provided with the AIM Vision Module. Thus, some of these routines may be modified by a system customizer.

> **NOTE:** In general, the calling sequences and the interpretations of program parameters must be preserved exactly as described in this chapter. This restriction is required to maintain compatibility with calls by other routines in the AIM system.

The descriptions of the routines are presented in alphabetical order, with each routine starting on a separate page. The "dictionary page" for each routine contains the following sections, as applicable:

Calling Sequence

The format of a V+ CALL instruction for the routine is shown.

> **NOTE:** The variable names used for the routine parameters are for explanation purposes only. Your application program can use any variable names that you want when calling the routine.

Function

This is a brief statement of the function of the routine.

Usage Consideration

This section is used to point out any special considerations associated with the use of the routine.

Input Parameters

Each of the input parameters in the calling sequence is described in detail. For parameters that have a restriction of their acceptable values, the restriction is specified.

Output Parameters

Each of the output parameters in the calling sequence is described in detail.

Global Variables

Global variables accessed by the routine are described in this section.

Details

A complete description of the routine and its use is provided here.

Related Routines

Other AIM routines, related to the function of the current routine, are listed here.

Calling Sequence

```
CALL qc.accum.stats(key, stats[], result, value, status)
```

Function

This routine accumulates statistics based on the results of an inspection.

Usage Considerations

This routine is designed to be called from the record-type execution routine.

The statistics array and accumulation parameters must be initialized by a call to **qc.set.acc.stat( )** prior to calling this routine.

Input Parameters

key	Real value specifying the key that identifies the statistics arrays to receive the new data.
stats[ ]	Array of real values containing the statistics accumulated so far for this key. This parameter should be specified in the calling program as **qc.stats[key,]**.
result	Real value specifying the Boolean result of testing the value for pass/fail.
value	Real value specifying the value that is the subject of the pass/fail test.

Output Parameters

stats[ ]	Same as the input array, but with updated statistics.
status	Real variable that receives a value indicating whether or not the operation was successful. See the standard V^+ error codes and AIM status values.

Details

The following global arrays are associated with each value for which statistics are being accumulated (each value has a **key**):

Global Array	Description
qc.stats[key,*]	(See below)
qc.cnt.ok[key,N]	Values in the bin that passed inspection
qc.cnt.fh[key,N]	Values in bin that failed over max limit
qc.cnt.hi[key,N]	Values that passed with high warning
qc.cnt.lo[key,N]	Values that passed with low warning
qc.sum[key,N]	Sum of the values in the bin
qc.sum.sq[key,N]	Sum of the squares of (value-nominal) for all the values in the bin
qc.min[key,N]	Minimum value in the bin
qc.max[key,N]	Maximum value in the bin

For each array, "N" is **qc.max.numbins** the number of "sample bins" (which is initially set to 50). This is the number of data points that are plotted horizontally.

There is a sample size associated with each inspection. For measurements, the sample size ranges from 1 to **qc.max.rbinsiz** (initially set to 200). For Boolean tests, the sample size ranges from 1 to **qc.max.bbinsiz** (initially set to 10000).

The elements of the array **qc.stats[key,*]** are described below. The label given for each element is the global index variable to be used when accessing the array (for example, **qc.stats[key,qc.stat.binsiz]**).

qc.stat.binsiz The number of measurements in a sample bin. This is in the range 1 to 10 for X-bar and R charts. For P-charts, the range is 1 to 10000.

qc.stat.cnt Total number of measurements in the statistics arrays. If the value is –1, the statistics arrays are reset to zero the next time this routine is called.

qc.stat.maxcm1 Maximum number of measurements in the statistics array, minus one bin worth. That is:

qc.stats[key,qc.stat.binsiz] * (qc.max.numbins–1)

qc.stat.okcnt The number of successful measurements. (This is less than or equal to **qc.stats[key,qc.stat.cnt]**.)

qc.stat.cbin The index of the current sample bin. (This must be less than **qc.max.numbins**.)

qc.stat.bincnt The number of measurements in the current sample bin. (This is less than or equal to **qc.stat.binsiz**.)

qc.stat.totcnt The total number of measurements. This is set to zero when it reaches 2^{24} (16,777,216).

qc.stat.totok The total number of inspections passed. This is set to zero when the total count wraps around to 0.

qc.stat.value The last value accumulated.

qc.stat.result The last result accumulated (TRUE or FALSE).

qc.stat.warn.hi The warning indicator for the last value. This is set to the value from the inspections results array, regardless of whether or not the inspection passed.

qc.stat.warn.lo The warning indicator for the last value. This is set to the value from the inspections results array, regardless of whether or not the inspection passed.

Related Routine

qc.set.acc.stat

Calling Sequence

```
CALL qc.set.acc.stat(mode, key, p.rec, bool.res,
           bin.size, $item, limits[], log.mode, $log.label)
```

Function

Allocate, change, or delete arrays for accumulating statistics to be displayed on the results page.

Usage Considerations

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

mode	Real value specifying one of various actions to perform. The possible values are: 0 Allocate (and zero) data structures 1 Modify a parameter and zero the data structures 2 Delete allocated data structures
key	Real variable specifying the key that was returned by this routine at allocation time. See below for more information on this parameter.
p.rec	Real value specifying a physical record number. (This is used only for mode 0.)
bool.res	Real value specifying whether the result on which to accumulate statistics is a Boolean (TRUE) or a real value (FALSE).
bin.size	Real value specifying the size of the bin in which the statistics are to be accumulated. This must be in the range 1 to 10 for real-valued results, or 1 to 10000 for Boolean results.
$item	String value specifying the label to associate with this particular result. This needs only to distinguish one result from another within the same record type. This string is truncated to 15 characters and may be an empty string (””).

limits[ ] Array of real values specifying the control limits for the value being tested. The values must be specified as follows:

limits[vi.lim.nom]	Nominal value
limits[vi.lim.min]	Minimum pass/fail limit
limits[vi.lim.max]	Maximum pass/fail limit
limits[vi.lim.lo]	Low warning limit
limits[vi.lim.hi]	High warning limit

where:

vi.lim.nom	= 0
vi.lim.min	= 1
vi.lim.max	= 2
vi.lim.lo	= 3
vi.lim.hi	= 4

(The elements are in the same order as in the database and in the data arrays.)

log.mode Real value that specifies the mode in which to log results, as follows:

0	No logging of results
1	Log all results
–1	Log only failed results
–2	Log only failed results and warnings

$log.label String value specifying the label to use in the process of logging results. The string must be one to three characters long. When logging results from several different inspections, this string is necessary for distinguishing between them in the log output. This parameter is required, but it may be an empty string (“”).

Output Parameters

key Real variable that receives the number allocated for this result. This number is to be used in all subsequent calls to this routine, as well as for the actual statistics accumulator (**qc.accum.stats( )**).

status Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

This routine is used for initialization and maintenance of parameters for statistics accumulation. It operates in three modes, as indicated by the **mode** argument.

When **mode** is 0, if the **key** parameter is 0 or undefined, data structures are allocated (and zeroed) and a “key” is returned. This key is to be used for all subsequent calls to this routine, as well as the actual statistics accumulator (**qc.accum.stats( )**). If the key is already defined, the statistics arrays are zeroed.

When **mode** is 1, the routine uses the input parameters to alter parameters for the computation or display of the statistics. If any value is changed, the data accumulation arrays are zeroed.

When **mode** is 2, the routine deletes an allocated data structure. The **key** indicates the statistic that is to be deleted. This mode should be called when any record is deleted that is accumulating statistics.

The following variables refer to the second index in **qc.stats[key,]** for those elements that are set using values passed to this routine:

qc.stat.p.rec — Physical record number of the record for which the results value is accumulated.

qc.stat.bool — TRUE if a Boolean value is being accumulated; FALSE if a real value is being accumulated.

qc.stat.nomchk — Nominal value for comparing to collected values. This is also used to normalize the data values for standard deviation and Cpk calculations. This can be very helpful for avoiding loss of precision. It should be set appropriately.

qc.stat.maxchk — Maximum pass/fail limit.

qc.stat.minchk — Minimum pass/fail limit.

qc.stat.hichk — High warning limit.

qc.stat.lochk — Low warning limit.

qc.stat.logem — Logging mode indicator, as follows:

0	No logging of results
1	Log all results
–1	Log only failed results
–2	Log only failed results and warnings

Related Routine

qc.accum.stats

Calling Sequence

```
CALL ve.*.action(event[], data[], list[,], index, status)
```

Function

Update the absolute shape parameters in **data[ ]**, based on the mouse event described in **event[ ]**.

Usage Considerations

This page describes a *group* of routines that provide similar functionality for different editing shapes.

The routine name shown in the calling sequence above is not the name of an executable routine. The character "*" in the name must be replaced by the appropriate letters for the specific routine (see below).

These routines can be used only while editing a vision record. Normally, they are called by the record-type edit routine (in mode 2).

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

event[ ]	Array of up to seven real values that describes a mouse event that happened for a particular handle. See the section "Edit Action Events" on page 60 for descriptions of the possible events and their representations in this array.
data[ ]	Array of real values containing numeric data for a specific vision record.
list[,]	Array of real values containing a list of handle descriptors for the handles to be used to manipulate the shape.
index	Real value specifying the handle in the list to which the mouse event pertains.

Output Parameters

data[ ]	Same as input except that some values may have changed.
status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

The mouse-button-down, mouse-move, and mouse-button-up events are used to note relative mouse movements. For each handle, these mouse movements affect the absolute shape parameters in different ways. For example, events on the handles for the rectangle shape have the following effects:

- Position handle.

  Mouse movement translates directly into movement of the center of the rectangle (**data[vs.x]** and **data[vs.y]**).

- Width handle.

As the mouse pointer is moved toward or away from the center of the rectangle, the width (**data[vs.dx]**) decreases or increases twice as much as the change in distance.

- Height handle.

  Same as the width handle, except for the height (**data[vs.dy]**).

- Angle handle.

  As the angle of the mouse pointer changes with respect to the rectangle's center, the angle of the rectangle (**data[vs.ang]**) changes proportionally. However, when the angle parameter is within one degree of vertical or horizontal, the angle parameter "snaps" to the nearest multiple of 90 degrees (using the routine **ve.snap.ang( )**).

The following routines process the mouse events for the indicated shapes. In most cases, the relationship between the mouse events and the parameter changes is as expected, or it is obvious from editing the associated standard vision tool.

Routine	Use
ve.ai.action	Area of interest (nonrotatable) window shape
ve.ai2.action	Area of interest (rotatable) window shape
ve.an.action	Annular window shape
ve.an2.action	Annular window shape with fixed center
ve.ar.action	Arc ruler shape
ve.cr.action	Circle ruler shape
ve.fa.action	Arc or circle finder shape
ve.fa2.action	Fixed-center arc finder shape
ve.fl.action	Line finder shape
ve.fp.action	Point finder shape
ve.ft.action	Fixed-feature handle shape
ve.gr.action	Grid-style rectangle shape
ve.ru.action	Linear ruler shape
ve.wi.action	Rectangle window shape

These routines work correctly only when used in conjunction with the corresponding routines **ve.*.init( )** and **ve.*.update( )**.

Related Routines

ve.*.init
ve.*.update
vrec.edit

Calling Sequence

```
CALL ve.*.init(mode, data[ ], list[,], index, valid)
```

Function

Initialize the handles for an editing shape.

Usage Considerations

This page describes a *group* of routines that provide similar functionality for different editing shapes.

The routine name shown in the calling sequence above is not the name of an executable routine. The character "*" in the name must be replaced by the appropriate letters for the specific routine (see below).

These routines can be used only while editing a vision record. Normally, they are called by the record-type edit routine (in mode 0).

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

mode	Real value that is currently not used.
index	Real value specifying the handles that need to be initialized. If **index** is 1, the position handle is initialized. If **index** is –1, all handles are initialized.
data[ ]	Array of real values containing numeric data for a specific vision record.
valid	Real value that is currently not used.

Output Parameter

list[,]	Array of real values that receives a list of handle descriptors for the handles that will be used to manipulate the shape.

Details

These routines define data for identifying handles to other routines. Specifically, the routines define global index variables and initialize the list of handles with the handle types. (If the **index** parameter is 1, only the position handle is initialized. Thus, the position handle is always initialized.)

These routines are prerequisites for use of the corresponding routines **ve.*.update( )** and **ve.*.action( )**.

- **ve.ai.init( )—**Area of interest (nonrotatable) window shape.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.ai.lft	Left side
et.ai.rt	Right side
et.ai.top	Top

Handle Index	Type (Shape/Style)
et.ai.bot	Bottom
et.ai.ul	Upper left corner
et.ai.ur	Upper right corner
et.ai.ll	Lower left corner
et.ai.lr	Lower right corner

- **ve.ai2.init( )**—Area of interest (rotatable) window shape.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.ai.lft	Left side
et.ai.rt	Right side
et.ai.top	Top
et.ai.bot	Bottom
et.ai.ang	Angle handle

- **ve.an.init( )**—Annular window shape.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.aw.start	Dimension handle
et.aw.end	Dimension handle
et.aw.rad	Dimension handle
et.aw.rng	Dimension handle
et.aw.rot	Angle handle

- **ve.an2.init( )** — Annular window shape with fixed center.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.an.or	Outer radius
et.an.ir	Inner radius
et.an.rot	Rotation
et.an.ang0	Start angle
et.an.angn	End angle

- **ve.ar.init( )** — Arc ruler shape.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.ar.rad	Dimension handle
et.ar.start	Dimension handle
et.ar.end	Dimension handle

- **ve.cr.init( )** — Circular ruler shape.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.cr.rad	Dimension handle
et.cr.a0	Angle handle

- **ve.fa.init( )** — Arc / Circle Finder shape.

  This routine is designed to apply to two standard vision-tool shapes: the Arc Finder and the Circle Finder. To use this routine for the circle-finder shape, the evaluation method of the record must be the same as for a circle finder. That is, the element **data[vs.type]** must be equal to **vw.tl.fcirc**. Otherwise, the routine operates as if for an arc-finder shape.

  For an arc-finder shape the following handles are initialized:

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.fa.rad	Dimension handle
et.fa.start	Dimension handle
et.fa.end	Dimension handle
et.fa.rng	Dimension handle
et.fa.rot	Angle handle

  For a circle-finder shape, the following handles are initialized:

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.fa.rng	Dimension handle
et.fa.radc	Dimension handle

- **ve.fa2.init( )** — Arc finder shape with fixable center.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.fa.rad	Dimension handle
et.fa.rng	Dimension handle
et.fa.rot	Angle handle
et.fa.ang0	Angle handle
et.fa.angn	Angle handle

- **ve.fl.init( )** — Line Finder shape.

  (This routine can be found in the file VFINDERS.V2.)

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.fl.ht	Dimension handle
et.fl.angwid	Angle handle

- **ve.fp.init( )** — Point Finder shape.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.fp.wid	Dimension handle
et.fp.anght	Angle handle

- **ve.ft.init( )**—Fixed feature handle.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.ft.ang	Angle
et.ft.rad	Radius

- **ve.gr.init( )** — Grid-style rectangle.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.fl.ht	Dimension handle
et.fl.angwid	Dimension handle

- **ve.ru.init( )** — Linear ruler shape.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.ru.start	Dimension handle
et.ru.end	Dimension handle

- **ve.ur.init( )** — Unrotatable rectangle.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.wi.wid	Dimension handle
et.wi.ht	Dimension handle

- **ve.wi.init( )** — Rotatable rectangle.

Handle Index	Type (Shape/Style)
et.pos	Position handle
et.wi.wid	Dimension handle
et.wi.ht	Dimension handle
et.wi.ang	Angle handle

Related Routines

ve.∗.action
ve.∗.update
vrec.edit

Calling Sequence

```
CALL ve.*.update(data[ ], list[,], index)
```

Function

Set the handle locations for an editing shape based on the absolute shape parameters in **data[ ]**.

Usage Considerations

This page describes a *group* of routines that provide similar functionality for different editing shapes.

The routine name shown in the calling sequence above is not the name of an executable routine. The character "*" in the name must be replaced by the appropriate letters for the specific routine (see below).

These routines can be used only while editing a vision record. Normally, they are called by the record-type edit routine (in mode 1).

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

data[ ]	Array of real values containing numeric data for a specific vision record.
list[,]	Array of real values containing a list of handle descriptors for the handles to be used to manipulate the shape.
index	Real value specifying which handles in the list need to be set. If **index** is 1, the location is set for the position handle. If **index** is –1, the locations are set for all handles in the list.

Output Parameter

list[,]	Array of real values receiving an updated list of handle descriptors for the handles to be used to manipulate the shape. The appropriate handles will have (x,y) location information defined.

Details

The following routines set the handle locations for the shapes indicated. The locations of the handles for each shape are not described, since they should be clear from working with the standard vision tools for which these routines were written.

Routine	Use
ve.ai.update	Area of interest (nonrotatable) window shape
ve.ai2.update	Area of interest (rotatable) window shape
ve.an.update	Annular window shape
ve.an2.update	Annular window with fixed center
ve.ar.update	Arc ruler shape
ve.cr.update	Circle ruler shape
ve.fa.update	Arc or circle finder shape
ve.fa2.update	Fixed-center arc finder shape

Routine	Use
ve.fl.update	Line finder shape
ve.fp.update	Point finder shape
ve.ft.update	Fixed-feature handle shape
ve.gr.update	Grid-style rectangle shape
ve.ru.update	Linear ruler shape
ve.wi.update	Rotatable rectangle shape

The absolute (x,y) location computed for each handle is assigned to the “et.x” and “et.y” elements of the handle descriptors in the list of handles.

If the **index** parameter is 1, only the location of the position handle is set.

These routines work correctly only when used in conjunction with the corresponding routine **ve.∗.init( )**.

Related Routines

ve.∗.action
ve.∗.init
vrec.edit

Calling Sequence

```
CALL ve.bad.cam(arg, db.p, bad.cam)
```

Function

Test if the camera record for the current record is calibrated correctly for the system.

Usage Consideration

This routine is designed to be used as a conditional spawn routine on menu pages. The arguments for this routine match those for conditional spawn routines.

Input Parameters

arg	Real value that is currently ignored.
db.p	Real value that is currently not used.

Output Parameter

bad.cam	Real variable that receives a value indicating the status of the camera calibration for the current record being edited. The value returned will be TRUE if the camera is *not* correctly calibrated. It will be FALSE if the camera is correctly calibrated.

Details

If the virtual camera for the current record either is not calibrated, or is calibrated as a robot-mounted camera in a system with no robot, the returned value of **bad.cam** indicates that the calibration is not correct.

Calling Sequence

```
CALL ve.circ.3pts(x1, y1, x2, y2, x3, y3, xc, yc,
                                                rad, status)
```

Function

Compute the circle that goes through three specified points.

Input Parameters

x1, y1	Real values specifying the (x,y) location of the first point.
x2, y2	Real values specifying the (x,y) location of the second point.
x3, y3	Real values specifying the (x,y) location of the third point.

Output Parameters

xc, yc	Real variables that receive the (x,y) location of the center of the computed circle.
rad	Real variable that receives the radius of the computed circle.
status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

The circle is computed by finding the perpendicular bisectors for the point pairs 1 and 2, and 2 and 3. The center is at the intersection of the two lines. The radius is the distance from the center to one of the points.

The **status** parameter reports arithmetic overflow if the three points are colinear (that is, if the points lie on a line).

Related Routine

vw.circ.3pts

Calling Sequence

```
CALL ve.draw.arrow(x0, y0, angle, mode, color)
```

Function

Draw the head of an arrow, given the direction the arrow is to point.

Usage Considerations

The calling routine should draw the line or arc to which the arrowhead is connected.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

x0, y0	Real values specifying the (x,y) location of the tip of the arrowhead.
angle	Real value specifying the direction the arrowhead should point. (Zero degrees is to the right; 90 degrees is up; etc.)
mode	Real value specifying the display mode to use for the G∗ graphics instructions (GARC, etc.): –-1 = no draw, 0 = erase, 1 = draw, 2 = complement, 3 = dashed. (This parameter should almost always be 2.)
color	Real value specifying the color to use when drawing the graphic. The possible values are 0 to 15, inclusive.

Output Parameter

None.

Details

This routine draws the standard representation of an arrowhead, pointing in the direction indicated. The arrowhead is not drawn if the location of its tip is outside the Vision window.

The sides of the arrowhead are 10 pixels long, and they depart from the tip at ±135 degrees from the direction (angle) of the arrow.

Calling Sequence

```
CALL ve.draw.frame(frame[ ], mode, color, status)
```

Function

Draw the standard graphic representation for a vision-frame feature.

Usage Considerations

The GTRANS system parameter must be set to mode 1. This is the default graphics mode for the AIM Vision Module.

This routine expects the variable **vw.v.cam** to indicate the virtual camera currently displayed. This is true during vision editing and in walk-thru training when **Show➡Runtime Graphics** is selected. Thus, before calling this routine from a record-type execution routine, you should make sure that the global variable **vw.run.disp[ ]** is nonzero.

Input Parameters

frame[ ]	Array of real values specifying the parameters of the vision-frame graphic to draw. The parameters are in millimeters and degrees, and are arranged as follows:

frame[vw.x]	X coordinate of the origin
frame[vw.y]	Y coordinate of the origin
frame[vw.ang]	Angle of the X axis
frame[vw.cos]	Cosine of the angle
frame[vw.sin]	Sine of the angle

mode	Real value specifying the display mode to use for the G∗ graphics instructions (GARC, etc.): –1 = no draw, 0 = erase, 1 = draw, 2 = complement, 3 = dashed. (This parameter should almost always be 2.)
color	Real value specifying the color to use when drawing the vision-frame graphic. The possible values are 0 to 15, inclusive.

Output Parameter

status	Real variable that receives a value indicating whether or not the operation was successful. The value is 0 if the operation was successful, or equal to **ec.arith.ovr** for arithmetic overflow. (This error indicates bad values for the sine and cosine elements in the vision-frame parameters.)

Details

This routine is provided to allow vision frames to be drawn with an appearance that is consistent with the other vision frames drawn by the Vision Module.

The vision frame is drawn with 100-pixel X and Y axes extending in the positive directions from the origin. At the end of each axis there is an arrow pointing away from the origin and a label for the axis.

Related Routines

ve.draw.line
ve.draw.point

Calling Sequence

```
CALL ve.draw.line(line[ ], mode, color, status)
```

Function

Draw the standard graphic representation for a line feature.

Usage Considerations

The GTRANS system parameter must be set to mode 1. This is the default graphics mode for the AIM Vision Module.

This routine expects the variable **vw.v.cam** to indicate the virtual camera currently displayed. This is true during vision editing, and in walk-thru training when **Show➡Runtime Graphics** is selected. Thus, before calling this routine from a record-type execution routine, you should make sure that the global variable **vw.run.disp[ ]** is nonzero.

Input Parameters

line[ ] — Array of real values specifying the parameters of the line to draw. The parameters are in millimeters and degrees and are arranged as follows:

line[vw.x]	X coordinate of a point on the line
line[vw.y]	Y coordinate of a point on the line
line[vw.ang]	Angle of the line
line[vw.cos]	Cosine of the angle
line[vw.sin]	Sine of the angle

mode — Real value specifying the display mode to use for the G∗ graphics instructions (GARC, etc.): –1 = no draw, 0 = erase, 1 = draw, 2 = complement, 3 = dashed. (This parameter should almost always be 2.)

color — Real value specifying the color to use when drawing the line. The possible values are 0 to 15, inclusive.

Output Parameter

status — Real variable that receives a value indicating whether or not the operation was successful. The value is 0 if the operation was successful or equal to **ec.arith.ovr** for arithmetic overflow. (This error indicates bad values for the sine and cosine elements in the line parameters.)

Details

This routine is provided to allow lines to be drawn with an appearance that is consistent with the other lines drawn by the Vision Module.

The line is drawn with infinite length, but it is clipped by the edges of the Vision window.

Related Routines

ve.draw.frame
ve.draw.point

Calling Sequence

```
CALL ve.draw.point(x0, y0, mode, color)
```

Function

Draw the standard graphic symbol for a point feature.

Usage Considerations

The GTRANS system parameter must be set to mode 1. This is the default graphics mode for the AIM Vision Module.

This routine expects the variable **vw.v.cam** to indicate the virtual camera currently displayed. This is true during vision editing, and in walk-thru training when **Show➡Runtime Graphics** is selected. Thus, before calling this routine from a record-type execution routine, you should make sure that the global variable **vw.run.disp[ ]** is nonzero.

Input Parameters

x0, y0	Real values specifying the coordinates (in millimeters) for the center of the point graphic.
mode	Real value specifying the display mode to use for the G∗ graphics instructions (GARC, etc.): –1 = no draw, 0 = erase, 1 = draw, 2 = complement, 3 = dashed. (This parameter should almost always be 2.)
color	Real value specifying the color to use when drawing the point graphic. The possible values are 0 to 15, inclusive.

Output Parameter

None.

Details

This routine is provided to allow points to be drawn with an appearance that is consistent with the other points drawn by the Vision Module.

The point is displayed as a 3-pixel by 3-pixel box with an 11-pixel by 11-pixel cross hair.

Related Routines

ve.draw.frame
ve.draw.line

Calling Sequence

```
CALL ve.force.pic.ok(p.rec, status)
```

Function

Force the current picture to be the correct one for the given record.

Usage Considerations

This routine can be used only while editing a vision record.

This routine may be called only by the record-type edit routine.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameter

p.rec	Real value specifying the physical record number of the record for which we need to force the current picture.

Output Parameter

status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

If live video is being displayed, this routine changes the display mode to be **vw.vdisp.mode** with overlay on.

This routine determines the correct picture to be displayed for the given record. If the picture currently displayed is not that one, a new picture is taken with the correct picture record.

Errors (nonzero status) will be generated when the scheduler is active or when the picture is wrong and a new one cannot be taken (probably because image lock is on).

Related Routine

ve.get.ref.pic

Calling Sequence

```
CALL ve.get.ref.pic(p.rec, pic.rec)
```

Function

Determine the correct image to display for editing a record.

Usage Consideration

If the record to be edited is a picture record, that record is the correct image. If the record is a vision tool, src.1 is chosen. Otherwise, the ref.pic will be the required current picture.

Input Parameter

p.rec	Real value specifying the physical record number of the record.

Output Parameter

pic.rec	Real value that receives the physical record number of the picture that should be displayed during editing of the specified input record.

Details

The correct picture is determined as follows:

- If the specified record is a picture record, the same record number is returned.
- If the specified record is a vision tool, source 1 (the picture source for the vision tool) is returned.
- Otherwise, the reference picture is chosen as the correct picture to display.

Related Routine

ve.force.pic.ok

Calling Sequence

```
CALL ve.line.arrows(x1, y1, x2, y2, offset1, offset2,
                                                mode, color)
```

Function

Depict a linear dimension by drawing a line with an arrowhead at each end.

Usage Consideration

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

x1, y1	Real values specifying the (x,y) location of point 1 (one end of the linear range).
x2, y2	Real values specifying the (x,y) location of point 2 (the other end of the linear range).
offset1	Real value specifying whether or not to keep the arrowhead a short distance away from point 1. That is, this parameter is set TRUE to allow space for graphics at that point.
offset2	Real value specifying whether or not to keep the arrowhead a short distance away from point 2. That is, this parameter is set TRUE to allow space for graphics at that point.
mode	Real value specifying the display mode to use for the G∗ graphics instructions (GARC, etc.): –1 = no draw, 0 = erase, 1 = draw, 2 = complement, 3 = dashed. (This parameter should almost always be 2.)
color	Real value specifying the color to use when drawing the graphic. The possible values are 0 to 15, inclusive.

Output Parameter

None.

Details

If the linear range is small, the line is drawn in two short sections on the outside of the linear range, with the arrowheads pointing at each other.

For each end of the range (point 1 and point 2), there is a separate parameter to indicate whether or not to leave a little space near the end point. If an indicator (**offset1** or **offset2**) is TRUE, a two-pixel space is left at the corresponding end of the line to allow for a point symbol or other graphic that may appear there.

This routine uses the routine **ve.draw.arrow( )** to draw the arrowheads. See the description of that routine for a description of the appearance of the arrowheads.

Related Routines

ve.draw.arrow
ve.plot.arange

Calling Sequence

```
CALL ve.mv.ang(event[], xc, yc, angle, dsp.dot)
```

Function

Make an angle value track the movement of the mouse pointer relative to a given reference point.

Usage Considerations

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine (in mode 2) for mouse events on angle handles.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

event[ ]	Array of up to seven real values that describes a mouse event. See the section "Edit Action Events" on page 60 for descriptions of the possible events and their representations in this array.
xc, yc	Real values specifying the coordinates of the original reference point. These are ignored except for mouse-button-down events.
angle	Real value specifying the original angle value. This parameter is used as *input* only for mouse-button-down events.
dsp.dot	Real value specifying whether or not the routine should display a 3-pixel by 3-pixel white dot at the reference point (center of rotation) while the angle is being changed. Any nonzero value causes the dot to be drawn.

Output Parameter

angle	Real variable that receives the new angle value as the mouse is moved. This parameter is used as *output* only for mouse-move and mouse-button-up events. No value is returned for mouse-button-down events.

Details

This routine reacts only to mouse-button-down, mouse-move, and mouse-button-up events.

When a mouse-button-down event occurs, the routine stores the location of the reference point, the original angle, and the original location of the mouse pointer. Then, when a mouse-move event occurs, the routine passes back a new angle value based on the angular change of position of the mouse pointer relative to the reference point.

If requested, a 3-pixel by 3-pixel white dot is drawn at the reference point so the operator can see the center of rotation.

Related Routines

ve.mv.arcpt
ve.mv.dim
ve.mv.pos
ve.mv.rad
ve.mv.rot
ve.mv.rsides
ve.mv.sides
ve.snap.ang
vrec.edit

Calling Sequence

```
CALL ve.mv.arcpt(event[], x1, y1, x2, y2, x3, y3, status)
```

Function

Make a point (one of three that define a circle) track the movement of the mouse pointer.

Usage Considerations

Limit checking is performed to ensure that the three points can still form a circle.

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine (in mode 2) for mouse events on angle handles.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

event[ ]	Array of up to seven real values that describes a mouse event. See the section "Edit Action Events" on page 60 for descriptions of the possible events and their representations in this array.
x1, y1	Real values specifying the coordinates of one of the points **not** to be moved.
x2, y2	Real values specifying the coordinates of the other point **not** to be moved.
x3, y3	Real values specifying the original coordinates of the point that **is** to be moved. These values are used as *input* only for mouse-button-down events.

Output Parameters

x3, y3	Real variables that receive the updated coordinates of the point, based on the mouse movement since the last mouse-button-down event. These parameters are used only for mouse-move and mouse-button-up events. No values are returned for mouse-button-down events.
status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

This routine reacts only to mouse-button-down, mouse-move, and mouse-button-up events.

When a mouse-button-down event occurs, the routine stores the original locations of the moving point and the mouse pointer. Then, when a mouse-move event occurs, the routine passes back a new point location based on the relative mouse movement.

The real benefit of this routine is that it does not allow the moving point to move onto (or across) an imaginary line through the two stationary reference points. Also, the routine does not allow the moving point to get within five pixels of either of the reference points. Either of these situations would cause a problem when computing a new circle from the three points. Thus, an error "status" value is returned and the calling program is expected to pass it on or set a known valid point location and pass on a different status value.

A 3-pixel by 3-pixel white dot is drawn at each of the reference points so that the operator can see what is going on.

> **NOTE:** Unlike the other **ve.mv.*( )** routines, this routine expects the integrity of the reference points (x1,y1) and (x2,y2) to be maintained by the calling program. This routine *does not* save them. Therefore, they *must* have the same values each time this routine is called.

Related Routines

ve.mv.ang
ve.mv.dim
ve.mv.pos
ve.mv.rad
ve.mv.rot
ve.mv.rsides
ve.mv.sides
vrec.edit

Calling Sequence

```
CALL ve.mv.dim(event[], xc, yc, dim)
```

Function

Make the value of a symmetrical dimension track the movement of the mouse pointer relative to a given reference point.

Usage Considerations

This routine, for width and height handles, changes the dimension by twice as much as the relative mouse movement.

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine (in mode 2) for mouse events on width and height handles.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

event[ ]	Array of up to seven real values that describes a mouse event. See the section “Edit Action Events” on page 60 for descriptions of the possible events and their representations in this array.
xc, yc	Real values specifying the coordinates of the original reference point. These are ignored except for mouse-button-down events.
dim	Real value specifying the original value of the dimension to be changed. This parameter is used for *input* only for mouse-button-down events.

Output Parameter

dim	Real variable that receives the new value for the dimension when the mouse is moved. This parameter is used for *output* only for mouse-move and mouse-button-up events. No value is returned for mouse-button-down events.

Details

This routine reacts only to mouse-button-down, mouse-move, and mouse-button-up events.

When a mouse-button-down event occurs, the routine stores the location of the reference point, the original dimension value, and the original location of the mouse pointer. Then, when a mouse-move event occurs, the routine passes back a new dimension value based on the change in the position of the mouse pointer. The change in the dimension value is twice as large as the change in the distance of the mouse pointer from the reference point.

For example, if the operator is dragging the width handle for a window, the reference point would be the center of the window, and the dimension (that is, the width) would vary twice as fast as the distance of the handle from the center of the tool.

Related Routines

ve.mv.ang	ve.mv.rad	ve.mv.rsides
ve.mv.arcpt	ve.mv.rot	ve.mv.sides
ve.mv.pos	vrec.edit	

Calling Sequence

```
CALL ve.mv.pos(event[], x0, y0)
```

Function

Make a point track the relative movement of the mouse pointer.

Usage Considerations

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine (in mode 2) for mouse events.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

event[ ]	Array of up to seven real values that describes a mouse event. See the section "Edit Action Events" on page 60 for descriptions of the possible events and their representations in this array.
x0, y0	Real values specifying the coordinates of the original point location. These parameters are used for *input* only for mouse-button-down events.

Output Parameters

x0, y0	Real variables that receive the new point location as the mouse is moved. These parameters are used for *output* only for mouse-move and mouse-button-up events. No values are returned for mouse-button-down events.

Details

This routine reacts only to mouse-button-down, mouse-move, and mouse-button-up events.

When a mouse-button-down event occurs, the routine stores the locations of the original point and the mouse pointer. Then, when a mouse-move event occurs, the routine passes back a new point location based on the change in the location of the mouse. The change in the point location is exactly the same as the change in the location of the mouse pointer.

Related Routines

ve.mv.ang
ve.mv.arcpt
ve.mv.dim
ve.mv.rad
ve.mv.rot
ve.mv.rsides
ve.mv.sides
vrec.edit

Calling Sequence

```
CALL ve.mv.rad(event[], xc, yc, rad)
```

Function

Make a radius value track the movement of the mouse pointer relative to a given reference point.

Usage Considerations

This routine is for radius and length handles.

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine (in mode 2) for mouse events.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

event[ ]	Array of up to seven real values that describes a mouse event. See the section "Edit Action Events" on page 60 for descriptions of the possible events and their representations in this array.
xc, yc	Real values specifying the coordinates of the original reference point. These are ignored except for mouse-button-down events.
rad	Real value specifying the original radius value. This parameter is used for *input* only for mouse-button-down events.

Output Parameter

rad	Real variable that receives the new radius value when the mouse is moved. This parameter is used for *output* only for mouse-move and mouse-button-up events. No value is returned for mouse-button-down events.

Details

This routine reacts only to mouse-button-down, mouse-move, and mouse-button-up events.

When a mouse-button-down event occurs, the routine stores the location of the reference point, the original radius value, and the original location of the mouse pointer. Then, when a mouse-move event occurs, the routine passes back a new radius value based on the change in the position of the mouse pointer. The change in the radius value (relative to its original value) is exactly the same as the change in the distance of the mouse pointer from the reference point.

Related Routines

ve.mv.ang	ve.mv.arcpt
ve.mv.dim	ve.mv.pos
ve.mv.rot	ve.mv.rsides
ve.mv.sides	vrec.edit

Calling Sequence

```
CALL ve.mv.rot(event[], xc, yc, a1, a2, a3, dsp.dot)
```

Function

Make three angle values track movement of the mouse pointer relative to a given reference point.

Usage Considerations

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine (in mode 2) for mouse events on angle handles.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

event[ ]	Array of up to seven real values that describes a mouse event. See the section "Edit Action Events" on page 60 for descriptions of the possible events and their representations in this array.
xc, yc	Real values specifying the coordinates of the original reference point. These are ignored except for mouse-button-down events.
a1, a2, a3	Real values specifying the original angle values. These parameters are used for *input* only for mouse-button-down events.
dsp.dot	Real value specifying whether or not the routine should display a 3-pixel by 3-pixel white dot at the reference point (center of rotation) while the angle is being changed. Any nonzero value causes the dot to be drawn.

Output Parameters

a1, a2, a3	Real variables that receive the new angle values as the mouse is moved. These parameters are used for *output* only for mouse-move and mouse-button-up events. No values are returned for mouse-button-down events.

Details

This routine reacts only to mouse-button-down, mouse-move, and mouse-button-up events.

When a mouse-button-down event occurs, the routine stores the location of the reference point, the original angles, and the original location of the mouse pointer. Then, when a mouse-move event occurs, the routine passes back new angle values based on the angular change of position of the mouse pointer relative to the reference point.

If requested, a 3-pixel by 3-pixel white dot is drawn at the reference point so the operator can see the center of rotation.

Related Routines

ve.mv.ang	ve.mv.arcpt
ve.mv.dim	ve.mv.pos
ve.mv.rad	ve.mv.sides
ve.mv.rsides	vrec.edit

Calling Sequence

```
CALL ve.mv.rsides(event[], hndl[], dim, data[])
```

Function

Make the dimensions and center change based on the relative motion of the mouse to the given handle location.

Usage Consideration

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine (in mode 2) for mouse events on angle handles.

Input Parameters

event[ ]	Array of up to seven real values that describes a mouse event. See the section “Edit Action Events” on page 60 for descriptions of the possible events and their representations in this array.
hndl[ ]	Array of real values describing a handle. The position of this handle is used as the reference point. This array has the same format as a handle in the list of handles for graphical editing. That is: hndl[et.type] = et.htyp.pos hndl[et.x] = X coordinate for select handle hndl[et.y] = Y coordinate for select handle
dim	Dimension that changes as the mouse pointer moves away from the reference point.
data[ ]	Array of real values containing numeric data for a specific vision record.

Output Parameter

data[ ]	Same as the input, except that some elements may have been modified by the event.

Details

This routine reacts only to mouse-button-down, mouse-move, and mouse-button-up events.

When a mouse-button-down event occurs, the routine stores the location of the reference point, the original angles, and the original location of the mouse pointer. Then, when a mouse-move event occurs, the routine passes back new angle values based on the angular change of position of the mouse pointer, relative to the reference point.

Related Routines

ve.mv.ang
ve.mv.arcpt
ve.mv.dim
ve.mv.pos
ve.mv.rad
ve.mv.sides
vrec.edit

Calling Sequence

```
CALL ve.mv.sides(event[], data[], xs, ys)
```

Function

Make the dimensions and center change based on the relative motion of the mouse to the given handle location.

Usage Consideration

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine (in mode 2) for mouse events on angle handles.

Input Parameters

event[ ]	Array of up to seven real values that describes a mouse event. See the section “Edit Action Events” on page 60 for descriptions of the possible events and their representations in this array.
data[ ]	Array of real values containing numeric data for a specific vision record.
xs, ys	Real values specifying which way the dimension grows compared to the mouse movement.

Output Parameter

data[ ]	Same as the input, except that some elements may have been modified by the event.

Details

This routine reacts only to mouse-button-down, mouse-move, and mouse-button-up events.

When a mouse-button-down event occurs, the routine stores the location of the reference point, the original angles, and the original location of the mouse pointer. Then, when a mouse-move event occurs, the routine passes back new angle values based on the angular change of position of the mouse pointer relative to the reference point.

If either **xs** or **ys** has a value of 0, the corresponding coordinates and dimensions are not changed.

Related Routines

ve.mv.ang
ve.mv.arcpt
ve.mv.dim
ve.mv.pos
ve.mv.rad
ve.mv.rsides
vrec.edit

Calling Sequence

```
CALL ve.on.screen(list[,], index, ok)
```

Function

Check for one or more handles visible in the Vision window.

Usage Considerations

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

list[,]	Array of real values containing a list of handle descriptors for the edit handles. This is the list of handles set up and maintained by the record-type editing routine. See **vrec.edit( )** on page 103 for details.
index	Real value specifying the index into **list[,]** for the handle(s) to check. If **index** is –1, all the handles are checked. No handles are checked if **index** is 0.

Output Parameter

ok	Real variable that receives the value TRUE if the specified handle is (or all the handles are) in the Vision window. The value FALSE is returned if the specified handle is outside the Vision window, or if **index** is –1 and any of the handles are outside the Vision window.

Details

This routine checks the (x,y) location of the specified handle (or of all handles) in the list against the millimeter boundaries for the Vision window (or the screen), as set by **et.min.x.sc**, **et.max.x.sc**, etc. (These limit variables are automatically set to the correct values for the displayed picture.)

As always, any handle with a negative type value (**list[N,et.type]**) is ignored.

Related Routine

ve.tl.upd.chk

Calling Sequence

```
CALL ve.param.chg(event[], data[], status)
```

Function

Make the change to the data array that corresponds to the database field change indicated in a given event.

Usage Consideration

This routine is for use only in record-type editing routines under certain circumstances.

Input Parameters

event[ ]	Array of up to seven real values that describes a proposed change to a parameter value. See the routine **vrec.edit( )** on page 103 for descriptions of the possible events and their representations in this array.
data[ ]	Array of real values containing numeric data for a specific vision record.

Output Parameters

data[ ]	Same as the input, except that some elements may have been modified by the event.
status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

This routine makes the change to the (numeric or string) data array that corresponds to the change to the database value indicated in the given event.

When a change is made to a string data-array element, the global subarray **$vw.data[vi.db[**TASK( )**],data[vs.p.rec],]** is accessed.

Calling Sequence

```
CALL ve.plot.arange(xc, yc, ang1, ang2, mode, color)
```

Function

Depict an angular range by drawing an arc with an arrowhead at each end.

Usage Consideration

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

xc, yc	Real values specifying the (x,y) location of the center from which the angular range is measured.
ang1	Real value specifying one end of the angular range.
ang2	Real value specifying the other end of the angular range.
mode	Real value specifying the display mode to use for the G∗ graphics instructions (GARC, etc.): –1 = no draw, 0 = erase, 1 = draw, 2 = complement, 3 = dashed. (This parameter should almost always be 2.)
color	Real value specifying the color to use when drawing the graphic. The possible values are 0 to 15, inclusive.

Output Parameter

None.

Details

If the angular range is small, the arc is drawn in two short sections on the outside of the angular range, with the arrowheads pointing toward each other. The arc is always drawn with a 100-pixel radius.

The tips of the arrowheads are always drawn two pixels back from the actual extent of the angular range. This is to allow for lines or other graphics that appear at that location.

This routine uses **ve.draw.arrow( )** to draw the arrowheads at the ends of the arc.

Related Routines

ve.draw.arrow
ve.line.arrows

Calling Sequence

```
CALL ve.pt.line(xpt, ypt, cos0, sin0, x0, y0, xx,
                                                yy, dist2)
```

Function

Find the point on a line that is closest to a given point, and the square of the distance between those points.

Input Parameters

xpt, ypt	Real values specifying the (x,y) location of the given point.
cos0, sin0	Real values specifying the cosine and sine, respectively, of the angle of the line.
x0, y0	Real values specifying the (x,y) location of a point on the line.

Output Parameters

xx, yy	Real variables that receive the (x,y) location of the point on the line that is closest to the given point (xpt,ypt).
dist2	Real variable that receives the square of the distance from the computed point (xx,yy) to the given point (xpt,ypt). This is also (the square of) the shortest distance from the given point to the line. (Zero is returned if the given point lies on the line.)

Details

This routine determines the line that passes through the given point (xpt,ypt) and is perpendicular to the given line. The intersection point (xx,yy) of that line with the given line is returned, as well as the square of the distance between the given point and the intersection point.

Related Routines

vw.pt.lin.dist
vw.pt.line

Calling Sequence

```
CALL ve.set.angs(data[], a0, an, ar)
```

Function

Extract and compute the three key angles needed when computing the location of angle handles on round and annular edit shapes.

Usage Considerations

This routine can be used only while editing a vision record. This routine is normally called by the record-type editing routine (in mode 1).

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameter

data[ ]	Array of real values containing numeric data for a specific vision record.

Output Parameters

a0	Real variable that receives the starting angle for the shape.
an	Real variable that receives the ending angle for the shape.
ar	Real variable that receives the angle value that is halfway around the shape from the starting angle to the ending angle.

Details

The starting and ending angles are extracted from **data[vs.a0]** and **data[vs.an]**, and they are forced to be positive. The angle that is halfway around the shape from the starting angle is then computed.

This routine understands clockwise arc and circle ruler shapes that have their starting and ending angles reversed compared to most shapes.

This routine can be most helpful when computing the locations for rotation handles on shapes that are round, annular, or pie-shaped.

Related Routine

vrec.edit

Calling Sequence

```
CALL ve.set.handle(handle[], xx, yy, data[])
```

Function

Set the position of a handle using Cartesian coordinate specifications.

Usage Consideration

We suggest using the newer, more complete, routine **ve.setr.handle( )**.

This routine is normally called by the record-type editing routine (**vrec.edit( )**) when that routine is called in mode 1 to set the handle locations.

Input Parameters

handle[ ]	Array of real values describing an editing handle.
xx, yy	Real values specifying the (x,y) coordinate of the handle relative to the location point of the editing shape (ignores the angle of the editing shape).
data[ ]	Array of real values containing numeric data for a specific vision record. Specifically, this array contains the absolute shape information that is used to determine the absolute handle positions. The pertinent absolute shape parameters are: data[vs.x] = X location of the shape data[vs.y] = Y location of the shape The center of a shape is usually used as its location. There can be exceptions, however, such as the linear ruler, which uses the starting point.

Output Parameter

handle[ ]	Same as the input handle, but now containing an absolute location for the handle computed as follows: handle[et.x] = tl[vs.x]+xx handle[et.y] = tl[vs.y]+yy

Details

This routine computes an *absolute* handle location based on the pseudorelative Cartesian coordinates passed in. It then puts the coordinates of that handle location in the given handle-descriptor array. Note in the equations (above) that the angle of the editing shape is ignored. To use the angle, see the routine **ve.setr.handle( )**.

Related Routines

ve.setr.handle
ve.set.phandle
ve.setr.phandle
vrec.edit

Calling Sequence

```
CALL ve.set.limits()
```

Function

Set the limits for vision tool absolute shape parameters in the data array using the global arrays **et.min[ ]** and **et.max[ ]**.

Usage Considerations

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameter

None.

Output Parameter

None.

Details

The arrays **et.min[ ]** and **et.max[ ]** are minimum and maximum limit arrays. They parallel the data array for the record being edited. That is, the same index used for the data array can be used to access the corresponding minimum and maximum values in **et.min[ ]** and **et.max[ ]**, respectively.

This routine sets the default limits for the position and dimensional parameters of the absolute shape parameters in the data array for a vision tool. These are only **default** values—they are meant to be used only when appropriate, or when most of them are correct. In the latter case, you can redefine the incorrect element(s) of **et.min[ ]** or **et.max[ ]** after calling this routine.

The specific values set are as follows:

- Vision-tool position:

  et.min[vs.x] = et.min.x.tl
  et.max[vs.x] = et.max.x.tl
  et.min[vs.y] = et.min.y.tl
  et.max[vs.y] = et.max.y.tl

- Vision-tool dimensional limits:

  et.min[vs.dx] = et.min.x.sc
  et.max[vs.dx] = et.max.x.sc∗1.414
  et.min[vs.dy] = et.min.y.sc
  et.max[vs.dy] = et.max.y.sc∗1.414

  NOTE: The array elements listed above must be set prior to execution of the routine **ve.tl.upd.chk( )**. This routine provides a convenient way to get them initialized.

Related Routine

ve.tl.upd.chk

Calling Sequence

```
CALL ve.set.phandle(handle[], radius, angle, data[])
```

Function

Set the position of a handle using absolute polar coordinate specifications.

Usage Consideration

We suggest using the newer, more complete, routine **ve.setr.handle( )**.

This routine is normally called by the record-type editing routine (**vrec.edit( )**) when that routine is called in mode 1 to set the handle locations.

Input Parameters

handle[ ]	Array of real values describing an editing handle.
radius	Real value specifying the distance from the location point of the editing shape to the handle (ignores the angle of the editing shape).
angle	Real value specifying the angle at which to measure the distance (radius). The angle is measured relative to the +X axis of the Vision window, not the editing shape.
data[ ]	Array of real values containing numeric data for a specific vision record. Specifically, this array contains the absolute shape information that is used to determine the absolute handle positions. The pertinent absolute shape parameters are: data[vs.x] = X location of the shape data[vs.y] = Y location of the shape The center of a shape is usually used as its location. There can be exceptions, however, such as the linear ruler, which uses the starting point.

Output Parameter

handle[ ]	Same as the input handle, but now containing an absolute location for the handle computed as follows: handle[et.x] = tl[vs.x]+rad∗COS(ang) handle[et.y] = tl[vs.y]+rad∗SIN(ang)

Details

This routine computes an *absolute* handle location based on the pseudorelative polar coordinates passed in. It then puts the coordinates of that handle location in the given handle-descriptor array. Note in the equations (above) that the angle of the editing shape is ignored. To use the angle, see the routine **ve.setr.phandle( )**.

Related Routines

ve.set.handle
ve.setr.handle
ve.setr.phandle
vrec.edit

Calling Sequence

```
CALL ve.setr.handle(handle[], xx, yy, data[])
```

Function

Set the size and position of a handle using relative Cartesian coordinates.

Usage Consideration

This routine is normally called by the record-type editing routine when that routine is called in mode 1 to set the handle locations.

Input Parameters

handle[ ]	Array of real values describing an editing handle.
xx, yy	Real values specifying the (x,y) coordinate of the handle, relative to the location point of the editing shape (ignores the angle of the editing shape).
data[ ]	Array of real values containing numeric data for a specific vision record. Specifically, this array contains the absolute shape information that is used to determine the absolute handle positions. The pertinent absolute shape parameters are: data[vs.x] = X location of the shape data[vs.y] = Y location of the shape The center of a shape is usually used as its location. There can be exceptions, however, such as the linear ruler, which uses the starting point.

Output Parameter

handle[ ]	Same as the input handle, but now containing an absolute location for the handle computed as follows: AUTO cos0, sin0 cos0 = COS(tl[vs.ang]) sin0 = SIN(tl[vs.ang]) list[et.x] = tl[vs.x]+xx∗cos0-yy∗sin0 list[et.y] = tl[vs.y]+xx∗sin0+yy∗cos0

Details

This routine computes the size and position of a handle using *true-relative* Cartesian coordinates passed in. It then puts the coordinates of that handle location in the given handle-descriptor array.

Related Routines

ve.set.handle
ve.set.phandle
ve.setr.phandle
vrec.edit

Calling Sequence

```
CALL ve.setr.phandle(handle[], rad, ang, data[])
```

Function

Set the size and position of a handle using relative polar coordinates.

Usage Consideration

This routine is normally called by the record-type editing routine when that routine is called in mode 1 to set the handle locations.

Input Parameters

handle[ ]	Array of real values describing an editing handle.
radius	Real value specifying the distance from the location point of the editing shape to the handle (ignores the angle of the editing shape).
angle	Real value specifying the angle at which to measure the distance (radius). The angle is measured relative to the +X axis of the Vision window, not the editing shape.
data[ ]	Array of real values containing numeric data for a specific vision record. Specifically, this array contains the absolute shape information that is used to determine the absolute handle positions. The pertinent absolute shape parameters are: data[vs.x] = X location of the shape data[vs.y] = Y location of the shape The center of a shape is usually used as its location. There can be exceptions, however, such as the linear ruler, which uses the starting point.

Output Parameter

handle[ ]	Same as the input handle, but now containing an absolute location for the handle computed as follows: list[et.x] = tl[vs.x]+rad∗COS(ang+tl[vs.ang]) list[et.y] = tl[vs.y]+rad∗SIN(ang+tl[vs.ang])

Details

This routine computes the size and position of a handle using *true-relative* polar coordinates passed in. It then puts the coordinates of that handle location in the given handle-descriptor array.

Related Routines

ve.set.handle
ve.setr.handle
ve.set.phandle
vrec.edit

Calling Sequence

```
CALL ve.snap.ang(angle, modulo)
```

Function

Snap the given angle to the nearest multiple of a specified value if it is already within one degree of that angle.

Usage Considerations

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

angle	Real variable specifying the angle to possibly change.
modulo	Real value specifying the modulus value to use (in degrees).

Output Parameter

angle	Real variable that is unchanged from the input or that receives the modified angle.

Details

This routine first converts the angle to be in the range 0 to 360 degrees. Then, if the angle is within one degree of being a multiple of the modulus given, the value is rounded to the nearest multiple of **modulo**.

This routine is often used by standard record-type editing routines to snap the angle of a vision tool to either perfectly horizontal or perfectly vertical. Some vision tools run considerably faster in those cases.

Related Routines

ve.mv.ang
ve.mv.rot
vrec.edit

Calling Sequence

```
CALL ve.sys.option(arg, db.p, ok)
```

Function

Check for the presence of certain system or AIM options.

Usage Considerations

This routine is designed to be used as a conditional spawn routine on menu pages. The arguments for this routine match those for conditional spawn routines.

Effective with AIM version 2.2, this routine supersedes the routine **ve.ocr.option( )**. Wherever that routine was called with previous AIM versions, this routine may be called instead—with **arg** set to zero.

Input Parameters

arg	Real value that specifies which vision system option or AIM option to check for, as follows: 0 ok is TRUE if OCR is present 1 ok is TRUE if AIM ROBOT MODULE is not active 2 ok is TRUE if using Vers. 2 of VME board 3 ok is TRUE if vw.image.lock is TRUE 4 ok is TRUE if HIGH-END board present 5 ok is TRUE if VISION system #1 is present 6 ok is TRUE if VISION system #2 is present (If arg < 0, then ok is FALSE for the above conditions)
db.p	Real value that is currently not used.

Output Parameter

ok	Real variable that receives the value TRUE if the specified option is available in the system. Otherwise, the value FALSE is returned.

Details

This routine checks to see if certain V^+ vision-related system options or AIM options are present and returns an indication of what was found.

Calling Sequence

```
CALL ve.tl.exec.ok(arg, db.p, ok)
```

Function

Check if it is okay to perform vision tools in the current picture.

Usage Considerations

This routine is designed to be used as a conditional spawn routine on menu pages. The arguments for this routine match to those for conditional spawn routines.

This routine can be used only when the current record is a vision tool.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

arg	Real value that is currently not used.
db.p	Real value that is currently not used.

Output Parameter

ok	Real variable that receives TRUE if it is okay to perform vision tools in the current picture.

Details

This routine assumes that the current record is a vision tool. Thus, the record is assumed to have a picture record and may have a vision frame source.

This routine makes the following checks. These ensure that the current picture and scaling parameters are all consistent with the record being edited.

1. There is a current record (**ve.cur.p.rec** is not zero).
2. The picture source is linked and evaluated successfully.
3. The picture source is the picture being displayed.
4. If there is a vision-frame source, it is evaluated successfully.

Calling Sequence

```
CALL ve.tl.upd.chk(event[], data[], $data[], list[,],
                                              index, status)
```

Function

Perform some standard limit checking and handle updating for a vision tool or moving shape (such as a fixed line or point).

Usage Considerations

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine (in mode 2).

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

event[ ]	Array of up to seven real values that describes a user editing event. The only event of concern to this routine is the mouse-move event. See the section "Edit Action Events" on page 60 for descriptions of events and their representations in this array.
data[ ]	Array of real values containing numeric data for a specific vision record.
$data[ ]	Array containing string data for a specific vision record.
list[,]	Array of real values containing a list of handle descriptors for the edit handles. This is the list of handles set up and maintained by the record-type editing routine. See **vrec.edit( )** on page 103 for details.
index	Real value specifying the index into **list[,]** for the handle that is presently clicked on (if **event[ ]** represents a mouse event). This handle is checked for being within the bounds of the Vision window. If **index** is –1, all the handles are checked and the **event[ ]** array is ignored.

Output Parameter

status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

This routine requires prior initialization of the arrays **et.min[ ]** and **et.max[ ]** for proper operation. Specifically, elements **vs.x**, **vs.y**, **vs.dx**, and **vs.dy** must be defined in both arrays. The routine **ve.set.limits( )** can be used to easily initialize these elements with common default values.

Using these arrays, the location and dimensional shape parameters of the vision tool are checked, and an error is reported if they are outside the limits.

The position of the current editing handle is also checked to make sure it is within the bounds of the Vision window. If the **index** value passed in is –1 (obviously not for a mouse event), all the handles are checked for being within the Vision window.

Related Routines

ve.on.screen
ve.set.limits

Calling Sequence

```
CALL ve.update.shp(db, data[])
```

Function

Update the relative shape parameters in the database and data array, based on the absolute shape parameters in the data array.

Usage Considerations

The database record specified by **data[vs.p.rec]** must be open for access.

This routine applies only to records that have a shape to edit.

This routine can be used only while editing a vision record. This routine is normally called by the record-type edit routine.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

db	Real value specifying the number of the database being edited.
data[ ]	Array of real values containing numeric data for a specific vision record.

Output Parameter

data[ ]	Array of real values containing the updated numeric data for the vision record.

Details

The absolute shape parameters in the data array are used to update the relative shape parameters in both the data array and the database.

If the record has a vision-frame source and that source has not been successfully evaluated, this routine exits without doing anything. If the vision-frame source is based in another picture, its results are first transformed to be in the reference picture of the current record.

Related Routine

vrec.edit

Calling Sequence

```
CALL ve.warning.sign(src.num, db.p, incomplete)
```

Function

Check the record for the source number indicated to see if it, or any of its source records, are not fully specified or have not completed successfully.

Usage Considerations

This routine is usually used (as a conditional spawn routine) to control the display of warning signs next to source record names.

This routine can be called only when editing a Vision database record.

Input Parameters

src.num	Real value specifying the source number being checked for validity. Negative means it does not have to be successful. Positive means it must be successful. The value ±99 means required reference frame (source 0).
db.p	Real value specifying the number of the primary database being edited. (This parameter is not used, but it is part of the standard calling sequence for a conditional spawn routine on a menu page.)

Output Parameter

incomplete	Real variable that receives FALSE if the source record is present and successfully evaluated. TRUE is returned if any of the following conditions apply:

- The source number specified is greater than the number of sources that should be used for the current record.
- The source specified is not present, nor are any of the records in the tree of required records below it.
- The source number is 0 (a vision frame), and the “relative” check box for the record is not checked.
- The source name cannot be found in the Vision database.
- The scheduler is not active, and the source has not been successfully evaluated.

Details

This routine is used for almost all the menu pages for vision records. When a record has source records, their names appear on the menu page. It is convention to conditionally display the “warning_sign” icon next to the names, depending on the status of the source records. This routine can be used as the conditional spawn routine for deciding whether or not to display the icon.

Calling Sequence

```
CALL vi.world.loc(db, l.rec, vision.loc, camera.loc,
                                          robot.loc, status)
```

Function

Return a vision location in world coordinates.

Usage Consideration

This routine is designed to be called from statement routines involving motion. It is not normally used within vision record-type routines.

Input Parameters

db	Real value specifying the number of the database being edited.
l.rec	Real value that specifies the *logical* record number of a Vision database record. The record must be successfully evaluated, and it must be a member of the point, line, circle, or vision-frame class.

Output Parameters

vision.loc	Location variable that receives a transformation containing the position and orientation information from the results of the record.
camera.loc	Location variable that receives the camera transformation when the picture was taken (that is, the world location of the coordinate frame for the results of this record).
robot.loc	Location variable that receives a transformation value that describes the robot location when the picture was taken. (The value is NULL if the picture is not relative to the robot.)
status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

When a robot-relative picture record is executed, the world locations of the robot and the current camera coordinate frame are stored. When a vision result is to be used, it must be considered in the context of its reference picture. Therefore, this routine determines the reference picture and returns the world location of its coordinate frame, as well as the robot position when that picture was taken.

Also, the Vision Module has a provision for cameras that view objects from the back side, relative to the robot that may need to acquire them. This routine gives the vision location the proper pitch angle so that it aligns with the robot tool tip. The pitch information is stored in the camera database.

In a system without a robot, camera records may be given calibrated locations relative to other camera records. If this has been done, the world coordinate system is defined by the actual vision-frame locations designated during this calibration process. The camera location (**camera.loc**) returned by this routine is the location as defined in this calibration.

Calling Sequence

```
CALL vw.add.to.class(class, rec.typ, error,$desc.string)
```

Function

Add a record type to an existing class in VisionWare.

Usage Consideration

This routine should be called from the record-type definition routine.

Input Parameters

class	Real value specifying the class number to which the record type is to be added. This must be the number of an existing class, previously defined by the routine **vw.mk.new.class( )**. Typical standard class numbers are: ve.pt.class Point class ve.lin.class Line class ve.cir.class Circle class ve.frm.class Vision-frame class (For a complete list of standard class-number variables, see the section "Class Data Structures" on page 81.)
rec.typ.num	Real value specifying the record type to be added to the designated class.
$desc.string	Optional string describing how this record type will be interpreted as a member of this class.

Output Parameter

error	Real variable that receives TRUE if the class specified does not exist already. FALSE signals success.

Global Variables

ve.class[,]	Real array containing lists of the record types in each class.
$ve.class[,]	String array containing the routine names and labels for each class.

Details

Classes are groups of record types that have similar results. This routine is used to add a record type to an existing class. For example, the Line Finder record type is added to the standard LINE class by calling this routine in the definition routine for the Line Finder record type.

When there is more than one record type in a class, there is a menu page for the class that allows for selection of one of the record types present in the class. When a custom record type is added to an existing class, such as LINE or POINT, the "new record" menu page for that class should be expanded to include a radio button for the new record type.

For more details on classes and their data structures, see the sections "Adding Custom Classes" on page 56 and "Class Data Structures" on page 81.

Related Routines

ve.init.classes
vw.mk.new.class

Calling Sequence

```
CALL vw.build.list(db, rec, ei, status)
```

Function

Build an evaluation list for the specified record in the vision database.

Usage Considerations

A new list is allocated and the evaluation tree is analyzed to fill in the list.

The global array **vw.eval.list[vi.db[**TASK( )**],,]** is updated.

Input Parameters

db	Real value specifying the number of the database being edited.
rec	Real value specifying the physical record number for the vi.db database.
ei	The evaluation index to use for entry in **vw.eval.list[vi.db[**TASK( )**],,]**.

Output Parameters

ei	The evaluation index for the list that was built.
status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

This routine builds an evaluation list for the specified record in the vision database. A new list is allocated and the evaluation tree is analyzed to fill in the list.

The evaluation list is stored in **vw.eval.list[vi.db[**TASK( )**],,]**, which is indexed by **vw.data[rec,vs.ei.list]**. The list contains the record for each node being evaluated. The records are listed in the order that provides the best evaluation performance.

Related Routine

vw.build.module
vw.eval.list

Calling Sequence

```
CALL vw.build.module(error)
```

Function

This routine builds evaluation lists for an entire module. There is an evaluation list built for each vision argument in all the statements in all the sequences in this module.

Usage Considerations

All data structures and statistics for the current vision database are erased and rebuilt.

The module must be the current one for this task. This routine does not alter the update or link time of any database, including the sequence database.

Input Parameter

None.

Output Parameter

error	Standard AIM operator response code.

Details

This routine scans each sequence in the module that is about to run and finds the arguments to statements that are records in the Vision database. (The routine skips statements that are disabled via a comment symbol.)

For each of these records, a list is constructed that consists of all the records that need to be executed prior to execution of that record. The routine chooses the most efficient order it can for this list. This list is used by the routine **vw.run.eval( )** at runtime.

After the "eval lists" have been built for each of the sequence arguments, this routine checks the global array **vw.cu.elists[ ]**. If this array has any records in it (that is, **vw.cu.elists[0]** is not zero), this routine builds evaluation lists for each of the records. Then it resets **vw.cu.elists[0]** to zero. Thus, this list needs to be filled in (or at least have the count set correctly) before each call to this routine.

Next, this routine sets the global **vw.multi.pics** to TRUE if more than one picture record is being used in the sequence. (Use of this variable by the runtime routines saves time when there is only one picture in the sequence.) This routine also sets the global **vw.num.pics** to the number of pictures in the sequence.

Several checks are performed regarding the pictures in the sequence and their usage. A warning is generated if pictures are requested in such a way as to require taking the same picture twice. If, for some reason, a picture is requested when it is not available, an error is generated and the preruntime is aborted. However, these checks are performed only on a per-evaluation-list basis, without taking into account other evaluation lists in the sequence.

This routine also creates the evaluation lists for records that are the tops of repeat trees and the "dependents" lists for pictures and repeat records. The evaluation lists for the tops of repeat trees are used by combination records. The dependents lists are used by the routine **vw.clear.rec( )**.

After all list building is completed, it checks to see if it can perform ping-ponging and virtual camera preallocation.

Calling Sequence

```
CALL vw.cc.draw(data[], $data[], dmode)
```

Function

Draw the editing shape for the Computed Circle record type when its evaluation method is “fixed circle”.

Usage Considerations

This routine can be used as the editing “draw” routine for a record type that positions a simple circle shape. In that case, it would be specified in the record-type definition routine for that record type.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

data[ ]	Array of real values containing numeric data for a specific vision record.
$data[ ]	Array of string values (not used).
dmode	Real value specifying the display mode to use when drawing. The possible values are:

ve.dm.dim	Draw subtly (dimly)
ve.dm.high	Draw obviously (highlighted)
ve.dm.nop	No outline drawn

Output Parameter

None.

Details

This routine draws the standard representation of a circle, based on the absolute shape parameters in the data array. However, the circle is not drawn if its center is outside the Vision window.

Related Routines

vrec.def
vrec.draw
vw.cf.draw
vw.cl.draw
vw.cp.draw
vw.tl.draw (in the file VDRAW.SQU)

Calling Sequence

```
CALL vw.cf.draw(data[], $data[], dmode)
```

Function

Draw the editing shape for the Computed Frame record type when its evaluation method is “fixed frame”.

Usage Considerations

This routine can be used as the editing “draw” routine for a record type that positions a simple vision-frame shape. In that case, it would be specified in the record-type definition routine for that record type.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

data[ ]	Array of real values containing numeric data for a specific vision record.
$data[ ]	Array of string values (not used).
dmode	Real value specifying the display mode to use when drawing. The possible values are: ve.dm.dim Draw subtly (dimly) ve.dm.high Draw obviously (highlighted) ve.dm.nop No outline drawn

Output Parameter

None.

Details

This routine draws the standard representation of a vision frame, based on the absolute shape parameters in the data array. It uses the routine “ve.draw.frame” to draw the graphic for the vision frame.

> **NOTE:** The vision frame is not drawn if its origin is outside the Vision window.

Related Routines

ve.draw.frame
vrec.def
vrec.draw
vw.cc.draw
vw.cl.draw
vw.cp.draw
vw.tl.draw (in the file VDRAW.SQU)

Calling Sequence

```
CALL vw.circ.3pts(pt1[], pt2[], pt3[], cir[], status)
```

Function

Compute the circle that goes through three points.

Usage Consideration

The input and output parameters are compatible with the results of records in the point and circle classes, respectively.

Input Parameters

pt1[ ]	Array of real values containing the coordinates for the first point, using the standard representation. That is, the (x,y) location is (**pt1[vw.x]**,**pt1[vw.y]**).
pt2[ ]	Array of real values containing the coordinates for the second point, in the same format as for point 1.
pt3[ ]	Array of real values containing the coordinates for point #3, in the same format as for point #1.

Output Parameters

cir[ ]	Real array that receives the data for the computed circle, in the standard representation: cir[vw.x] X coordinate of the center cir[vw.y] Y coordinate of the center cir[vw.rad] Radius of the circle
status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

The circle is computed by finding the perpendicular bisectors for the point pairs 1 and 2, and 2 and 3. The center is at the intersection of the two lines. The radius is the distance from the center to one of the points.

The “status” parameter reports an error if the three points are colinear (that is, if the points lie on a line).

> **NOTE:** This routine performs the same function as the routine **ve.circ.3pts( )**. This routine differs in that it is designed to work with input (points) and output (circle) representations that are compatible with the results formats for the point and circle classes.

Related Routine

ve.circ.3pts

Calling Sequence

```
CALL vw.circ.line(cir[], lin[], x1, y1, x2, y2, status)
```

Function

Find the two points of intersection between a line and a circle.

Usage Consideration

The input parameters are compatible with the results of records in the circle and line classes.

Input Parameters

cir[ ] Array of real values containing the standard representation of a circle:

cir[vw.x]	X coordinate of the center
cir[vw.y]	Y coordinate of the center
cir[vw.rad]	Radius of the circle

lin[ ] Array of real values containing the standard representation of a line:

lin[vw.x]	X coordinate of a point on the line
lin[vw.y]	Y coordinate of a point on the line
lin[vw.ang]	Angle of the line
lin[vw.cos]	Cosine of the angle
lin[vw.sin]	Sine of the angle

Output Parameters

x1, y1 Real variables that receive the (x,y) location of one of the intersection points.

x2, y2 Real variables that receive the (x,y) location of the second intersection point.

status Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

If the line is exactly tangent to the circle, both intersection points are the same.

An error status is returned if the line does not intersect the circle.

- After sources have been checked, but before execution, “Edit All” mode is checked for. Also, “Pause After Operation” mode is checked for after execution.
- Trace messages are displayed to identify each record as it is evaluated.

Related Routines

vw.new.eval
vw.run.init

Calling Sequence

```
CALL vw.clear.list(p.rec)
```

Function

Mark as “not done” all the records that are in the evaluation list for the specified record.

Usage Considerations

The given record must be specified as an argument for a statement in the current sequence.

This routine is for use in preruntime or runtime code only.

Input Parameter

p.rec	Real value specifying the physical record number of the record.

Output Parameter

None.

Details

At preruntime, “evaluation” lists are created for each of the vision records found as arguments to statements in the current sequence.[1] This routine loops through the evaluation list for the given record and clears the “eval” and “repeat” flags for each record in the list. This process includes the record specified since it is in the list.

> **NOTE:** This routine is fundamentally different from the routine **vw.clear.rec( )**. See the Details section of the dictionary page for the routine for a discussion of the differences.

Related Routines

vw.clear.rec
vw.run.eval
vw.run.eval2

1. For more information on evaluation lists, see the dictionary page for the routine **vw.run.eval( )**.

Calling Sequence

```
CALL vw.clear.rec(p.rec)
```

Function

Mark the given record as “not done”, and mark all records that depend on that record as “not done” and as “not repeating” (for repeat records).

Usage Considerations

The given record must be a picture or a repeat record.

This routine is for use in preruntime or runtime code only.

Input Parameter

p.rec	Real value specifying the physical record number of the record to clear. This record must be a picture record or a repeat record.

Output Parameter

None.

Details

At preruntime, special lists are created for picture records and repeat records involved in execution of the sequence. For a particular picture or repeat record, these lists include all the records that have that record in their trees (that is, all the records that depend on the results of that particular record). These lists are called “lists of dependents”.

This routine requires that a list of dependents exist for the record being cleared. The routine loops through the list and clears the “eval” and “repeat” flags of each of the dependent records. Then, for the specified record, the routine clears the “eval” flag (but does not clear the “repeat” flag). The operations of the routine are shown by the following code:

```
AUTO ii, t.rec

FOR ii = 1 TO vw.dependents[vi.db[],p.rec,0]
     t.rec = vw.dependents[vi.db[],p.rec,ii]
     vw.data[vi.db[TASK()],t.rec, vs.eval] = vw.stt.no.ref
     vw.data[vi.db[TASK()],t.rec, vs.more] = vw.stt.go
END
vw.data[vi.db[TASK()],p.rec, vs.eval] = vw.stt.no.ref
```

This routine is used by combination records to clear all records that depend on a particular repeat record prior to reevaluating the repeat tree. The “repeat” flag is not cleared for the specified record since if the specified record is a repeat record, we may want to get the next iteration of results from it for the reevaluation. See the template routines for combination records in Appendix E for an example of this routine.

This routine is also used by MotionWare (in the conveyor vision code) when using repeating vision-frame finders and to retake pictures when appropriate.

This routine is fundamentally different from **vw.clear.list( )**. This routine clears a record and all the records above it in any number of trees. The routine **vw.clear.list( )** clears a record and all the records below it, but only in its own subtree. Both routines are meant to precede a call to

vw.run.eval( ). You should use **ve.clear.rec( )** when you wish to retake a picture or get the next iteration of a repeat record and force reevaluation of all the records that depend on the results of that record. You should use **vw.clear.list( )** when you wish to evaluate a top-level record and you need to have all the source records evaluated recursively.

One thing that may not be obvious is that a call to **vw.clear.rec( )** for a particular picture record clears (at least) the same records as a call to **vw.clear.list( )** for a single-picture evaluation list containing that picture. If there is only one evaluation list containing that picture record, the two routines clear exactly the same records.

Related Routines

vw.clear.list
vw.run.eval
vw.run.eval2

Calling Sequence

```
CALL vw.conv.frm(ref.pic, src.data[], status)
```

Function

Convert the results of a record to the coordinate frame of a specified reference picture.

Usage Considerations

This routine is normally called from the execution routine to convert sources.

This routine does not need to be called if the variable vw.multi.pics is FALSE, because this indicates there is only one picture.

Input Parameters

ref.pic	Real value specifying the physical record number of the record. The results passed in the array **src.res[]** are transformed by this routine to be in the coordinate frame of this picture record. The reference picture stored in the data array is changed to be this picture.
src.data[ ]	Array of real values containing numeric data for a specific vision record.
src.res[ ]	Array of real values containing numeric data resulting from execution of the record represented by the array **src.data[]**.

Output Parameters

src.data[ ]	Same as the input parameter, except that the reference picture may be modified.
src.res[ ]	Same as the input parameter, except that the results may be relative to a different reference picture.
status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

This is the primary routine that supports the mixing of results from different pictures. When a record has more than one source and there is more than one picture being used in the sequence, this routine should be used to convert the results of the sources that have a reference picture different from that for the record being executed.

This routine first checks that the reference picture for the given results is different from that specified by the **ref.pic** parameter. If they are the same, no conversion is needed.

Next, the difference transformation between the two reference pictures is computed. If the coordinate frames for the two reference pictures are not coplanar (or sufficiently close), it is not possible to represent the old 2-D results in the coordinate frame for the new reference picture. In this case, an error is generated if walk-thru training is enabled.

There is a tolerance for slightly noncoplanar coordinate frames. Specifically, the Z axes must be within 0.1 degree of being parallel, and the origin of each frame cannot be more than 0.05 millimeter from the X-Y plane of the other frame.

Related Routine

vrec.exec

Calling Sequence

```
CALL vw.cp.draw(data[], $data[], dmode)
```

Function

Draw the editing shape for the Computed Point record type when its evaluation method is “fixed point”.

Usage Considerations

This routine can be used as the editing “draw” routine for a record type that positions a simple point shape. In that case, it would be specified in the record-type definition routine for that record type.

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

data[ ]	Array of real values containing numeric data for a specific vision record.
$data[ ]	Array of string values that is not currently used.
dmode	Real value specifying the display mode to use when drawing. The possible values are:

ve.dm.dim	Draw subtly (dimly)
ve.dm.high	Draw obviously (highlighted)
ve.dm.nop	No outline drawn

Output Parameter

None.

Details

This routine draws the standard representation of a point based on the absolute shape parameters in the data array. It uses the routine **ve.draw.point( )** to draw the graphic for the point.

NOTE: The graphic is not drawn if the point is outside the Vision window.

Related Routines

ve.draw.point
vrec.def
vrec.draw
vw.cc.draw
vw.cf.draw
vw.cl.draw
vw.tl.draw(in the file VDRAW.SQU)

Calling Sequence

```
CALL vw.def.morph(number, $def.rtn, okay, halt)
```

Function

This routine defines a custom morphology number in all vision systems.

Usage Consideration

This routine does not depend on the Image Processing record type to be loaded.

Input Parameters

number	Real value specifying the morphological number being defined.
$def.rtn	This is the name of the routine to be executed to initialize the morph definition.

Output Parameters

okay	Real variable that receives TRUE if the initialization was successful; otherwise, returns FALSE.
halt	Real variable that receives TRUE if the initialization process is being halted.

Details

This routine is called from the Morph Definition records, located in the initialization database. It calls the specified routine (specified by **$def.rtn**) to get an array for defining the morph pattern as the given number.

This routine is not dependent on any record type that performs morphological operations. Therefore, it does not require the Image Processing record type to be loaded. However, to use the custom morph pattern, you must create an Image Processing record and enter the custom morph number.

Calling Sequence

```
CALL vw.def.rtype($id, $def.rtn, enable, rec.type,
                                              adept, okay, halt)
```

Function

This routine is used by the initialization database records to load and initialize a record type.

Usage Considerations

This routine is intended to be used at initialization only. It is called once for each record type.

This routine is used to define a Vision record type (e.g., Finder tools). It is called during initialization for all standard Vision Module record types. This routine is also used to define a custom record type that differs from the standard record types. See section 3.15 on page 51, Appendix C , and Appendix D for details on creating custom record types.

Input Parameters

$id — String used as the basis for constructing all files associated with this database. There must be, at minimum, a file V<$id>.SQU that is loaded and will contain the record type routines. There may also be an overlay file named V<$id>.OVR which, if present, is loaded temporarily and then deleted after the given initialization routine is executed.

$def.rtn — This is the name of the routine to be executed to initialize the record type. It must have the correct calling sequence, as specified in the *AdeptVision Reference Guide* or the *VisionWare Reference Guide* for a record type definition routine. See **vrec.def( )** on page 96 for details.

enable — Set to TRUE if this record type should be initialized; FALSE if the record type should not be initialized or installed.

rec.type — A number given to this record type as it is created.

Number	Usage
0	$def.rtn will specify the record type numbers.
1 through 99	Reserved for standard Adept record types.
100 and greater	Used for custom record types.

adept — Set to 1 if this is an Adept set of record types. The module header filename is “a.v”+$.id. Set to 0 if this is a custom record type(s). The module header filename is “c.v”+$id.

Output Parameters

okay — Real variable that receives TRUE if the initialization was successful.

halt — Real variable that receives TRUE if AIM startup must be halted.

Details

If the record type number is 0, this routine will be an intermediate routine that returns a list of definition routine names and record type numbers to accompany them. This mechanism is used to group several connected record types together in one “optionable” file.

Related Routine

vrec.def

Calling Sequence

```
CALL vw.draw.feat(data[], $data[], res[], $res[],
                                  class, dmode, handle, hndl[])
```

Function

For a record in one of the geometric feature classes (that is, point, line, circle, and vision frame), display a representation of its results in the format for an indicated class.

Usage Consideration

This routine is designed to be used as a "draw" routine for a class. To specify this as the draw routine for a particular class, it must be named in the call to **vw.mk.new.class( )** that defines the class.

Input Parameters

data[ ]	An array of data for one record (from **vw.data[,,]**).
$data[ ]	An array of data for one record (from **$vw.data[,,]**).
res[ ]	An array of results for one record (from **vw.res[,,]**).
$res[ ]	An array of results for one record (from **$vw.res[,,]**).
class	Real value specifying which of the geometric feature classes to display the record as. This must specify one of the following classes: ve.pt.class Point class ve.lin.class Line class ve.cir.class Circle class ve.frm.class Vision-frame class
dmode	Real value specifying the display mode to use when drawing. The possible values are: ve.dm.nop No outline drawn ve.dm.dim Draw subtly (dimly) ve.dm.high Draw obviously (highlighted)
handle	Optional, real value specifying whether or not the routine should return the location of a handle to use for visually selecting the displayed record from among several others. TRUE (nonzero) means yes, do return a handle. FALSE (zero) means do not return one. (Default value is FALSE.)

Output Parameter

hndl[ ]	Array of real values describing a handle (which is returned only if the input parameter "handle" is TRUE). This array has the same format as a handle in the list of handles for graphical editing. That is: hndl[et.type] = et.htyp.pos hndl[et.c] = X coordinate for select handle hndl[et.y] = Y coordinate for select handle

Details

This routine assumes that the record indicated is a member of the display class specified.

This routine draws the standard representation for a point, line, circle, or vision frame, depending on the class specified. The graphics used are identical to those generated by the edit draw routines for Computed Point, Computed Line, etc.

If a handle location is requested, the handle location returned depends on which class is used. For the point, line, circle, and vision-frame classes, the location is the point itself, the point on the line, the center of the circle, or the origin of the vision frame, respectively.

Related Routines

vclass.draw
vw.draw.vtool
vw.mk.new.class

Calling Sequence

```
CALL vw.draw.vtool(data[], $data[], res[], $res[],
                                class, dmode, handle, hndl [])
```

Function

For a vision-tool record, display the record using its editing shape.

Usage Consideration

This routine is designed to be used as a "draw" routine for a class. To specify this as the draw routine for a particular class, it must be named in the call to **vw.mk.new.class( )** that defines the class.

Input Parameters

data[ ]	An array of data for one record (from **vw.data[,,]**).
$data[ ]	An array of data for one record (from **$vw.data[,,]**).
res[ ]	An array of results for one record (from **vw.res[,,]**).
$res[ ]	An array of results for one record (from **$vw.res[,,]**).
class	Real value that is currently not used.
dmode	Real value specifying the display mode to use when drawing. The possible values are: ve.dm.nop No outline drawn ve.dm.dim Draw subtly (dimly) ve.dm.high Draw obviously (highlighted)
handle	Optional, real value specifying whether or not the routine should return the location of a handle to use for visually selecting the displayed record from among several others. TRUE (nonzero) means yes, do return a handle. FALSE (zero) means do not return one. (Default value is FALSE.)

Output Parameters

hndl[ ]	Array of real values describing a handle (which is returned only if the input parameter "handle" is TRUE). This array has the same format as a handle in the list of handles for graphical editing. That is: hndl[et.type] = et.htyp.pos hndl[et.x] = X coordinate for select handle hndl[et.y] = Y coordinate for select handle

Details

This routine uses the editing-shape graphic for a vision tool to display it as a member of the vision-tool class.

If a handle location is requested, the location returned is the position handle used during shape editing. Note that the location is not always the center of the shape.

Related Routines

vclass.draw
vw.draw.feat
vw.mk.new.class

Calling Sequence

```
CALL vw.eval(rec.type, prec, data[ ], vwdata[,], vwres[,])
```

Function

This routine evaluates a record from the vision database.

Usage Consideration

All records on which the specified vision database record depends must be evaluated before this routine is called.

Input Parameters

rec.type	Real value specifying the number to use for identifying the record type being evaluated. This is used as the primary way of referring to this record type.
prec	Real value specifying the physical record number of the record.
data[ ]	Array of real values containing numeric data for a specific vision record.
vwdata[,]	Two dimensional sub-array of **vw.data[„]** for the current Vision database (**vi.db[**TASK( )**]**).
vwres[,]	Two dimensional sub-array of **vw.data[„]** for the current Vision database (**vi.db[**TASK( )**]**).

Output Parameters

data[ ]	Same as input **data[ ]** except that some values may have changed.
vwres[,]	Two dimensional sub-array of **vw.data[„]** for the current Vision database (**vi.db[**TASK( )**]**).

Details

This routine is used to evaluate a record from the vision database.

All vision tools are prepped by the front end of this routine before the evaluation process begins. This means that the picture source is checked, and the correct buffer is selected.

All nonvision tools are passed directly to the evaluation process.

Related Routine

vw.eval.list
vw.run.eval2

Calling Sequence

```
CALL vw.eval.list(ei)
```

Function

This routine evaluates the records in the specified evaluation list.

Usage Consideration

The global results arrays are updated.

Input Parameter

ei	Number of the evaluation list to execute. This number can be found in the **data[vs.ei.list]** slot in the data array for a record. An evaluation list must already exist for some record before this routine can be used.

Output Parameter

None.

Details

This routine calls the routine **vw.eval( )** for each of the records on an evaluation list. If the source records of a record have not been evaluated, it waits for them to be completed.

This routine is used by "combination" record types, following a call to **vw.clear.rec( )**.

An evaluation list can be built using the routine **vw.build.list( )**. See **vw.build.list( )** on page 187 for more details.

Calling Sequence

```
CALL vw.frame.3pts(pt0[], ptx[], pty[], frame[])
```

Function

Compute a vision frame defined by three points: the origin, one on the X-axis, and one in the +Y direction.

Usage Consideration

The input and output parameters are compatible with the results of records in the point and vision-frame classes, respectively.

Input Parameters

pt0[ ] — Array of real values containing the coordinates for the origin point, using the standard representation. That is, the (x, y) location is (**pt0[vw.x]**, **pt0[vw.y]**).

ptx[ ] — Array of real values containing the coordinates for a point on the X axis, in the same format as for the origin. This point can be on the +X or the –X axis.

pty[ ] — Array of real values containing the coordinate for a point in the +Y direction from the origin, in the same format as for the other points.

Output Parameter

frm[ ] — Real array that receives the computed vision frame in the standard representation:

frm[vw.x]	X coordinate of the origin
frm[vw.y]	Y coordinate of the origin
frm[vw.ang]	Angle of the X-axis
frm[vw.cos]	Cosine of the angle
frm[vw.sin]	Sine of the angle

Details

If the three points are colinear, the positive Y-axis is at the angle of the X-axis plus 90 degrees, and the Z-axis points out of the screen.

If the three points are exactly coincident, the angle of the X-axis is zero, the angle of the Y-axis is 90 degrees, and the Z-axis points out of the screen.

Calling Sequence

```
CALL vw.free.all(vsys)
```

Function

Free all the frame buffers in the specified vision system for reallocation.

Usage Consideration

This routine is for use only in statement routines. It should not be used by record-type routines.

Input Parameter

vsys	Vision system to free buffers for.

Output Parameter

None.

Global Variables

vw.buf.list[vsys,]	List of available frame buffers.
vw.buf.pic[vsys,]	Cross index to the picture record that was allocated the buffer. This array is indexed by (buf.num–1000), where “buf.num” is the buffer number (1001 or 1002).

Details

During sequence execution, when picture records are first evaluated, frame buffers are allocated to each record as they are needed (ping-pong picture records use two frame buffers). This allocation remains and new pictures are frame-grabbed into those designated buffers each time the picture record is executed. This routine cancels all frame buffer allocations.

Buffer allocation never fails. That is, when a picture needs a buffer to execute, it always gets one. The picture that previously used that buffer is invalidated at that time, and any subsequent operations that depend on that previous picture will fail.

Unless this routine is executed, or another picture gets allocated buffers from previous pictures, the buffer allocation remains fixed for all cycles of the sequence.

Calling Sequence

```
CALL vw.line.line(line1[], line2[], xx, yy, status)
```

Function

Compute the point of intersection of two lines.

Usage Consideration

The input parameters are compatible with results of records in the line class.

Input Parameters

line1[ ]	Array of real values containing the standard representation of a line:

line1[vw.x]	X coordinate of a point on the line
line1[vw.y]	Y coordinate of a point on the line
line1[vw.ang]	Angle of the line
line1[vw.cos]	Cosine of the angle
line1[vw.sin]	Sine of the angle

line2[ ]	Array of real values containing the standard representation of another line.

Output Parameters

xx, yy	Real variables that receive the (x,y) location of the point at the intersection of the two lines.
status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

The “status” parameter reports an error if the two lines are parallel.

Calling Sequence

```
CALL vw.mk.new.class($name, $draw, $menu.page, high.clr,
                                                dim.clr, class)
```

Function

Create a new class for the Vision Module.

Usage Consideration

This routine should be called from the application initialization routine. It is located in the load file for your AIM application module. (For example, for VisionWare, the routine is **vw.mod.init( )** in the file VWMOD.OV2.)

Input Parameters

$name	String value, variable, or expression specifying the name of the class. This name is used as a means of identifying the class when selecting or displaying members of the class.
$draw	String value, variable, or expression specifying the name of the routine used to draw a graphical depiction of the results of a record that is a member of this class.
$menu.pg	String value, variable, or expression specifying the name of the menu page to display when creating a new record that belongs to this class. This menu page allows the user to select a specific record type and name for the new record.
high.clr	Real value specifying the color to use when drawing the results in a "highlighted" mode (for example, when the results of a record are highlighted as a means of selecting from among the various records whose results are in this class).
dim.clr	Real value specifying the color to use when drawing the results in a "dimmed" mode (for example, when the results of all the records in this class are displayed as a means of aiding in selection of a source record).

Output Parameter

class	Real variable that receives the number of the class just created. This must be used when adding record types to this class. It is also used as the primary index into the global arrays that describe the classes.

Global Variables

ve.class[,]	Real array containing lists of the record types in each class (see Chapter 3).
$ve.class[,]	String array containing the routine names and labels for each class (see Chapter 3).
ve.clr[,]	Real array containing the colors for the class graphics when being drawn in various modes (see Chapter 3).

Details

Classes are groups of record types that have similar results. More specifically, certain slots in the results array (**vw.res[„]**) for each of the record types must be able to be interpreted in a uniform way across the class. Then, if a record type belongs to this class, any records of that type will have results that can be used for the same purpose. This means that there can be a single graphical representation of these results.

Almost all record types have some number of sources, and each source is designated to be a record from a particular class. That way, the record type execution routine can depend on the results of interest being in the expected slots in the results array for each of its source records. Also, when the operator needs to create a new source record, the Vision Module knows what class that record must belong to and can guide the operator with a menu page displaying only the allowable record types.

To define a new class, you need to specify a name for the class. It is used for display in appropriate situations. You also specify the name of a graphics routine and colors for different modes of display.

A menu page needs to be created for each class that includes more than one record type. That gives the operator a choice of only those record types that are included in the class. This menu page name is specified as an argument to this routine.

This routine just defines just the empty shell of a class. The real usefulness of a class is in the record types that comprise it. Record types are added to classes one at a time, using the routine **vw.add.to.class( )**.

Note that a record type can (and often does) belong to more than one class. For example, a record type that returns a vision frame (and thus should belong to the vision-frame class), might also be useful as a member of the point or line class, utilizing the origin and X-axis information, respectively.

Related Routines

ve.init.classes
vw.add.to.class

Calling Sequence

```
CALL vw.new.eval()
```

Function

Clear the “done” state for all vision records.

Usage Considerations

This routine is called by the VisionWare runtime scheduler (**rn.sched( )**) at the start of each execution cycle.

If you are using multiple runtime vision schedulers (as in MotionWare), this routine should not be used. See the routine **vw.clear.rec( )** for an alternative way of clearing the “done” state for records.

Input Parameter

None.

Output Parameter

None.

Details

This routine increments the “evaluation done” value for vision-record status so that all the vision records with a previous status of “done” will appear not to be done. This is used to force reevaluation of all records at runtime.

When a record is done executing, the data array element **data[vs.eval]** is set to the current value of the global variable **vw.stt.done[ ]**. This signifies that the record is done. This routine changes the value of **vw.stt.done[ ]**, so that effectively, no records are marked as “done”.

Related Routines

rn.sched
vw.clear.rec

Calling Sequence

```
CALL vw.pt.lin.dist(pt[], lin[], xx, yy, dist2)
```

Function

Find the point on a line that is closest to a given point and the square of the distance between those points.

Usage Consideration

The input parameters are compatible with results of records in the point and line classes.

Input Parameters

pt[ ]	Array of real values containing the coordinates for a point using the standard representation. That is, the (x,y) location is (pt[vw.x],pt[vw.y]).
lin[ ]	Array of real values containing the standard representation of a line:

lin[vw.x]	Coordinate of a point on the line
lin[vw.y]	Y coordinate of a point on the line
lin[vw.ang]	Angle of the line
lin[vw.cos]	Cosine of the angle
lin[vw.sin]	Sine of the angle

Output Parameters

xx, yy	Real variables that receive the (x,y) location of the point on the line that is closest to the point specified by **pt[]**.
dist2	Real variable that receives the square of the distance from the computed point (xx,yy) to the point specified by **pt[]**. (This distance is the shortest distance from the given point to the line.)

Details

This routine determines the line that passes through the given point and is perpendicular to the given line. The intersection point (xx,yy) of that line with the given line is returned as well as the square of the distance between the given point and the intersection point. (The distance is returned as zero if the given point lies on the line.)

Note that this routine performs the same function as **ve.pt.line( )**. This routine differs in that it is designed to have its input point and line in representations that are compatible with the results formats for the point and line classes.

Related Routines

ve.pt.line
vw.pt.line

Calling Sequence

```
CALL vw.pt.line(what, pt[], lin[], new[])
```

Function

Compute a new feature (as indicated by the **what** argument) based on a given point and line.

Usage Consideration

The input and output parameters are compatible with results of records in the point, line, and vision-frame classes, as appropriate.

Input Parameters

what — Real value specifying what kind of new feature to compute using the point and line. The possible values are:

0 Find the point on the line that is closest to the given point. Also return the distance and angles of the lines involved (in the array **new[]**).

1 Compute the line, parallel to the given line, that goes through the given point.

2 Compute the line, perpendicular to the given line, that goes through the given point.

3 Compute a vision frame that has the line as the X-axis with the point on the +Y-axis.

pt[ ] — Array of real values containing the coordinates for a point using the standard representation. That is, the (x,y) location is (**pt[vw.x]**,**pt[vw.y]**).

lin[ ] — Array of real values continuing the standard representation of a line:

lin[vw.x]	X coordinate of a point on the line
lin[vw.y]	Y coordinate of a point on the line
lin[vw.ang]	Angle of the line
lin[vw.cos]	Cosine of the angle
lin[vw.sin]	Sine of the angle

Output Parameter

new[ ] — Array of real values representing a new feature in the appropriate standard representation depending on the **what** input parameter as follows:

If **what** is 0: Nearest point and point-line distance.

new[vw.x]	X coordinate of nearest point on line
new[vw.y]	Y coordinate of nearest point on line
new[vw.ang]	Point-line distance
new[vw.cos]	Angle of input line
new[vw.sin]	Angle perpendicular to input line

If **what** is 1: Parallel line through point.

new[vw.x]	X coordinate of nearest point on the line
new[vw.y]	Y coordinate of nearest point on the line
new[vw.ang]	Angle of the line
new[vw.cos]	Cosine of the angle
new[vw.sin]	Sine of the angle

If **what** is 2: Perpendicular line through point.

new[vw.x]	X coordinate of nearest point on the line
new[vw.y]	Y coordinate of nearest point on the line
new[vw.ang]	Angle of the line
new[vw.cos]	Cosine of the angle
new[vw.sin]	Sine of the angle

If **what** is 3: Vision frame.

new[vw.x]	X coordinate of the origin
new[vw.y]	Y coordinate of the origin
new[vw.ang]	Angle of the line
new[vw.cos]	Cosine of the angle
new[vw.sin]	Sine of the angle

Details

When computing a vision frame, if the point is on the line, the angle of the positive Y-axis is the angle of the line plus 90 degrees, and the Z-axis points out of the screen.

Related Routine

ve.pt.line
vw.pt.lin.dist

Calling Sequence

```
CALL vw.pt.pt(pt1[], pt2[], lin[])
```

Function

Compute the line through two points.

Usage Consideration

The input and output parameters are compatible with results of records in the point and line classes, respectively.

Input Parameters

pt1[ ]	Array of real values containing the coordinates for the first point using the standard representation. That is, the (x,y) location is (**pt1[vw.x]**,**pt1[vw.y]**).
pt2[ ]	Array of real values containing the coordinates for the second point in the same format as in point #1.

Output Parameter

lin[ ]	new[vw.x]	X coordinate of a point on the line
	new[vw.y]	Y coordinate of a point on the line
	new[vw.ang]	Angle of the line
	new[vw.cos]	Cosine of the angle
	new[vw.sin]	Sine of the angle

Details

If the two points are coincident, the angle of the line is zero.

Calling Sequence

```
CALL vw.refresh(data[], results[])
```

Function

This is the standard refresh routine.

Copy the first 16 results in the results array to the array **ai.ctl[]** so that they can be displayed.

Usage Consideration

This routine can be used as a record-type refresh routine.

Input Parameters

data[ ]	Array of real values containing numeric data for a specific vision record.
results[ ]	Array of real values containing numeric data resulting from execution of the vision record represented by the array **data[]**.

Output Parameters

None.

Control Variable

cv.ve.results	Index for the global control array **ai.ctl[]** for the element that contains the start of the execution results for the current record.

Details

This routine is designed to be used as a record-type refresh routine or as part of a larger record-type refresh routine (see **vrec.refresh( )** on page 111).

This routine simply copies the first 16 values in the results array into the array **ai.ctl[ ]**, starting at index **cv.ve.results**.

Related Routine

vrec.refresh

Calling Sequence

```
CALL vw.run.dsp.flg(arg, db.p, $cmd)
```

Function

Toggle the start of the "runtime graphics" switch. Update the vision display and the check mark on the pull-down menu.

Usage Consideration

This is a menu spawn routine. It is called whenever the selection **Show➡Runtime Graphics** is chosen.

Input Parameters

arg	Real value that is currently not used.
db.p	Real value that is currently not used.

Output Parameter

$cmd	String variable used to receive the I/O command. This may include a standard AIM error indication. Currently, this parameter always returns the value **$io.cmd.nop**.

Global Variable

vw.run.disp[ ]	Real variable that controls the runtime display. During editing, this is always set to TRUE.
vw.runtime.disp[ ]	Real variable that defines the state of the "runtime graphics" switch. Set to TRUE if "runtime graphics" is ON; otherwise, set to FALSE.

Details

This routine toggles (between TRUE and FALSE) the global variable **vw.runtime.disp[vi.db[**TASK( )**]]**, indicating the state of the "runtime graphics" switch. The routine also updates the flags byte that controls the display of the check mark on the Show pull-down menu. Lastly, the routing sets the vision display overlay mode if the scheduler is active.

Calling Sequence

```
CALL vw.run.eval(rec, resp, error)
```

Function

Shell routine for **vw.run.eval2( )**.

Input Parameters

rec	Physical record number for the record that should be evaluated.
resp	Error response mask for any errors which are generated. The operator will be restricted to these error responses.

Output Parameter

error	Standard AIM operator response code. The variables **rn.opr.retry** and **rn.opr.skip** are handled internally (not returned).

Details

This routine is now just a shell routine for **vw.run.eval2( )**.The purpose is to maintain backward compatibility for existing programs.

Related Routine

vw.run.eval2

Calling Sequence

```
CALL vw.run.eval2(mode, rec, resp, error)
```

Function

This routine evaluates the specified vision record that appears as an argument in the executing sequence and handles walk-thru training.

Usage Considerations

This routine can be called only from a runtime routine (such as **rn.sched( )**) or a statement routine (such as **inspect( )**).

Global results arrays are updated.

Input Parameters

mode	Defines process for looping through the evaluation list: 0 (Normal VisionWare mode) Check every record, unless the record was already evaluated. Do *not* check sources to see if they are evaluated. 1 (Normal MotionWare mode) Check all records except pictures. Skip records with any sources not evaluated.
p.rec	Real value specifying the physical record number of the record to evaluate.
resp.mask	Real value specifying the operator responses that are allowed. See the standard error response mask for the routine **rn.error( )**.

Output Parameter

error	Real variable that receives a standard AIM operator response code. The variables **rn.opr.retry** and **rn.opr.skip** are handled internally (not returned).

Details

This routine is the standard way for a statement routine to invoke use of the Vision Module's automatic precomputation and ordering of the required records for execution.

At preruntime, the sequence that is about to be executed is scanned for the presence of vision records used as arguments in the statements. (A vision record is simply a record from the Vision database.) For each record found, a list is constructed of all the records that need to be executed prior to the execution of the primary vision record in the statement.

This routine is designed to utilize that list to perform the execution of all the correct records in the correct order, to handle errors that occur, and to respond to operator directives.

The "evaluation" of a vision record consists of first evaluating all the prerequisite records, followed by execution of the record itself. This routine evaluates the specified record by going down the list of prerequisite records (constructed at preruntime) and executing each one of them in order.

This routine analyzes the list in different ways, depending on the runtime mode that is being used (see below). That is, when walk-thru training is active, this routine deals with each record on the list differently than when sequence execution is running full speed, as follows:

- No-picture mode (reusable tree):

  ```
  [mode arg = 1]
  ```

  This mode is designed for MotionWare—pictures are *never* taken in this mode. In addition, before a record is evaluated (by calling **vw.eval( )**) each source record is checked to see if it is done. If all are not "done", that record evaluation is skipped. This allows for multiple **vw.run.eval( )** calls for the same tree. It is intended that another picture be taken between each call to allow more of the tree to be evaluated each time. The caller will then check the evaluation state of the top-of-tree record to see if it is finished yet.

- Normal execution mode:

  ```
  rn.sw.walk[TASK()] == FALSE
  ```

  If the record is already evaluated, the previous results are used and no new evaluation is performed. If the record is not evaluated, wait for any source nodes that are not complete and evaluate the new node by calling **vw.eval( )** for all records in the evaluation list.

- Walk-thru mode:

  ```
  rn.sw.walk[TASK()] == TRUE
  ```

  After sources have been checked but before execution, "Edit All" mode is checked for. Also, "Pause After Operation" mode is checked for after execution.

  Trace messages are displayed to identify each record as it is evaluated.

  Even if the main record is evaluated, the routine enters the main evaluation loop. It then waits for any source nodes that are not complete. It evaluates the new node by first calling walk-thru training and then calling **vw.eval( )** for all nodes in the evaluation list. An operator response of "retry action" causes the node being considered to be reevaluated. It always waits for each evaluation to be completed before going on to the next node.

In all cases, if a record is encountered that has already been evaluated by a previous statement (or because it appeared earlier in the list), that record is skipped. If a record has not yet been evaluated, its source records are checked. When it has been determined that all the source records for a record have been completed (successfully or not), the record itself is ready to be executed.

Related Routine

vw.build.list
vw.build.mod
vw.run.eval

Calling Sequence

```
CALL vw.run.init(status)
```

Function

Initialize the data structures needed for running a sequence that has vision records as arguments.

Usage Consideration

This routine must be called whenever the sequence is modified, or when a different sequence is selected.

Input Parameter

None.

Output Parameter

status	Real variable that receives a value indicating whether or not the operation was successful and what action should be taken by the calling routine. See the standard AIM runtime status values.

Details

This routine is called from the runtime whenever the scheduler is started. It initializes data structures and certain display and evaluation states.

Calling Sequence

```
CALL vw.set.up.tl(data[], $data[], mm.per.pix)
```

Function

Support routine for the **vw.*.data( )** routines that initializes a vision-tool record with standard shape and default picture parameters.

Usage Considerations

This routine is designed to be called from a record-type set-data routine (in mode 0).

The menu page being displayed must have **ve.page.mngr( )** as its user page routine.

Input Parameters

data[ ]	Array of real values containing numeric data for a specific vision record.
$data[ ]	Array containing string data for a specific vision record.

Output Parameters

data[ ]	Same as input **data[ ]**, but with some values changed.
$data[ ]	Same as input **$data[ ]**, but with some values changed.
mm.per.pix	Real variable that receives the millimeters-per-pixel scaling for the default picture initialized into the vision tool. This can be used when initializing the size of the tool in the shape parameters.

Details

This is a support routine, for use by the record-type set-data routines, to initialize new records. This routine performs some initialization common to all vision tools and possibly to other record types. It performs the following initialization:

1. The number of sources is set to 1.
2. If there is a default picture (as there almost always is), the name and number of that picture record are stored in the data arrays. (This is not done when the top of the tree is a calibration record.) Also, the millimeter-per-pixel scaling is extracted and used to initialize the position of the vision-tool shape to be at the center of the Vision window. This is useful for computing the default sizes of the new tool being created.

   NOTE: The **mm.per.pix** is per graphics pixel, regardless of the size of the frame store size. This allows the default sizes to be specified using a common value for all frame buffer sizes.

Related Routine

vrec.set.data

Calling Sequence

```
CALL vw.typ.def.rtn($routine, rec.type, status, halt)
```

Function

Execute a record-type definition routine, passing on the number for the new record type.

Usage Consideration

This routine should be called from the application initialization routine. It is located in the load file for your AIM application module.

Input Parameters

$routine	String value that specifies the routine to execute. The routine specified should have at least one argument (see below).
rec.type	Real value specifying the number to use for identifying the record type. This is used as the primary way of referring to this record type. It is also the leftmost index for the record-type definition arrays **vw.typ.def[,]** and **$vw.typ.def[,]**, the source classes array **vw.src.classes[,,]**, and the results definition array **vw.td.results[,,]**.

Output Parameters

status	Real variable that receives a standard AIM runtime status value indicating the success or failure of this operation.
halt	Real variable that receives TRUE if the routine specified did not exist and the user chose “Halt” instead of “Continue” from the pop-up.

Details

This routine is an entry point for defining a record type. For custom record types, it is called from the application initialization routine (∗**.mod.init( )**) with the name of the definition routine for the new record type. (For example, for VisionWare the initialization routine is **vw.mod.init( )** in the file VWMOD.OV2.)

The routine is also provided a unique number to be used for identifying the record type. Record types that are specific to an AIM module start at 100, and must be unique. Other custom record types start at 200.

Before the specified routine is executed, its presence in memory is checked. If it is not currently in memory, an error pop-up is displayed with the choices of “Halt” or “Continue”. The action chosen determines the return value of the **halt** parameter.

If the program exists, it is called with the record-type number passed as the only argument. Therefore, the routine specified must have at least one argument. If the routine expects other arguments, it must be able to execute with those arguments omitted.

Appendix A
Glossary

The terms described here are used throughout this manual.

Browsing

This refers to editing of the Vision database while the system is in paused-runtime mode. This is the most restrictive mode of editing. In this mode, some parameters, such as those for vision tool position and edge-strength threshold, can be changed, but most parameters cannot be changed. Specifically, the names of records or source records cannot be changed.

CIRCLE

A member of the circle class.

Class

This is a nonexclusive group of record types that all have some portion of their results formatted in the same way, so that they may be used interchangeably in certain circumstances. For example, all the records in the point class have a point for a result, and store its X and Y coordinates in consistent locations in their results arrays (at indexes “vw.x” and “vw.y”, respectively). See the section “Classes” on page 9. Also see Chapter 3.

Combination record
Combination record type

A combination record is used in conjunction with a “repeat” record to repeatedly execute a sub-tree of vision operations for the purpose of combining the results obtained from each repetition. See “Repeat record” on page 225. Also, see Appendix E and the *VisionWare User’s Guide*.

Computed feature

This is a vision operation that computes a geometric feature, such as a point, line, circle, or vision frame. The four standard vision operations in this category are Computed Point, Computed Line, Computed Circle, and Computed Frame.

Data arrays

This term refers to the global real array **vw.data[„]** and string array **$vw.data[„]**.

When the data arrays for a single record are mentioned, the reference is to the columns of data in the arrays that are for just the specific record. For example, if the physical record number of the record is “p.rec”, the data arrays for the record are **vw.data[,p.rec,]** and **$vw.data[,p.rec,]**.

If reference is made to the “data array” (that is, singular instead of plural), that means the particular array that has the correct data type (numeric or string) for the discussion. The string data array is not used very much, so most references are to the real array.

Editing

This term refers to editing of the Vision database when the scheduler is idle—that is, when there are no restrictions on the ability to edit the records.

Evaluate a record

This means to evaluate all source records (recursively) and then to execute the record.

Evaluation lists
Eval lists

At preruntime, an evaluation list is created for each vision argument in a statement in the sequence. These lists are used at runtime to efficiently evaluate the appropriate records in the correct order. See the description of **vw.build.module( )** on page 188.

Execute a record

This means to call the execution routine for the record (assuming that all the source records have been successfully executed).

VISION FRAME

A member of the vision-frame class.

Information-only
Info-only

These terms refer to a type of vision operation that is not executed at runtime but, rather, is processed at preruntime. If there is nothing about a vision operation that depends on information generated at runtime, the operation should be set up as an information-only record type.

LINE

A member of the line class.

Link time

This is the earliest stage of sequence execution. It happens just after the START button is pushed and before the stage called “preruntime”. It is the time when all the relevant references to database records are linked together using the record numbers (rather than names).

“New record” menu pages

These are the menu pages that are used to specify the name and record type when creating a new record. These menu pages are kept in a separate .MNU file, since they are different for each application module. In this file there is a general menu page that encompasses all the record types in the application module. Also, there should be a separate menu page for each of the classes that contain multiple record types. Then, when creating a new record that should belong to one of these classes, the user can select a record type from among a list of just the valid ones.

Paused runtime

This occurs when runtime is active but one of the “pause at end of” options (or a runtime error) has stopped execution of the sequence.

POINT

A member of the point class.

Preruntime

This is one of the early stages of sequence execution. It happens just after “link time”, and before the cycling begins. In this stage there is an opportunity to execute code that is specific to a record type.

Record type

This term is used in two ways:

1. The name for the quality that makes any number of records the same in functionality and data structure. For example, “the execution routine for the Computed Point record type”.
2. The unique number that identifies all records that have a common function, menu page for editing, and support routines. For example, the array **vw.typ.def[,]** is indexed by record type.

There are some terms used to refer to general nonexclusive categories of record types. These have definitions elsewhere in the glossary but are mentioned here for reference. They are “vision operations”, “vision tools”, “computed features”, and “information-only”.

Repeat record

A repeat record is one that can be reevaluated under certain conditions to obtain multiple instances of similar results. For example, a blob-finder can be repeated to obtain information about each of the individual blobs in the window. Repeat records are most commonly used in a combination-repeat pair (with a combination record), but also can be used by a specialized statement routine. (Also, MotionWare makes use of repeat records for conveyor-related applications.)

Results arrays

This term refers to the global real array **vw.res[„]** and string array **$vw.res[„]**.

When the results arrays for a single record are mentioned, the reference is to the columns of data in the arrays that are for just the specific record. For example, if the physical record number of the record is “p.rec”, the results arrays for the record are **vw.res[,p.rec,]** and **$vw.res[,p.rec,]**.

If reference is made to the “results array” (that is, singular instead of plural), that means the particular array that has the correct data type (numeric or string) for the discussion. The string results array is not used very much, so most references are to the real array.

Results definition array

This term refers to the global array **vw.td.results[„]**. This array contains the definitions of the “testable” results for each record type. It is normally encountered as a subarray for a particular record type, passed to the record-type definition routine as “res.def[,]”. This subarray is then optionally filled with the names and data types of the results (from the results array, **vw.res[,,]**) that need to be accessible via the test-a-value process. See the section “Test-a-value” on page 226. Also, see the description in Chapter 3 of the record-type definition routine.

Results page

This is the menu page that displays the results and accumulated statistics for the vision operations in the current or last sequence. There is a button on this page to display the “chart page” for the current vision operation. See the section “Accumulating Statistics” on page 45 for details.

Runtime

This is the main stage of sequence execution, when the sequence is constantly cycling. This term does not apply, however, if walk-thru training is enabled.

Select a source
Source selection
Source selection menu page

When editing a source for some record, the "Go/Select" menu option or the Display function key (F5) displays the possible records available for selection as sources for that record. The page that is displayed is called the "Source selection menu page". It shows a scrolling window with a list of the valid records for selection, with a graphic representation for each record shown in the vision window when possible. The record currently highlighted in the scrolling window is also highlighted in the vision window. The act of selecting a source using this page is called "source selection".

Source
Source record

These terms refer to a record whose results are needed for the successful execution of another record. They are always used in reference to a "parent" record that needs the results from one or more other records in its operation. These other records are called the "source records" or the "sources" for that parent record.

Source classes

When a record type is being defined, one designates which sources are needed for each evaluation method by specifying a class for each of the sources. For example, one of the evaluation methods for a record type may require a record from the point class and a record from the line class. These classes are the "source classes" for that evaluation method.

Standard routine

A standard routine is one that is provided by Adept as part of AIM and is documented on a "dictionary page" in a manual or is available in an unprotected file. The standard routines for VisionWare are described in Chapter 8.

Stray record

A stray record is any record that is not a top-level record and is not a source record for any other record.

Test-a-value

"Test-a-value" is a term used for referring to the process of accessing a single result of a vision operation, usually for the purpose of inspecting or collecting it. The Inspection record type and Value Combination record type both have test-a-value source records. This is because they are interested in a single value from any record. Any record type that has results that should be tested for some reason should belong to the Test-a-value class. This is done automatically by defining results that are "testable" in the results definition array passed into the record-type definition routine.

Top level

A top-level record can be selected for use as an argument to a sequence statement and will show on the "Top Level" page of the tree display.

Vision operation

This is a general term for the functionality contained in a vision record. Vision operation is often used when referring to the usage of a vision record.

Vision record

This is a record in the Vision database. The record contains all the data that is necessary for performing a vision operation.

Vision tool

This is a vision operation that operates on a picture. Rulers and Line Finders are typical examples of vision-tool operations.

See the description of the record-type definition routine **vrec.def( )** on page 96 for what this means for those creating a custom record type.

Walk-thru training

When used in the context of Vision database editing, this denotes a partially restricted mode of editing. The only values in the database that are not open to change are the record names. Any change that affects the tree structure (new records, deleting records, etc.) is not allowed.

Appendix B
Flow of Control

Sometimes, just knowing what your individual custom routines are supposed to do is not enough. That is, you need to know exactly when, in the flow of control, those routines are called—and in what modes. The following sections list the important activities handled by the Vision Module for several of the key times that it has control.

If some of the activities described here are not clear, you can just ignore them for now. When you need to know about them, they will make sense. These descriptions will be most helpful, at first, for just understanding the context in which the various record-type routines operate.

In the descriptions below, there are several lines with the form:

CALL: routine(mode) — Description

This represents a call to one of the routines specific to a record-type, such as those described in Chapter 6.

For those routines that can operate in different modes, the mode is given in parentheses. Also, to aid understanding, a short description of what the routine is supposed to do is given. For example, the line

CALL: set.data(mode 0) — New record initialization

means that the set-data routine for the record type of the current record will be called in mode 0. This will perform the initialization of the data for the new record.

In several of the sequences of events described below, the current record being edited is executed. This process has several steps of its own and is described in a separate section. Therefore, during editing, whenever the current record is executed, the symbol "(*)" is used as a reminder to look at that section for more details. This symbol also appears in the title of the section that describes that process. A different routine (**vw.eval( )**) is used for executing at runtime. It is described in its own section.

B.1 Start-up of AIM

When AIM is just starting, it displays messages in a blue start-up window regarding the steps it is performing. The following actions are performed as the Vision Module is loaded.

1. Initialize vision system and vision window.
2. Initialize support globals for Vision Module common to both editing and runtime.
3. Define standard record-type classes.
4. Define standard record types.
5. Define default calibrations for all virtual cameras.
6. Perform the initializations in the Vision Initialization database.

B.2 Loading/Unloading a Module With a Vision Database

When AIM is started, there is no “active” Vision database. When a module is loaded that has a vision database component, that vision database’s information is loaded into the system from the files they are stored in. Similarly, when such a module is unloaded, the vision database’s information is saved back to the files.

Loading

Many database-specific global variables are initialized during the loading procedure.

1. Initialize the data arrays for each record from the Vision database.
2. Perform any miscellaneous data checks, and auto-convert the old databases.
3. Determine and select the vision system for use with the database.
4. Enable vision, if needed.
5. Load the model files for this Vision database.
6. Link the Vision database.
7. Initialize the allocation list of virtual cameras for this vision system.
8. For each record in the database:

   CALL: set.data(mode 2) — Data-setup.
9. Check the database for any circularly linked records.

Unloading

1. Deselect all virtual frame buffers.
2. Store the models used by the Vision database in files.
3. Free the virtual cameras allocated to this database.
4. Delete all models referred to by the Vision database.
5. Delete all large data structures allocated for the database, such as **vw.data[vi.db[**TASK( )**,,]**, and **vw.res[vi.db[**TASK( )**,,].**

B.3 Editing

This section contains all the key situations that occur during the editing of the Vision database, whether the scheduler is active or not.

Start of Vision Editing

The operator has just started vision editing by selecting the menu item “Edit/Vision” or by entering the database from some other activity.

1. Initialize support globals for vision editing.

Redraw of a Menu Page

Redraws of the menu page occur in numerous situations. The most predictable are:

- when the operator presses the **Redraw** function key (**Shift**+**F6**)
- when the record changes and a new menu page must be displayed
- when an AUTO-REDRAW value on the menu page is changed
- when returning from a pop-up.

1. If the runtime is *not* running:

   Clear graphics from the vision window.

   Update data arrays from database.

   CALL: set.data(mode 2) — Data-setup.

2. If the scheduler is *not* active:

   Clear the first 15 values in the results array.

   Assign: data[vs.eval] = <not done>.

   Assign: data[vs.status] = <invalid status>.

3. Select the correct vision system.

4. Assign: data[vs.editing] = FALSE.

5. Assign: list[0,0] = 0.

6. Initialize editing variables specifically for this record (**ve.rec.type**, **ve.type**, **$ve.edit**, etc.).

7. If you have just started editing this record:

   CALL: edit(mode –1) — Enter record for editing.

8. If runtime is running, go to <end of redraw>.

9. If **eval.method** is 0, go to <end of redraw>.

10. If the scheduler is *not* active:

    Clear the "done" state for the trees of the source records for the current record.

    Evaluate all the records in the trees of the sources.

11. If there are more than 0 source records:

    Set the reference picture.

    If the reference picture is bad, go to <display sources>.

12. If the scheduler is *not* active:

    Force the reference picture to be shown.

    If it cannot be shown, go to <end of redraw>.

13. Set the screen editing variables based on the virtual camera currently displayed.

14. Update and reconcile relative and absolute shape parameters.

15. CALL: edit(mode 0) — Edit initialization.

    If error code returned, go to <display sources>.

16. If data[vs.editing]:

    Force the shape parameters to be on screen (after confirmation).

17. -- <display sources> --

18. If *not* a combination record:

    Display a graphic for each of the sources, if possible.

19. If the scheduler is active, save the evaluation state of this record.

20. Execute the current record (*).

21. If the scheduler is active, restore the evaluation state of this record.
22. Display the graphics requested by the Show pull-down.
23. If the record is not executed, go to <end of redraw>.
24. If data[vs.editing]:

    CALL: edit(mode 1) — Set handle locations.

    Draw handles.
25. -- <end of redraw> --
26. Open the current record.
27. CALL: refresh( ) — Refresh routine.

Refresh of Menu Page

Besides happening as the last step of a redraw, a menu page that is constantly auto-refreshing executes this code once every refresh cycle (as specified in the menu page header).

1. CALL: refresh( ) — Refresh routine.

(*) Execute a Record During Editing

This section describes what happens when a record requires execution during editing. It is not always for the record being edited, but it may be for one of the records in the tree for that record.

> **NOTE:** The notation "(*)" above means that this section is referred to when this symbol appears in other sections of this appendix.

1. Save the value of **vw.multi.pics[ ]** and set it to 1 (preruntime sets it to –1 if there is more than one picture). This prevents allocation of virtual cameras during editing.
2. Save the value of **vw.num.pics[ ]** and set it to (vw.num.frm.bufs+1).
3. If there is a picture record and "image lock" is on:

    If the current image is okay, pretend it was the result of executing the picture record and mark it as successfully done.

    Otherwise, mark the record as done but not successful.
4. If (executing the current edit record) AND (data[vs.editing]) AND [(in live-video mode) OR (data[vs.editing] > 0)]:

    Just use the editing graphic, don't really execute.
5. If the scheduler is *not* active:

    CALL: set.data(mode 1) — Preruntime computations.

    If any error code is returned, go to <done>.
6. If this is an "information-only" record, go to <done>.
7. If any source records are not "done", go to <done>.
8. If the scheduler is *not* active, set the reference picture record.
9. If a picture record:

    Set VDISPLAY overlay mode to not erase current tools.

Disable waiting on any signals.

If the scheduler is *not* active:

Disable the ping-pong mode temporarily.

If this execution is *not* triggered by "New Picture" pull-down:

Disable waiting (on either I/O signal or Ext signal).

CALL: vw.eval( ) — Runtime execution.

If waiting is allowed, time-out after 10 seconds if a picture has not been taken.

Set the new default picture, camera records, and names.

Restore waiting modes and ping-pong mode, if suspended.

10. If *not* a picture record:

    Force the current picture to be correct for this record. Or go to <done>.

    For vision tools, when the record being executed is the record for the current menu page, start a timer.

    CALL: vw.eval( ) — Runtime execution.

    If timing a vision tool, display the time in the Vision window.

11. Restore the original values of **vw.multi.pics[ ]** and **vw.num.pics[ ]**.

Mouse Events That Are Near Handles

These situations occur only if there is a shape being edited on the screen. The most common case is for vision tools. When a mouse-down event occurs, its position is checked to see if it is near one of the handles being used to edit the shape. Only then will the following actions be taken (until a mouse-up event occurs or the window is deselected):

1. Mouse down:

   Execute record (*) to erase previous shape.
   Erase all handles.
   CALL: edit(mode 2) — Edit event handling.
   CALL: draw( ) to draw the new shape.
   Draw all handles.

2. Mouse move:

   CALL: draw( ) for previous shape, to erase it.
   Erase all handles.
   CALL: edit(mode 2) — Edit event handling.
   CALL: draw( ) to draw the new shape.
   Draw all handles.

3. Mouse up:

   CALL: draw( ) for previous shape, to erase it.
   Erase all handles.
   CALL: edit(mode 2) — Edit event handling.
   Execute record (*) with new shape.
   Draw all handles.

4. Window deselected (clicked on another window).

   (Same as mouse up.)

Direct Changing of Record Data

When a value on the menu page is changed directly by entering a new value or using a slide bar:

1. For source record names:

   Check validity and link when necessary.

   Prevent creation of loops in source dependency.
2. Execute record (*) to erase previous shape.
3. Erase all handles.
4. CALL: edit(mode 2) — Edit event handling.
5. If value changed was the Evaluation Method:

   Reset number of sources in the data array and database.

   CALL: edit(mode 0) — Edit initialization.
6. If **data[vs.editing]** *and* record has a "shape":

   CALL: ve.update.shp( ) — Convert absolute shape to relative.

   CALL: edit(mode 1) — Set handle locations.
7. Execute record (*) with new shape.
8. Draw all handles.

When a New Record Is Created

1. Create the new record with specified name and record type.
2. CALL: set.data(mode 0) — New record initialization.
3. Write data arrays to database records.
4. Link all records.
5. CALL: set.data(mode 2) — Data-setup.

If Another Menu Page Pops Up and Down

Several different windows may pop up on top of the main menu page while editing is in process. In this case, the following will happen:

> **NOTE:** If the new popped-up window has the standard page user routine (**ve.page.mngr( )**, which should have an **arg** of 1 specified in the page header), all the actions described in this appendix will also apply to the new page.

1. Erase handles and ignore mouse events while main menu page is inactive.
2. When the pop-up menu page goes away, redraw will occur.

B.4 Scheduler Is Active

Most of the code for the scheduler is public and open to change. Also, it is often different for each application module. Except where noted, the following applies to all standard application modules released by Adept, and describes the minimal events needed when including vision arguments in a sequence.

Link Time

1. All the vision record names in the statements are linked to their actual logical record numbers.

Preruntime

1. Initialize support globals for vision runtime.
2. Call the routine **vw.build.module( )**. This builds the "evaluation" lists and initializes other runtime variables. See **vw.build.module( )** on page 188 for more details.
3. (VisionWare only) Call the routine **pr.prep.module( )**. This step does preruntime preparation for the sequence steps. See the section "Preruntime" on page 87 for more details.
4. (VisionWare only) Find inspections that can be executed in groups and build data structures to support group execution at runtime. See sections 5.1 and 5.2 for more details.

Runtime (Cycling Through the Sequence)

1. (VisionWare only) At the top of each cycle, the "eval done" flag is incremented so that all vision operations appear to be not done.
2. When a statement routine calls **vw.run.eval( )** for a vision argument, each vision operation in the list is executed by:

   CALL: vw.run.eval( ) — Runtime execution.
   OR
   CALL:vw.run.eval2( )—Runtime execution.

3. (VisionWare only) When inspections are grouped, all the records in the inspection tree are considered together and executed in optimal order. Then, the inspections are executed in the order they were specified in the statements.
4. If logging is enabled, the data buffer is periodically flushed if the flush time is set to zero or greater. (This is set on the "Log Results" pop-up.)

B.5 Runtime Execution Routine—vw.eval( )

The main purpose of this routine is to call the execution routine for a record. In addition, for vision tools some things are done automatically to save code in all the individual execution routines. In fact, so much more is done that we treat them as separate cases below.

Although **vw.eval( )** is referred to as the runtime execution routine, it is also called from editing to execute records when needed.

Using **vw.eval( )** for *non*-vision tools:

1. If there is a source 1 for this record, set the reference picture to be the same as it was. (This is not done for pictures.)
2. CALL: exec( ) — The execution routine.

Using **vw.eval( )** for vision tools:

1. Check that the picture source record has been successful.
2. If more than one picture in sequence (**vw.multi.pics[ ]**):

   If the correct frame buffer is not selected,

   VSELECT correct buffer and update **vw.cur.buf**.

   If the vision tool is to be displayed,

   VDISPLAY the picture for the vision tool.
3. Set the virtual camera to use for this vision tool.
4. Set the reference picture to be the same as for source 1.
5. If there is a vision-frame source:

   Check that the vision frame has been successful.

   Convert the vision frame to be in the coordinate frame for the reference picture for the record.

   Compute the absolute shape parameters of the tool in the coordinate frame of the reference picture.
6. Set the display mode for this task. For point, line, and arc finders, set the V.SHOW.EDGES switch if editing or in walk-thru training.
7. CALL: exec( ) — The execution routine.
8. For point, line, and arc finders, unset the V.SHOW.EDGES switch if it was set in step 6.

Appendix C
Template Routines for Custom Record Types

In the process of creating a custom record type, you have to write several custom routines. The full function and calling sequences for these routines are described in Chapter 6, but sometimes an example or template version of the routine can be very helpful in actually getting the job done.

This appendix provides template routines for two basic kinds of record types: purely computational records, and vision tools. In an effort to keep them as simple as possible, these record types do not have shape parameters that need to be specified or graphically edited. Therefore, only the definition routine, the set-data routine, and the execution routine are needed.

The template routines described in this appendix can be found in the disk file VISTMPLS.V2, without the name prefix "***.".

In Appendix D, example routines for simple hypothetical record types are presented. Those routines are based on the templates in this appendix. Appendix E contains template and example routines for combination record types.

C.1 Comments on Notation

Various notational devices are used in the following template routines.

The symbol ";*-->" is used to mark those places where you may, or must, alter or insert custom code to make the template routine into a working custom routine. To distinguish them from ordinary comments, directions on what is needed at a particular location are given in angle brackets (<...>).

The name prefix "***." is used throughout these routines to represent the custom prefix you will eventually choose for the record type. You should pick a unique custom prefix and substitute it wherever you see "***." (particularly in the names of the routines).

Two semicolons (;;) at the beginning of a line indicate that the line is a general explanation of some aspect of the routine. Such lines would normally be omitted when the routine is filled in.

The "real" comments (that is, those with a single semicolon) in the routines are written assuming a general knowledge of the structure of record types and how to create custom record types. Specifically, you should be familiar with the section"Creating a Custom Record Type" on page 51, which describes the general procedure for creating a custom record type.

C.2 Computational Record Type

This first set of template routines is for a record type that does only computations based on the results in its source records. This is the most basic kind of record type. We assume there are no

special needs regarding editing of parameters. Most significantly, we assume that there are no shape parameters that need to be edited graphically. These assumptions result in a very simple and straightforward record type—only the definition and execution routines are needed.

As a small departure from making this the most simple record type possible, we assume that we may need to have some of its results available to test from an inspection record. Therefore, we must define the results in the results definition arrays.

The template routines for computational records are identified by the prefix "***.cmp" to distinguish them from the vision-tool template routines, which have the prefix "***.vtl".

> **NOTE:** In the routines that follow, where a line would normally extend off the page, it is split and continued on the next line. In these cases, the first of the two lines ends with "...". These split lines must be merged (without the "...") if these programs are typed in and used.

Definition Routine—***.cmp.def( )

```
.PROGRAM ***.cmp.def(rec.type, def[], $def[], src.classes[,], ...
                                          res.def[,], $res.labels)

; ABSTRACT:  This is a template RECORD-TYPE DEFINITION routine for
; a computational custom record type (NOT a vision tool).
;
; This custom record type will compute something based on
; the data in few source records.  There is no shape to
; drag around and therefore no vision frame to worry about.
;
; (See standard calling sequence for all record-type definition
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None
;
; DATA STRUCTURES: See standard routine header.
;
; Copyright (c) 1991 by Adept Technology, Inc.

; Use of vw.data[]:
; vs.rec.type                   ;Must == ***.rec.type
;
;*NOTE: The above variable "***.rec.type" should be the same one as given
;* when the declaration routine "vw.typ.def.rtn()" is called as part
;*      of the application initialization process.  It is mentioned here
;*      just for completeness.
;
; vs.type                       ;Evaluation Method: Must be non-0.
;*-->    ;   <Document possible values here>

;MODES - describe the ones that are used - document ones that are not.
;*--> <list all uses of the modes here - in following manner>
;*--> vs.md0                    ;<used for ...>
;*--> vs.md1                    ;<used for ...>
;*--> vs.md2 -thru- vs.md15     ;(not used)

; vs.shp                        ;(not used)
```

```
; vs.rel.x -thru- .rel.an       ;(not used)
; vs.flags                     ;Flags, bit positions used are:
;     vw.flg.top.lvl = ^H40     ; Top-level node?
; vs.num.src                   ;Number of sources.
; vs.ref.frm                   ;(not used)
; vs.src.1                     ;Source #1
; vs.src.2 -thru- vs.src.8     ;(not used)
; vs.x -thru- vs.an            ;(not used)

; Use of $vw.data[]:
; vs.str.1                     ;(not used)
; vs.str.2                     ;(not used)
; vs.name                      ;Name of record.

; Source classes for each eval method.
;
;*--> src.classes[1,0] = <N?>   ;Number of sources for method 1.
;*--> src.classes[1,<1..N?>] = <some class number>
;
;*--> <If there are more eval methods, list the source classes here>
;

; Use of vw.res[]:
;*--> vw.r.0   ;<used for ...>
;*--> vw.r.1   ;<used for ...>
;*--> vw.r.2 -thru- vw.r.15     ;(unused)
;
;NOTE: Even if not using descriptive variables, this is the best central
;place to document the use of the results array.

; Use of $vw.res[]:
;
;       None.

; Define the results that we want to have available to test when these
; records are used as "test-a-value" records, such as from an inspection.

        res.def[1, 0] = vw.r.0
        res.def[1, 1] = 0       ;Real value
;*-->   $res.labels[1] = "<Label for result 1>"

        res.def[2, 0] = vw.r.1
        res.def[2, 1] = 1       ;Boolean value
;*-->   $res.labels[2] = "<Label for result 2>"

        res.def[0, 0] = 2       ;Number of results

; Define the basic record type characteristics.

 def[vw.td.shape] = FALSE
 def[vw.td.icon] = 0            ;Index into your custom icon.
 def[vw.td.custom] = TRUE
 def[vw.td.class] = 0
 def[vw.td.flags] = 0
 def[vw.td.vtool] = FALSE
 def[vw.td.info] = FALSE
;*--> def[vw.td.def.tst] = <default index into res.def[,] array>
 def[vw.td.combo] = FALSE
```

```
; Setup the strings (mostly routine and menu page names)

;*--> $def[vw.td.exec] = "cmp.exec"  ;<needs correct prefix>
;*--> $def[vw.td.name] = "<name of record type>"
;*--> $def[vw.td.pg.file] = "***vis" ;<custom menu page file>
;*--> $def[vw.td.pg.name] = "<menu page name>"
 $def[vw.td.res.filt] = ""
      $def[vw.td.data] = ""
   $def[vw.td.draw] = ""
   $def[vw.td.edit] = ""
   $def[vw.td.refresh] = "vw.refresh" ;Use standard routine.
;*--> $def[vw.td.ic.name] = "***_icon";<needs correct prefix>

; Finally, add to the appropriate classes.

;*-->   CALL vw.add.to.class(<class name>, rec.type, 0) ;<Other classes?>

.END
```

Execution Routine—***.cmp.exec( )

```
.PROGRAM ***.cmp.exec(data[], results[], vw.data[,], vw.res[,])

; ABSTRACT:  This is a template EXECUTION routine for a generic
; computational record type.  It CANNOT be executed as is, but
; must be completed.
;
; Based on the data in the source records, some results are
; computed which can be used later by other records like
; inspections.
;
; (See standard calling sequence for all record-type execution
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None
;
; Copyright (c) 1991 by Adept Technology, Inc.

 AUTO stt, num.src, ref.pic, ii, db

 stt = 0
 db = vi.db[TASK()]             ;Vision database  ;L428

 num.src = data[vs.num.src]     ;Number of sources.
 ref.pic = data[vs.ref.pic]     ;Reference picture record number.

; Check that sources are OK.  Must check all the sources, unless you define
; the record type to be a "vision tool", in which case the vision frame
; and picture sources (0 and 1) are checked by VisionWare automatically.
; For vision frames, since they are optional, you will need to check
; them separately, as follows:
;
; IF data[vs.ref.frm] THEN
;     IF vw.data[data[vs.ref.frm],vs.status] THEN
```

```
;  stt = vw.data[data[vs.ref.frm],vs.status]
;  GOTO 90
;     END
;       END
;
; Since this simple record type has no shape, it never uses the vision
; frame, and it therefore does not need to be checked.

 FOR ii = vs.src.1 TO vs.src+num.src
     IF vw.data[data[ii],vs.status] THEN
  stt = vw.data[data[ii],vs.status]
  GOTO 90
     END
 END

; Convert sources if necessary.  This must be done for any record where
; there is more than one source that has coordinate values in it when there
; is more than one picture present in the database (at editing) or in the
; sequence (at runtime).  The standard routine called below will convert
; the results of all other sources to be in the same "reference picture" as
; source one is in.  That way all feature-to-feature calculations can be
; done in the same space.  The "reference picture" is changed for each of
; the converted records so the results are always consistent with the
; reference picture specified in the data array.

 IF vw.multi.pics[db] THEN      ;L428
     FOR ii = vs.src.2 TO vs.src+num.src
  CALL vw.conv.frm(ref.pic, vw.data[ii,], vw.res[ii,], stt)
  IF stt GOTO 90
     END
 END

; With regard to the "FOR ii = ..." loops above:  If the number of sources
; is fixed, then it would be more efficient NOT to use loops, but rather
; do each check one at a time.  But you will have to weigh the use of the
; extra code against the faster execution.

; Branch to appropriate action, based on eval method.

 CASE data[vs.type] OF

;*-->   VALUE ***.meth.1:       ;<need real name for eval method #1>

;*-->     <perform computations of results based on source data>

;*-->   VALUE ***.meth.2:       ;<need real name for eval method #2>

;*-->     <perform computations of results based on source data>

;*-->   VALUE ???:              ;<other methods?>

;*-->     <perform computations of results based on source data>

   ANY
     stt = ec.bad.vis.data           ;Invalid vision tool data
        END

; Set the eval state flag to show complete.
```

```
90 data[vs.status] = stt
        data[vs.eval] = vw.stt.done[db]              ;L428+

; Draw the graphic for this result if all correct flags are set.

 IF vw.run.disp[db] THEN             ;Check runtime global first
     IF vw.run.disp[db] > 0 THEN     ;Only if editing or WTT.
  IF (vw.cur.pic[db] == ref.pic) AND NOT stt THEN    ;L428-

;*-->      <perform graphics code here>

  END
     END
 END

; About the above code:  The first test is done so that in the case where
; no graphics have been requested, the fastest possible test is done.
; Once it is established that graphics are desired, then speed is not so
; much of an issue.  The next test (vw.run.disp > 0) will insure that we
; are in editing or walk-thru training.  This is the only time that
; graphics are allowed for this kind of record because it executes from
; the MAIN task.  The vision task can change the current picture and
; selected virtual camera and we would not be able to reliably draw any
; graphics in the correct scaling.
;
; The innermost tests check that the operation was successful and that the
; current picture is the same as the reference picture.  This is important
; since the results are in absolute coordinates of the reference picture.

.END
```

C.3 Vision-Tool Record Type

This section contains template routines for a simple vision-tool record type that has no shape. That is, it operates on a picture but has no shape parameters that need to be repositioned or computed relative to a vision frame. This record type has one source, a PICTURE, as do all vision tools. It executes some vision tools in the picture, and computes some results from it (perhaps a vision frame, a circle, or just some measured values).

Remember that the term “vision tool” has a special meaning here. It means that the record-type description parameter **def[vw.td.vtool]** is set to TRUE in the record-type definition routine. See the description of that parameter on the dictionary page for **vrec.def( )** on page 96.

Also, like the computational record type, we assume that the results of one of these records include some values that could need to be tested for validity. Therefore, we must define them in the results definition arrays. This is done in the record-type definition routine.

> **NOTE:** In the routines that follow, where a line would normally extend off the page, it is split and continued on the next line. In these cases, the first of the two lines ends with “...”. These split lines must be merged (without the “...”) if these programs are typed in and used.

Definition Routine—***.vtl.def( )

```
.PROGRAM ***.vtl.def(rec.type, def[], $def[], src.classes[,], ...
                                          res.def[,],$res.labels)
```

```
; ABSTRACT:  This is a template RECORD-TYPE DEFINITION routine for
; a vision tool custom record type.
;
; This custom record type will execute some vision tools in
; a picture and compute some results.  There is no shape to
; drag around and therefore no vision frame to worry about.
;
; (See standard calling sequence for all record-type definition
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None
;
; DATA STRUCTURES: See standard routine header.
;
; Copyright (c) 1991 by Adept Technology, Inc.

; Use of vw.data[]:
; vs.rec.type  ;Must == ***.rec.type
;
;*NOTE: The above variable "***.rec.type" should be the same one as given
;* when the declaration routine "vw.typ.def.rtn()" is called as part
;*      of the application initialization process.  It is mentioned here
;*      just for completeness.
;
; vs.type   ;Evaluation Method: Must be non-0.
; <Let's assume only possible value is 1>

;MODES - describe the ones that are used - document ones that are not.
;*--> <list all uses of the modes here - in following manner>
;*--> vs.md0                    ;<used for ...>
;*--> vs.md1                    ;<used for ...>
;*--> vs.md2 -thru- vs.md15     ;(not used)

; vs.shp                       ;(not used)
; vs.rel.x -thru- .rel.an      ;(not used)
; vs.flags                     ;Flags, bit positions used are:
;     vw.flg.top.lvl = ^H40    ; Top-level node?
; vs.num.src                   ;Number of sources.
; vs.ref.frm                   ;(not used)
; vs.src.1                     ;Source #1 - always a PICTURE record.
; vs.src.2 -thru- vs.src.8     ;(not used)
; vs.x -thru- vs.an            ;(not used)

; Use of $vw.data[]:
; vs.str.1                     ;(not used)
; vs.str.2                     ;(not used)
; vs.name                      ;Name of record.

; Source classes for each eval method.

 src.classes[1,0] = 1          ;Number of sources for method 1.
 src.classes[1,1] = ve.pic.class;PICTURE class.
;
;*--> <If there are more eval methods, set the source classes here>
;
```

```
; Use of vw.res[]:
;*--> vw.r.0                        ;<used for ...>
;*--> vw.r.1                        ;<used for ...>
;*--> vw.r.2 -thru- vw.r.15         ;(unused)
;
;NOTE: Even if not using descriptive variables, this is the best central
;place to document the use of the results array.

; Use of $vw.res[]:
;
;       None.

; Define the results that we want to have available to test when these
; records are used as "test-a-value" records, such as from an inspection.

        res.def[1, 0] = vw.r.0
        res.def[1, 1] = 0           ;Real value
;*-->   $res.labels[1] = "<Label for result 1>"

        res.def[2, 0] = vw.r.1
        res.def[2, 1] = 1           ;Boolean value
;*-->   $res.labels[2] = "<Label for result 2>"

        res.def[0, 0] = 2           ;Number of results

; Define the basic record type characteristics.

 def[vw.td.shape] = FALSE
 def[vw.td.icon] = 0                ;Index into your custom icon.
 def[vw.td.custom] = TRUE
 def[vw.td.class] = 0
 def[vw.td.flags] = 0
 def[vw.td.vtool] = TRUE            ;THIS IS IMPORTANT.
 def[vw.td.info] = FALSE
;*--> def[vw.td.def.tst] = <default index into res.def[,] array>
 def[vw.td.combo] = FALSE

; Set up the strings (mostly routine and menu page names)

;*--> $def[vw.td.exec] = "vtl.exec"  ;<needs correct prefix>
;*--> $def[vw.td.name] = "<name of record type>"
;*--> $def[vw.td.pg.file] = "***vis" ;<custom menu page file>
;*--> $def[vw.td.pg.name] = "<menu page name>"
 $def[vw.td.res.filt] = ""
;*--> $def[vw.td.data] = "vtl.data"  ;<needs correct prefix>
   $def[vw.td.draw] = ""
   $def[vw.td.edit] = ""
   $def[vw.td.refresh] = "vw.refresh"  ;Use standard routine.
;*--> $def[vw.td.ic.name] = "***_icon" ;<needs correct prefix>

; Finally, add to the appropriate classes.

;*-->   CALL vw.add.to.class(<class name>, rec.type, 0) ;<Other classes?>

.END
```

Set-Data Routine—***.vtl.data( )

```
.PROGRAM ***.vtl.data(mode, data[], $data[], stt)

; ABSTRACT:  This is a template routine for a generic record type.
; It must be altered where appropriate, then it can be
; used as a SET.DATA routine for a custom computation record
; type.
;
; (See standard calling sequence for all record-type set.data
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None.
;
; Copyright (c) 1991 by Adept Technology, Inc.

 stt = 0

 CASE mode OF

   VALUE 0: ;New record initialization.

;*-->     data[vs.type] = 1          ;You may want to change this
     ; if using more than one
     ; evaluation method.

     ; This routine, vw.set.up.tl(), will make sure this new
     ; record is set-up with the default picture record as source 1.
     ; It will set the "data[vs.num.src]" to 1.  If you have
     ; other sources, then you must reset this variable AFTER
     ; the call to this routine.  This routine also does stuff
     ; concerning the shape parameters, but since this record
     ; type does not use them, we will ignore that aspect.

     CALL vw.set.up.tl(data[], $data[], 0)

;*-->     <Other new-record initialization can go here>

   VALUE 1:                          ;Preruntime computations.

;*-->     <Custom preruntime initialization can go here>

   VALUE 2:                          ;Data-extension computations.

;*-->     <Custom data-extension computations can go here>

 END

    100 RETURN
.END
```

Execution Routine—***.vtl.exec( )

```
.PROGRAM ***.vtl.exec(data[], results[], vw.data[,], vw.res[,])
```

```
; ABSTRACT:  This is a template EXECUTION routine for a vision tool
; record type.  It CANNOT be executed as is, but must be completed.
;
; Vision tools are performed on the picture source and results
; computed which can be used later by other records.
;
; (See standard calling sequence for all record-type execution
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None
;
; Copyright (c) 1991 by Adept Technology, Inc.

        AUTO dm, stt, tsk, vc, db

 stt = 0
        tsk = TASK()  ;Current task number
        vc = data[vs.vcam]                ;Designated virtual camera
        dm = vw.dmode[tsk]                ;Designated display mode
         db = vi.db[tsk]                  ;Vision database to use  ;L428

;*--> Notice that there is NO need to check for the successful completion
; of the source records, since there is only one, a picture, and it will
; be checked automatically for vision tools.

; Execute the vision tools and do the computations.

;*--> <code goes here>
;
;*--> Use "dm" as the display mode variable for vision tools.
;*--> Use "vc" as the virtual camera for vision tools and setting
;*-->   any switches and parameters.
;
;*-->   IF vw.vis.err[tsk] GOTO 100        ;<do this after each vision instr.>
;
;*--> Remember to put the results in the array "results[]".  If the vision
; tool fails, set appropriate values into the results array, if you want,
; but these values are not officially defined if the status value is not 0.
;
;*--> If there are any errors, then set "stt" and GOTO 101.

; If there are further graphics to draw other than the ones automatically
; generated by the vision tools, then do them here (if appropriate).
; The second test is made because the extra graphics should be done only
; when editing or walk-thru training.  Otherwise, only allow the fast graphics
; that are automatically done by the vision system for the vision tools.
; On vision coprocessor systems, this will always be overlapped.

 IF dm > -1 THEN   ;Graphics already approved.
     IF vw.run.disp[db] > 0 THEN          ;** ONLY IF EDITING **  ;L428

;*-->  <perform graphics code here>

     END
 END
```

```
; Done.  If the vision reacte routine trapped a system error during the
; vision instruction, then copy it to the status value and reset the
; vision error trap variable.

   100  stt = vw.vis.err[tsk]
        vw.vis.err[tsk] = 0

   101 data[vs.status] = stt
        data[vs.eval] = vw.stt.done[db]    ;Signal that eval is complete ;L428

 RETURN
.END
```

Appendix D
Example Routines for Custom Record Types

This appendix provides example routines for two simple custom record types, building on the template routines provided in Appendix C. The first is a computational record type for computing the centroid of three points. The second is a vision-tool record type for locating and inspecting a needle-bearing assembly.

The comments in the following routines are written assuming a general knowledge of the structure of record types and how to create custom record types. Specifically, you should be familiar with the section “Creating a Custom Record Type” on page 51, which describes a general procedure for creating a custom record type.

> **NOTE:** In the routines that follow, where a line would normally extend off the page, it is split and continued on the next line. In these cases, the first of the two lines ends with “...”. These split lines must be merged (without the “...”) if these programs are typed in and used.

The example routines described in this appendix can be found in the disk file VISTMPLS.V2.

D.1 Example Routines for Computational Record Type

This simple computational record type uses three POINT records and computes a new point at the centroid of the three. This record type, called the “Point Centroid”, is not actually provided with the vision module, but is presented as an example of how simple a record type can get. Seeing a record type in its minimum configuration may help you to understand the basic concepts.

For another example of a computational record type, see the file VFINDERS.V2. It contains the routines for the Computed Line record type.

In order to distinguish the names of routines and variables from those used by the vision-tool example record type, the routines for this example record type use the prefix “ctr” for the names of many of the routines and variables. If you copy these routines to use as a basis for a custom record type of your own, make sure to consistently and completely change the appropriate routine and variable names.

Definition Routine—ctr.def( )

```
.PROGRAM ctr.def(rec.type, def[], $def[], src.classes[,], res.def[,], $res.labels)

; ABSTRACT:  This is the RECORD-TYPE DEFINITION routine for the POINT
; CENTROID record type.  It computes the centroid
; of three POINTs to yield a new POINT.
;
; It has three source records (all POINTs) and stores the
; newly computed point in its results array in POINT form so
; that it can belong to the POINT class itself.
;
; There are no parameters, graphic shapes, vision frames,
; test-a-value menu pages, etc., to worry about.  This is about
; as simple a custom record type as can be.  There are only
; two routines, this one and the execution routine!
;
; (See standard calling sequence for all record-type definition
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None
;
; DATA STRUCTURES: See standard routine header.
;
; Copyright (c) 1991 by Adept Technology, Inc.

; Use of vw.data[]:
; vs.rec.type                    ;Must == ctr.rec.type
; vs.type                        ;Evaluation Method: Must be 1 in this case.
; vs.md0 -thru- vs.md15          ;(not used)
; vs.shp                         ;(not used)
; vs.rel.x -thru- .rel.an        ;(not used)
; vs.flags                       ;Flags, bit positions used are:
;     vw.flg.top.lvl = ^H40      ; Top-level node?
; vs.num.src                     ;Number of sources.
; vs.ref.frm                     ;(not used)
; vs.src.1                       ;Source #1
; vs.src.2 -thru- vs.src.8       ;(not used)
; vs.x -thru- vs.an              ;(not used)

; Use of $vw.data[]:
; vs.str.1                       ;(not used)
; vs.str.2                       ;(not used)
; vs.name                        ;Name of record.

; Source classes for each eval method.
 src.classes[1,0] = 3            ;Number of sources for method 1.
 src.classes[1,1] = ve.pt.class
 src.classes[1,2] = ve.pt.class
 src.classes[1,3] = ve.pt.class

; Use of vw.res[]:
; vw.x                           ;X coord of point.
; vw.y                           ;Y coord of point.
; vw.ang                         ;Angle (always 0).
; vw.cos                         ;Cos of above.
; vw.sin                         ;Sin of above.
; vw.r.5 -thru- vw.r.15          ;(not used)
```

```
; Use of $vw.res[]:
;
; None.

; No results to test, so don't need to set any values into res.def[,].

; Define the basic record type characteristics.

 def[vw.td.shape] = FALSE
 def[vw.td.icon] = 0                    ;Index into icon array (if any).
 def[vw.td.custom] = TRUE
 def[vw.td.class] = ve.pt.class         ;Can be displayed as a point.
 def[vw.td.flags] = 0
 def[vw.td.vtool] = FALSE
 def[vw.td.info] = FALSE
 def[vw.td.def.tst] = 0
 def[vw.td.combo] = FALSE

; Set up the strings (mostly routine and menu page names)

 $def[vw.td.exec] = "ctr.exec"          ;Execution routine name
 $def[vw.td.name] = "Point Centroid"    ;Record type name
 $def[vw.td.pg.file] = "CUSVIS"         ;Custom menu page file
 $def[vw.td.pg.name] = "pt_centroid"    ;Menu page name
 $def[vw.td.res.filt] = ""
 $def[vw.td.data] = ""
   $def[vw.td.draw] = ""
   $def[vw.td.edit] = ""
   $def[vw.td.refresh] = "vw.refresh"   ;Use standard routine
 $def[vw.td.ic.name] = "ctr_icon"       ;Icon name

; Finally, add to the POINT class, so can be used by other records.

 CALL vw.add.to.class(ve.pt.class, rec.type, 0)
.END
```

Execution Routine—ctr.exec( )

```
.PROGRAM ctr.exec(data[], results[], vw.data[,], vw.res[,])

; ABSTRACT:  This is the EXECUTION routine for the POINT CENTROID
; record type.  It computes the POINT at the centroid of the
; three POINTS given as source records.
;
; (See standard calling sequence for all record-type execution
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None
;
; Copyright (c) 1991 by Adept Technology, Inc.

 AUTO ctr.x, ctr.y, ii, num.src, pt1, pt2, pt3, ref.pic, stt
 AUTO db                                    ;L428

 db = vi.db[TASK()]                         ;L428

 stt = 0
```

```
 num.src = data[vs.num.src]                        ;Number of sources.
 ref.pic = data[vs.ref.pic]                        ;Reference picture record number.
 pt1 = data[vs.src.1]
 pt2 = data[vs.src.2]
 pt3 = data[vs.src.3]

; Check that sources are OK.
; Since this simple record type has no shape, it never uses the
; vision frame, and it therefore does not need to be checked.

 FOR ii = vs.src.1 TO vs.src+num.src
     IF vw.data[data[ii],vs.status] THEN
  stt = vw.data[data[ii],vs.status]
  GOTO 90
     END
 END

; If using multiple pictures in the sequence, then convert POINTs 2 and 3
; to be in the same coordinate frame as POINT 1.

 IF vw.multi.pics[db] THEN                         ;L428
     CALL vw.conv.frm(ref.pic, vw.data[pt2,], vw.res[pt2,], stt)
     IF stt GOTO 90
     CALL vw.conv.frm(ref.pic, vw.data[pt3,], vw.res[pt3,], stt)
     IF stt GOTO 90
 END

; If any two of the three points are the same record, return an error.

 IF (pt1 == pt2) OR (pt2 == pt3) OR (pt3 == pt1) THEN
     stt = ec.bad.vis.data                         ;Invalid vision tool data
     GOTO 90
        END

; Compute the centroid and store the new POINT in the results array.

 ctr.x = (vw.res[pt1,vw.x]+vw.res[pt2,vw.x]+vw.res[pt3,vw.x])/3
 ctr.y = (vw.res[pt1,vw.y]+vw.res[pt2,vw.y]+vw.res[pt3,vw.y])/3

 results[vw.x] = ctr.x
 results[vw.y] = ctr.y
 results[vw.ang] = 0
 results[vw.cos] = 1
 results[vw.sin] = 0

; Set the eval state flag to show complete.

90 data[vs.status] = stt
        data[vs.eval] = vw.stt.done[db] ;L428+

; Draw the graphic for this result if all correct flags are set.

 IF vw.run.disp[db] THEN                           ;Check runtime global first
     IF vw.run.disp[db] > 0 THEN                   ;Only if editing or WTT.
  IF (vw.cur.pic[db] == ref.pic) AND NOT stt THEN  ;L428-
      CALL ve.draw.point(results[vw.x], results[vw.y], 2, io.col.pink)
  END
     END
 END
.END
```

D.2 Example Routines for Vision-Tool Record Type

This section contains example routines for a custom vision-tool record type called a “bearing checker”, which locates and measures a needle bearing assembly. The assembly, shown in Figure D-1, consists of a cylindrical outer housing containing a number of long thin rollers (also called needles) and a cylindrical inner ring. The assembly will be viewed end-on, appearing as two nested concentric “donuts” (the outer and inner rings) with the ends of the needles positioned between them in a ring. The innermost donut hole has a key slot that will be used to determine the orientation of the inner ring.

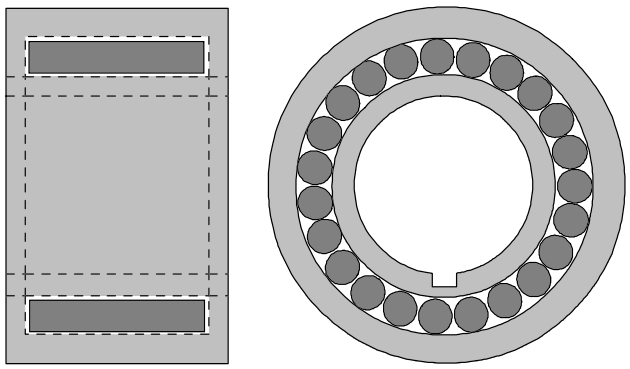

Figure D-1
Needle Bearing Assembly

The bearing-checker record first locates the housing, then determines the orientation based on the position of the key slot. It then measures the outer radius of the housing and counts the number of needles present.

For another example of a vision-tool record type, see the file VFINDERS.V2. It contains the routines for the Line Finder record type.

In order to distinguish the names of routines and variables from those used by the computational example record type, the routines for this example record type use the prefix “bearing” for the names of many of the routines and variables. If you copy these routines to use as a basis for a custom record type of your own, make sure to consistently and completely change the appropriate routine and variable names.

Definition Routine—bearing.def( )

```
.PROGRAM bearing.def(rec.type, def[], $def[], src.classes[,], ...
                                                  res.def[,], $res.labels)

; ABSTRACT:  This is a RECORD-TYPE DEFINITION routine for the BEARING
; CHECKER custom vision tool.
;
; This custom record type will locate and measure a needle
; bearing assembly.  It first locates the housing, then
; determines the orientation based on the position of the
; key slot.  It will also measure the outer radius of the
; housing and count the number of needle bearings present.
;
; (See standard calling sequence for all record-type definition
```

```
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None
;
; DATA STRUCTURES: See standard routine header.
;
; Copyright (c) 1991 by Adept Technology, Inc.

; Use of vw.data[]:
; vs.rec.type                     ;Must == bearing.type
; vs.type   ;Evaluation Method: Must be 1.
 bearing.rad = vs.md0             ;Radius of ring of needle bearings.
 bearing.num = vs.md1             ;Nominal number of needle bearings.
 bearing.clr = vs.md2             ;Color (B/W) of needle bearings.
 bearing.orad = vs.md3            ;Nominal radius of outside of housing.
;     vs.md4 -thru- vs.md15       ;(not used)

; vs.shp    ;(not used)
; vs.rel.x -thru- .rel.an         ;(not used)
; vs.flags                        ;Flags, bit positions used are:
;     vw.flg.top.lvl = ^H40       ; Top-level node?
; vs.num.src                      ;Number of sources.
; vs.ref.frm                      ;(not used)
; vs.src.1                        ;Source #1 - always a PICTURE record.
; vs.src.2 -thru- vs.src.8        ;(not used)
; vs.x -thru- vs.an               ;(not used)

; Use of $vw.data[]:
; vs.str.1                        ;(not used)
; vs.str.2                        ;(not used)
; vs.name                         ;Name of record.

; Source classes for each eval method.

 src.classes[1,0] = 1             ;Number of sources for method 1.
 src.classes[1,1] = ve.pic.class  ;PICTURE class.

; Use of vw.res[]:
; vw.x                            ;X coord of housing center.
; vw.y                            ;Y coord of housing center.
; vw.ang                          ;Angle of X-axis (through key slot).
; vw.cos                          ;Cos of above.
; vw.sin                          ;Sin of above.
 bearing.count = vw.r.5           ;Number of bearings counted.
; vw.r.6 -thru- vw.r.8            ;(unused)
; vw.rad                          ;Radius of outside of bearing.
; vw.r.10 -thru- vw.r.15          ;(unused)

; Use of $vw.res[]:
;
; None.

; Define the testable results:

 res.def[1,0] = bearing.count
 res.def[1,1] = 0                 ;Real-valued data.
 $res.label[1] = "Number of bearings counted"
```

```
 res.def[2,0] = vw.rad
 res.def[2,1] = 0                ;Real-valued data.
 $res.label[2] = "Radius of outside bearing"

 res.def[0,0] = 2                ;Two results total.

; Define the basic record type characteristics.

 def[vw.td.shape] = FALSE
 def[vw.td.icon] = 0             ;Index into BEARING icon.
 def[vw.td.custom] = TRUE
 def[vw.td.class] = 0
 def[vw.td.flags] = 0
 def[vw.td.vtool] = TRUE
 def[vw.td.info] = FALSE
 def[vw.td.def.tst] = 1          ;Bearing count is the default
     ;  value to test.
 def[vw.td.combo] = FALSE

; Set up the strings (mostly routine and menu page names)

 $def[vw.td.exec] = "bearing.exec"     ;Execution routine.
 $def[vw.td.name] = "Bearing Checker"  ;Name of record type.
 $def[vw.td.pg.file] = "CUSVIS"        ;Custom menu page file.
 $def[vw.td.pg.name] = "bearing_checker";Menu page name.
 $def[vw.td.res.filt] = ""
 $def[vw.td.data] = ""
   $def[vw.td.draw] = ""
   $def[vw.td.edit] = ""
   $def[vw.td.refresh] = "vw.refresh"  ;Use standard routine.
 $def[vw.td.ic.name] = "bearing_checker";Icon name.

; Finally, add to the appropriate classes.

        CALL vw.add.to.class(ve.frm.class, rec.type, 0);Vision Frame class
        CALL vw.add.to.class(ve.pt.class, rec.type, 0) ;Point class
        CALL vw.add.to.class(ve.cir.class, rec.type, 0);Circle class

.END
```

Execution Routine—bearing.exec( )

```
.PROGRAM bearing.exec(data[], results[], vw.data[,], vw.res[,])

; ABSTRACT:  This is an EXECUTION routine for the BEARING CHECKER custom
; vision tool.
;
; (See standard calling sequence for all record-type execution
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None
;
; Copyright (c) 1991 by Adept Technology, Inc.

        AUTO dm, stt, tsk, vc, db
```

```
 stt = 0
       tsk = TASK()              ;Current task number
       vc = data[vs.vcam]        ;Designated virtual camera
       dm = vw.dmode[tsk]        ;Designated display mode
 db = vi.db[tsk]  ;Vision database we are in  ;L428

; Execute the vision tools and do the computations.  Remember to use
;   "dm" as the display mode variable for vision tools and use "vc"
;   as the virtual camera for vision tools and setting any switches
;   and parameters.  And test for "vw.vis.err[tsk]" after every
;   vision instruction.

    ; Use VWINDOW (blob finder) to locate bearing housing.
    ; Use VFIND.ARC (arc finder), centered on bearing housing, to
    ;   determine precise outer radius and better center.
    ;
    ;  results[vw.x] = <x coordinate of center of arc>
    ;  results[vw.y] = <y coordinate of center of arc>
    ;  results[vw.rad] = <outer radius>
    ;
    ; Use arc ruler, centered on bearing housing, to find key slot.
    ; Use angle of key slot and center of bearing housing as the
    ;   vision frame for the results and as a basis for subsequent
    ;   vision tools.
    ;
    ;  results[vw.ang] = <angle of key slot from center>
    ;  results[vw.cos] = <cosine of that angle>
    ;  results[vw.sin] = <sine of that angle>
    ;
    ; Use another arc ruler at the nominal radius of the ring of bearings
    ;   to determine the position of any needle bearing in the ring.
    ; Compute the nominal location of each of the needle bearings, based
    ;   on the specified number of them, the radius of the ring, and the
    ;   computed position of one of them.
    ; Using lots of little VWINDOWIs or VWINDOWs, centered on the
    ;   computed nominal locations of each of the needle bearings, count
    ;   the number of actual needle bearings present.
    ;
    ;  results[bearing.count] = <number of bearings found>

; Display graphically the computed results that are not represented
; by the vision tools.  Must do this only if editing or walk-thru
; training is enabled.

 IF dm > -1 THEN   ;Graphics already approved.
     IF vw.run.disp[db] > 0 THEN ;** ONLY IF EDITING **              ;L428

  ; Print out the number of bearings in big letters.
  ; Draw the found vision frame.
  ; Put a point at each of the located bearings.
  ;   and mark the ones missing.

     END
 END

; Done.  If the vision reacte routine trapped a system error during the
; vision instruction, then copy it to the status value and reset the
; vision error trap variable.

   100  stt = vw.vis.err[tsk]
        vw.vis.err[tsk] = 0

   101 data[vs.status] = stt
        data[vs.eval] = vw.stt.done[db]  ;Signal that eval is complete ;L428

 RETURN
.END
```

Appendix E
Custom Combination Records

This appendix describes the workings of a combination record type and provides templates for writing some of the necessary custom record-type routines. This appendix assumes a general knowledge of the structure of record types and how to write custom record types.

Briefly, these are the minimum ingredients needed to create a custom combination record type:

- Icon—create with the icon editor and store in a custom file.
- Menu page—copy the Value Combination menu page to a custom *.MNU file and alter it to meet your needs.
- Definition routine—use the template provided and alter it as appropriate.
- Execution routine—use the template provided and fill in as marked.

E.1 How It Works

If you are already familiar with writing custom record types, you may be interested in the following distinct features of a combination record type.

1. The record-type definition routine for the new combination record must set **def[vw.td.combo]** to TRUE.
2. It must have a source record whose results are changed with each iteration of the repeat loop—it is these individual results that are combined by the combination record. This source record is the top of what is called the “repeat tree”. Whatever repeating is done, is done just so the results of this record are different with each iteration and contribute to the ultimate result of the combination record. This source record must be source record one.
3. The combination record also has associated with it a repeat record. This repeat record is not specified as a source record, but rather is determined at preruntime using some standard routines. These routines are used to first build an evaluation list for source one (the top of the repeat tree), similar to the one built for each of the statement arguments in a sequence.

   Then the routines search the repeat tree for the first unused repeat record. That is, if a combination-repeat pair is found, the repeat record in it cannot be used as the repeat record for our combination record, since it is already taken.

   When the repeat record is found, it is stored in the **vs.rpt.rec** element of the data array for the source record (not the combination record). This repeat record then forms the bottom of the repeat tree; records below this in dependency are not repeated during the repeat loops.

   See the template routine ***.set.data( )** for details on how the preruntime setup is done.

Execution Routine—The Basic Loop

The basic idea for the execution routine is simple, but certain error-checking conventions and added flexibility can make it look complicated. Therefore, we look first at the most simple implementation.

Remember that when this record is executed, the subtree for the source record and the source record itself have all been executed once already. The combination-record execution routine is therefore responsible only for the second repetition on, until the repeat record is exhausted. After recording the results of the first iteration, it can then enter a loop where it reexecutes the repeat record and the rest of the repeat tree and then records the new results obtained for the top record (source 1 of the combination record). If at any time, the repeat record enters a state of exhaustion (no more results), the loop terminates and any final computations are done.

To reexecute the repeat record and repeat tree, we simply clear the evaluation states of all the records that depend on the repeat record, along with the repeat record itself. Then, using the evaluation list created at preruntime (see above), we reexecute each of the records in the repeat tree in the correct order. There are standard routines supplied for each of these operations (as shown below).

The pseudocode below illustrates a bare-bones implementation of the repeat loop. In this pseudo-code (and in later examples) we assume the following four local variable assignments have been made:

```
db = vi.db[TASK()]
src.1 = data[vs.src.1]                          ;Source 1 record number
ei = vw.data[db,src.1, vs.ei.list]              ;Eval list number for src 1
rpt.rec = vw.data[db,src.1, vs.rpt.rec]         ;Initial repeat record
```

Pseudo-code for a bare-bones repeat loop:

```
DO
      IF vw.data[db,src.1,vs.status] THEN;Error in tree
            status = vw.data[db,src.1,vs.status]
            GOTO 90
      ELSE                                      ;Good tree, record result
            <save current result> or
              <combine current result with previous ones on the fly>
      END
      CALL vw.clear.rec(rpt.rec)                ;Clear all rpt rec
                                                ;dependents
      CALL vw.eval.list(ei)                     ;Evaluate the repeat tree
UNTIL vw.data[db,rpt.rec,vs.more] <> vw.stt.more[db];Until no more
```

Common Improvements to the Basic Loop

The basic loop shown above is implemented in the template routine ***.exec( )** with the following valuable enhancements.

First, the feature of *not* stopping on an error is enabled using a mode value in the data array. This mode value (**data[vs.stop.err]** in the example) can be changed from the menu page via a check box. When it is set, the status value **ec.vop.fail** for the source record causes the combination record to fail with that status. However, when the mode is FALSE, if any of the repetitions cause an **ec.vop.fail** in the source record, the results for that repetition are just ignored and execution continues on to the next repetition. This feature shows up on the menu page for the Value

Combination record as a check box with the label “Ignore ‘not found’ errors”. The element **data[vs.stop.err]** is cleared when the box is checked, and is set when the box is not checked.

Second, a mode value in the data array (**data[vs.max.rpt]**) is used to indicate the maximum number of results to collect and combine. Each time a result is successfully collected and / or combined during the repetition process, this value is checked to see if enough results have been collected.

> **NOTE:** The number of results collected may not be the same as the number of repetitions, due to the “stop-on-error” enhancement described above. This feature could have been implemented as the maximum number of repetitions, but is not in the template routine. You could add a separate mode value for this purpose, or alter this mode value.

Third, the error state of the source record is treated differently before the repeating actually starts. This is explained in the comments. There is also important error checking for the cases where there is no repeat record, etc. Also, you will notice that the “wait for eval done” loop is much more complicated in the template routine. This is done for runtime efficiency and includes conventions for doing wait loops in AIM.

E.2 Important Observations

You should make these important observations at this time:

- Since pictures and cameras will not depend on any repeat records, they never get reexecuted in these repeat loops.
- If records in other trees (that is, trees not involving this combination record) depend on the repeat record at the bottom of this repeat tree, their evaluation state is cleared as part of this repeat loop. This illustrates the importance of using a repeat record in only one combination-repeat pair at a time.

  > **NOTE:** In certain circumstances, a repeat record may be used by multiple operations. First, only one of the operations may use it as a repeat record. The others *may not* use a combination record above it.
  >
  > For example, if you wanted to check for the presence of any blobs at all in a particular area, you could use a blob finder with the repeat option checked in a simple inspection counting the number of blobs in the window. This inspection would ignore the fact that it was a repeat record. A later combination record, using the same blob finder as its repeat record, would have no problem. But any subsequent inspections or combination records would find that the blob finder had failed (due to exhaustion).

E.3 Template Routines for Combination Records

In the process of creating a custom combination record type, you have to write several custom routines. The full function and calling sequence for these routines are described in Chapter 6, but sometimes an example or template version of the routine can be very helpful in actually getting the job done. In the case of combination record types, however, template routines are absolutely necessary, because we are not providing a full description of all the required routines needed to implement certain routines. Therefore, template routines are provided for the definition, set-data,

and execution routines for a custom combination record type. They are referred to with the names **cmb.def( )**, **cmb.set.data( )**, and **cmb.exec( )**, respectively.

The prefix "cmb" is used throughout these routines as a generic prefix denoting a combination record. You should pick a unique custom prefix and substitute it wherever you see "cmb", especially in the names of the routines.

In the following template routines, the symbol ";*-->" is used to mark those places where you may, or must, alter or insert custom code to make the template routine into a working custom routine. To distinguish them from ordinary comments, directions on what is needed at a particular location is given in angle brackets (<...>).

Where some lines would normally extend off the page, they are split and continued on the next line. In these cases, the first of the two lines ends with "...". These split lines have to be merged (without the "...") if these programs are typed in and used.

Two semicolons (;;) at the beginning of a line indicate that the line is a general explanation of some aspect of the routine. Such lines would normally be omitted when the routine is filled in.

The template routines described in this appendix can be found in the disk file VISTMPLS.V2.

Definition Routine—cmb.def( )

```
.PROGRAM cmb.def(rec.type, def[], $def[], src.classes[,], res.def[,], $res.labels)

; ABSTRACT:  This is a template routine for a generic COMBINATION
; record.  When completed, it will be the DEFINITION routine for
; a custom combination record type.
;
; (See standard calling sequence for all record-type definition
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None
;
; DATA STRUCTURES: See standard routine header.
;
; Copyright (c) 1991 by Adept Technology, Inc.

; Use of vw.data[]:
; vs.rec.type  ;Must == cmb.rec.type
;
;*NOTE: The above variable "cmb.rec.type" is the same one given when
;* when the declaration routine "vw.typ.def.rtn()" is called as part
;*      of the application initialization process.  It is mentioned here
;*      just for completeness.
;
; vs.type                          ;Evaluation Method: Must be non-0.
;*-->                              ;<document possible values here>
; vs.md0                           ;(not used)
; vs.max.rpt = vs.md1              ;Max number of values to collect.
; vs.stop.err = vs.md2             ;Stop on "ec.vop.fail" error for source 1?
; vs.md3 -thru- vs.md15            ;(not used)
; vs.shp                           ;(not used)
; vs.rel.x -thru- .rel.an          ;(not used)
; vs.flags                         ;Flags, bit positions used are:
;     vw.flg.top.lvl = ^H40        ; Top-level node?
```

```
; vs.num.src                      ;Number of sources, must be 1.
; vs.ref.frm                      ;(not used)
; vs.src.1                        ;Source #1
; vs.src.2 -thru- vs.src.8        ;(not used)
; vs.x -thru- vs.an                          ;(not used)

; Use of $vw.data[]:
; vs.str.1                                   ;(not used)
; vs.str.2                                   ;(not used)
; vs.name                                    ;Name of record.


; Source classes for each eval method:

;*--> src.classes[cmp.meth,1,0] = 1          ;Number of sources
;*--> src.classes[cmp.meth.1,1] = <some class number>
;*-->
;*--> src.classes[cmp.meth,2,0] = 1          ;Number of sources
;*--> src.classes[cmp.meth.2,1] = <some class number>
;*-->
;*--> The variables "cmp.meth.*" should be changed to match the actual
;*--> description variables defined above as the possible eval methods.
;*--> Also, there must be a set of entries in the "src.classes[,]" array
;*--> for each eval method this record type can have.

; Use of vw.res[]:
;*--> <list all uses of the results array here - see examples>
;
;NOTE: Even if not using descriptive variables, this is the best central
;place to document the use of the results array.

; Define results that will be available for testing.
;*--> <define "res.def[,]" and "$res.labels[]" - see examples>

; Define the basic record type characteristics.

 def[vw.td.shape] = FALSE
 def[vw.td.icon] = 19
 def[vw.td.custom] = TRUE
 def[vw.td.class] = 0
 def[vw.td.flags] = 0
 def[vw.td.vtool] = FALSE
 def[vw.td.info] = FALSE
;*--> def[vw.td.def.tst] = <index>           ;<Index into res.def[,] array>
 def[vw.td.combo] = TRUE

; Set up the strings (mostly routine and menu page names)

;*--> $def[vw.td.exec] = "cmb.exec"          ;<need correct prefix>
;*--> $def[vw.td.name] = "***** Combination" ;<needs correct name>
;*--> $def[vw.td.pg.file] = "***vis"         ;<needs correct name>
;*--> $def[vw.td.pg.name] = "combo_***"      ;<needs correct name>
 $def[vw.td.res.filt] = ""
;*--> $def[vw.td.data] = "cmb.set.data"      ;<needs correct prefix>
   $def[vw.td.draw] = ""
   $def[vw.td.edit] = ""
   $def[vw.td.refresh] = "vw.cv.refresh"     ;Use existing routine.
;*--> $def[vw.td.ic.name] = "cmb_icon"       ;<needs correct prefix>

; Finally, add to the appropriate classes.

; None are needed.
.END
```

Set-Data Routine—cmb.set.data( )

```
.PROGRAM cmb.set.data(mode, data[], $data[], stt)

; ABSTRACT:  This is a template routine for a generic COMBINATION
; record.  It may be altered if necessary but can be used
; as is as a SET.DATA routine for a custom combination record
; type.
;
;               * NOTE *
;
; Unless the specially-flagged areas need additional code, the
; set.data routine for the Value Combination record type
; may be used, since it is exactly the same as this sample
; routine.  That routine is called "vw.cv.data" and can
; be specified in your definition routine as your set.data
; routine.
;
; (See standard calling sequence for all record-type set.data
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None.
;
; Copyright (c) 1991 by Adept Technology, Inc.

 AUTO src.1, ei, db

 db = vi.db[TASK()]                          ;L428

 stt = 0
 CASE mode OF

   VALUE 0:                                  ;New record initialization.

     ;None required.

;*-->     <New-record initialization can go here>

   VALUE 1:                                  ;Preruntime computations

     src.1 = data[vs.src.1]                  ;Get record number of source 1.
     IF NOT src.1 GOTO 100                   ;There must be a source 1.

;*-->     <Custom preruntime initialization can go here>

 ; Build an eval list for the source record.  Use preexisting
 ; list number if one exists already.

     ei = vw.data[db,src.1,vs.ei.list]       ;L428
     CALL vw.build.list(db, src.1, ei, stt)  ;L428
     IF stt GOTO 100

        ; Find the first unused repeat record by searching the repeat
        ; tree recursively.  But, first, clear the flags used for
        ; efficient recursive tree searches.  And also init rpt rec to 0.
```

```
     CALL ve.new.done()
     vw.data[db, src.1, vs.rpt.rec] = 0
     CALL vw.find.rpt(src.1, vw.data[db, src.1, vs.rpt.rec], 0, vw.data[db,,]);L428

        ; If a repeat record is found, then initialize the data structure
        ; used for clearing the repeat tree between each repetition.

     IF vw.data[db, src.1, vs.rpt.rec] THEN                    ;L428
  CALL vw.def.rec.deps(vw.data[db, src.1, vs.rpt.rec], db)     ;L428
     END

   VALUE 2:                                  ;Data-extension computations

;*-->     <Custom data-extension computations can go here>

 END

    100 RETURN
.END
```

Execution Routine—cmb.exec( )

```
.PROGRAM cmb.exec(data[], results[], vw.data[,], vw.res[,])

; ABSTRACT:  This is a template routine for a generic COMBINATION
; record.  When completed, it will be the EXECUTION routine for
; a custom combination record type.
;
; (See standard calling sequence for all record-type execution
; routines in Chapter 6.)
;
; INPUT PARM.: Standard inputs
; OUTPUT PARM.: and outputs.
;
; SIDE EFFECTS: None
;
; Copyright (c) 1991 by Adept Technology, Inc.

 AUTO status, src.1, ii, ei, rpt.rec, db

 status = 0                                ;Assume no error
 src.1 = data[vs.src.1]                    ;Short name for source 1.
 ii = 0                                    ;Start with 0 results.
 ei = vw.data[src.1, vs.ei.list]           ;Eval list number of source 1.
 db = vi.db[TASK()]                        ;L428

; Don't execute if editing with scheduler active while running.

 IF vw.sched.act AND vw.run.lock GOTO 100    ;L332

; The source tree has all been eval'd and it is assumed that there may
; be a repeat record in the source tree.  In fact, if there is not, then
; just collect the one result and go on.

 rpt.rec = vw.data[src.1,vs.rpt.rec]         ;Initial repeat record.
 IF NOT rpt.rec THEN                         ;No repeat records in sub-tree.
     IF vw.data[src.1,vs.status] THEN
  status = vw.data[src.1, vs.status]
  GOTO 90                                  ;Null exit.
```

```
    ELSE
  ii = 1                                  ;This is first and only result.

;*-->  <collect and combine first result>

  GOTO 50                              ;Goto final compute and store.
    END
 END

; Check the state of the repeat record before entering loop.  Special
; treatment here will avoid extra code in the loop.  If the REPEAT
; state is vw.stt.go, then one of the repeat record's sources was bad.
; In that case, just report the status of that source record and
; exit - there will be no results to accumulate.  If the REPEAT state
; was vw.stt.mdone, then the record failed on its own.  If it was a
; simple "not found" error, then check the stop.on.err flag, and don't
; return an error if not set.  Else return the status of source 1.

 CASE vw.data[rpt.rec,vs.more] OF
   VALUE vw.stt.more[db]:              ;Check first, since most likely case. ;L428
    ;Will avoid two other checks in most cases.
   VALUE vw.stt.go: ;Bad src to rpt record - can't continue.
     status = vw.data[src.1, vs.status]
     GOTO 90  ;Null exit.

   VALUE vw.stt.mdone:                 ;Repeat record failed on first try.
     IF vw.data[src.1, vs.status] THEN
  IF (vw.data[src.1,vs.status] <> ec.vop.fail) OR data[vs.stop.err] THEN
      status = vw.data[src.1, vs.status]
  END
     END
     GOTO 90                          ;Null exit.
 END

; Now loop for each of the repeat instances, recording the results.
; Stop when the MORE state of the repeat record is not set to "vw.stt.more[db]".
; Also, if any errors, stop with that status unless it is a vop.fail
; and 'Ignore "not found" errors' is not checked.

 DO
     IF vw.data[src.1,vs.status] THEN
  IF (vw.data[src.1,vs.status] <> ec.vop.fail) OR data[vs.stop.err] THEN
      status = vw.data[src.1, vs.status]
      GOTO 90                         ;Null exit.
  END
     ELSE                             ;Good tree, record result.
  ii = ii + 1

;*-->  <Collect and/or combine the result from vw.res[src.1,]>

  IF ii == data[vs.max.rpt] GOTO 50
     END
     CALL vw.clear.rec(rpt.rec)
     CALL vw.eval.list(ei)            ;Rip through list.
     IF ai.stop.prog GOTO 90          ;Shutdown requested.
 UNTIL vw.data[rpt.rec,vs.more] <> vw.stt.more[db]                        ;L428

; Done with the repetitions, compute final results and store in results[].

50
```

```
;*--> <Compute any final computations and store results in results[]>

 GOTO 100

; NULL or error exit:  Fill in results[] with null values.

90

;*--> <Fill in correct values for a null exit>

; Set the eval state flag to show complete.

100 data[vs.status] = status
        data[vs.eval] = vw.stt.done[db]                                    ;L428
.END
```

Appendix F
Switches and Parameters

In the execution routine for custom record types, it is sometimes necessary to set vision-related system switches or parameters (for example, the parameter V.EDGE.STRENGTH[virt.cam]) prior to using vision instructions. Most of these switches and parameters can just be set and then left with new values. We call these “transient” switches and parameters. However, some are set to certain default values at AIM startup, and are relied upon to have those values throughout the system. When such switches and parameters are changed by custom record-type routines, they must be restored to their original values after use. We call these “permanent” switches and parameters.

The following are the “permanent” switches and parameters. They are initialized at AIM startup for all virtual cameras. The notes “(Causes replanning)” identify those switches or parameters that cause prototypes to be replanned if the switch / parameter setting is changed.

ENABLE	V.BINARY	
ENABLE	V.BOUNDARIES	(Causes replanning)
ENABLE	V.DISJOINT	
DISABLE	V.EDGE.INFO	
ENABLE	V.FIT.ARCS	
DISABLE	V.HOLES	
DISABLE	V.OVERLAP	(Causes replanning)
ENABLE	V.RECOGNITION	(Causes replanning)
ENABLE	V.SUBTRACT.HOLE	
ENABLE	V.TOUCHING	
DISABLE	V.SHOW.BOUNDS	
DISABLE	V.SHOW.EDGES	
DISABLE	V.SHOW.GRIP	
DISABLE	V.SHOW.RECOG	
DISABLE	V.SHOW.VERIFY	
PARAMETER	V.BORDER.DIST = 0	
PARAMETER	V.IO.WAIT = 0	
PARAMETER	V.LAST.VER.DIST = 0	
PARAMETER	V.MAX.PIXEL.VAR = 1.5	
PARAMETER	V.MAX.VER.DIST = 3	(Causes replanning)

All other system switches and parameters are “transient”. They are not assumed to have any particular values. Custom routines can set them to any value and not restore their previous value.

> **NOTE:** V.EDGE.STRENGTH and V.THRESHOLD are among the “transient” parameters.

Appendix G
Disk Files

There are several filename extensions used for the disk (program) files supplied with the AIM Vision / VisionWare Module. The extensions indicate the type of information in each file, as described in Table G-1. Table G-2 lists all the program files that are distributed on the diskette labeled “Software Disk”.

Table G-1
Extensions for AIM Program File Names

Extension	File Contents
.V2	V+ programs with all comments included.
.SQU	V+ programs with comments removed to reduce the amount of system memory occupied.
.OV2	V+ programs (with all comments included) that are loaded into memory only when needed for the function they perform.
.OVR	V+ programs (with comments removed) that are loaded into memory only when needed for the function they perform.

In some cases, there are .V2 and .SQU files, or .OV2 and .OVR files, with the same name (for example,VFINDERS.V2 and VFINDERS.SQU). The programs in such paired files are functionally identical. The AIM system executes the programs in the .SQU and .OVR files. The corresponding .V2 and .OV2 program files are provided so system customizers can work with fully commented V+ programs.

The program **a.squeeze( )** can be used to create a .SQU file from a .V2 file or an .OVR file from an .OV2 file. That program is contained in the file SQUEEZE.V2 on the standard Adept Utility Disk #1. Refer to the manual *Instructions for Adept Utility Programs* for information on how to use the squeeze program.

Table G-2
Program Files for the Vision / VisionWare Module

File Name		Description of Contents
LVW	.V2	Commented source code containing the main VisionWare command programs, initialization routine, and scheduler routine.
QCLOG	.V2	Commented source code for data-logging.
QCLOG	.SQU	Squeezed version of QCLOG.V2.

Table G-2
Program Files for the Vision / VisionWare Module (Continued)

File Name		Description of Contents
VBLOB	.OV2	Commented source containing definition routines for the Blob Finder record type.
VBLOB	.OVR	Squeezed version of VBLOB.OV2.
VBLOB	.SQU	(Protected) Squeezed file containing VisionWare routines for the Blob Finder record type.
VCALAMP	.OVR	(Protected) Squeezed file containing the record type definition routine for the arm-mounted calibration record type.
VCALAMP	.SQU	(Protected) Squeezed file containing editing / execution routines for the arm-mounted calibration record type.
VCALASP	.OVR	(Protected) Squeezed file containing the record type definition routine for the Adept-mounted vision calibration record type.
VCALASP	.SQU	(Protected) Squeezed file containing subroutines used for Adept-mounted camera calibration in conjunction with AIM.
VCALCOP	.OVR	(Protected) Squeezed file containing the record type definition routine for the camera-only calibration record type.
VCALCOP	.SQU	(Protected) Squeezed file containing camera-only calibration editing routines.
VCALFILE	.OVR	(Protected) Squeezed file containing the file management routines for Vision Calibration.
VCALFMP	.OVR	(Protected) Squeezed file containing the record type definition routine for the fixed-mounted vision calibration record type.
VCALFMP	.SQU	(Protected) Squeezed file containing fixed-mounted (general case) routines for vision calibration.
VCALIB	.OVR	(Protected) Squeezed file containing the Vision calibration routines.
VCALIHP	.OVR	(Protected) Squeezed file containing record type definition routine for the upward-mounted calibration record type.
VCALIHP	.SQU	(Protected) Squeezed file containing upward-mounted calibration routines.
VCALINIT	.OV2	Commented source containing initialization routines for vision calibration.
VCALINIT	.OVR	Squeezed version of VCALINIT.OV2.
VCALROB	.OVR	(Protected) File containing routines needed for robot-related calibration.
VCALSUB	.SQU	Squeezed file containing common subroutines used throughout the vision calibration and record editing procedures.

Table G-2
Program Files for the Vision / VisionWare Module (Continued)

File Name		Description of Contents
VCALTEST	.OVR	(Protected) Squeezed file with routines for testing vision calibration.
VCALTXT	.V2	Commented vision calibration text definition routines.
VCALTXT	.SQU	Squeezed version of VCALTXT.V2.
VCFEAT	.V2	Commented source containing routines for the Computed Features record types.
VCFEAT	.SQU	Squeezed version of VCFEAT.V2.
VCFEAT	.OV2	Commented source containing initialization routines for the Computed Feature record types.
VCFEAT	.OVR	Squeezed version of VCFEAT.OV2.
VCORR	.OV2	Commented source containing initialization routines for the Correlation record types.
VCORR	.OVR	Squeezed version of VCORR.OV2.
VCORR	.SQU	(Protected) Squeezed file containing routines for the Correlation record types and related operations.
VDRAW	.SQU	(Protected) Squeezed file containing VisionWare draw routines.
VEDIT	.SQU	(Protected) Squeezed file containing VisionWare editing routines.
VFINDERS	.OV2	File containing initialization routines for the Point, Line, and Circle Finder record types.
VFINDERS	.OVR	Squeezed version of VFINDERS.OV2.
VFINDERS	.V2	Commented source containing routines that support the Point, Line, and Circle Finder record types.
VFINDERS	.SQU	Squeezed version of VFINDERS.V2.
VIMAGEP	.OV2	Commented source containing initialization routines for the Image Processing record type.
VIMAGEP	.OVR	Squeezed version of VIMAGEP.OV2.
VIMAGEP	.SQU	(Protected) Squeezed file containing routines for the Image Processing record type.
VINIT	.SQU	(Protected) Squeezed file containing VisionWare initialization-related routines.
VINSPECT	.OV2	Commented source containing initialization routines for the Inspection record type.
VINSPECT	.OVR	Squeezed version of VINSPECT.OV2.

Table G-2
Program Files for the Vision / VisionWare Module (Continued)

File Name		Description of Contents
VINSPECT	.SQU	(Protected) Squeezed file containing routines for the Inspection record type.
VISMOD	.OV2	Commented source containing Vision Module loading and data initialization overlay routines.
VISMOD	.OVR	Squeezed version of VISMOD.OV2.
VISRES	.OV2	Commented source containing routines for displaying Vision results.
VISRES	.OVR	Squeezed version of VISRES.OV2.
VISTMPLS	.V2	Commented source containing template and example routines.
VLOOPS	.OV2	Commented source containing record type definition routines for the Value Combination and Frame Pattern looping-specific record types.
VLOOPS	.OVR	Squeezed version of VLOOPS.OV2.
VLOOPS	.V2	Commented source containing routines for the Value Combination and Frame Pattern looping-specific record types.
VLOOPS	.SQU	Squeezed version of VLOOPS.V2.
VMENUSUB	.SQU	(Protected) Squeezed file containing routines to support the menu pages for VisionWare.
VOCR	.OV2	Commented source containing initialization routines for the OCR record types.
VOCR	.OVR	Squeezed version of VOCR.OV2.
VOCR	.SQU	(Protected) Squeezed file containing routines that support the optional OCR feature.
VPROT	.OV2	Commented source containing initialization routines for the Prototype Recognition record types.
VPROT	.OVR	Squeezed version of VPROT.OV2.
VPROT	.SQU	(Protected) Squeezed file containing routines for the Prototype Recognition record types and related operations.
VRULERS	.OV2	File containing the commented record type definition routine for the Ruler and Arc Ruler record types.
VRULERS	.OVR	Squeezed version of VRULERS.OV2.
VRULERS	.SQU	(Protected) Squeezed file containing routines for the Ruler and Arc Ruler record types.
VSETGO	.SQU	(Protected) Squeezed file containing routines to set video gain and offset automatically.

Table G-2
Program Files for the Vision / VisionWare Module (Continued)

File Name		Description of Contents
VSFRM	.OV2	Commented source containing initialization routines for the Conditional Frame record type.
VSFRM	.OVR	Squeezed version of VSFRM.OV2.
VSFRM	.V2	Commented source containing routines for the Conditional Frame record type.
VSHAPES	.V2	Commented shape-editing support routines.
VSHAPES	.SQU	Squeezed version of VSHAPES.V2.
VTOOLS	.OV2	Commented source containing system start-up initialization routines for defining all the standard VisionWare picture and record types.
VTOOLS	.OVR	Squeezed version of VTOOLS.OV2.
VTOOLS	.SQU	(Protected) Squeezed file containing edit routines for standard record types.
VTOOLSUB	.SQU	(Protected) Squeezed file containing support routines for standard record-type editing.
VUPGRADE	.OVR	(Protected) Squeezed file for upgrading a vision database file to the current version.
VWAUTO	.V2	Commented sample autostart file for starting VisionWare.
VWEVAL	.SQU	(Protected) Squeezed file containing evaluation routines for standard record types.
VWINDOW	.OV2	File containing the commented record type definition routine for the Window record type.
VWINDOW	.OVR	Squeezed version of VWINDOW.OV2.
VWINDOW	.V2	Commented source containing routines for the Window record type.
VWINDOW	.SQU	Squeezed version of VWINDOW.V2.
VWMOD	.OV2	Commented source containing VisionWare Module initialization overlay routines.
VWMOD	.OVR	Squeezed version of VWMOD.OV2.
VWRES	.SQU	(Protected) Squeezed file containing VisionWare-specific resident routines.
VWRUN	.V2	Commented VisionWare runtime scheduler and statement routines.
VWRUN	.SQU	Squeezed version of VWRUN.V2.

Table G-2
Program Files for the Vision / VisionWare Module (Continued)

File Name		Description of Contents
VWRUNSUB	.SQU	(Protected) Squeezed file containing runtime management and support routines.
VWSTATS	.V2	Commented support routines for the accumulation of vision statistics.
VWSTATS	.SQU	Squeezed version of VWSTATS.V2.

The filename extensions used for data files are described in Table G-3. Table G-4 lists the files associated with the Vision / VisionWare databases, menus, and other data. Unless noted otherwise, these files are distributed on the “Data Disk” diskette.

Table G-3
Extensions for Data File Names

Extension	File Contents
.DAT	Icon definitions; vision calibration data .
.DB	Database file.
.DBD	Optional default database file. The contents of these files are used as the initial data in new database files created by the module utility. If they do not exist, the .RFD file is used.
.HLP	Help information.
.MNU	Menu pages.
.RFD	Database record definitions. These files are used as the prototype for new database files unless a .DBD file exists.

Table G-4
Data Files for the Vision / VisionWare Module

File Name		Description of Contents
AREA1	.DAT	Sample ADVCAL-style file. See the Camera menu page.
HNDLICON	.DAT	Handle icon definitions.
STATVW	.DB	Statement database for VisionWare.
TUTORIAL	.VI	Obsolete. Replaced by the updated file named VWTUTOR.VI.
VCALVW	.VI	Vision database component for the Vision Calibration Module.
VCAMVW	.DB	Global Camera database for VisionWare.
VIMAGEP	.MNU	Menu pages for the Image Processing record type.

Table G-4
Data Files for the Vision / VisionWare Module (Continued)

File Name		Description of Contents
VIS	.DBD	Optional default database file for the default Vision database component.
VIS	.RFD	Record definition file for the Vision database.
VISCAL	.MNU	Menu pages for vision calibration results.
VISCAM	.DB	Global camera database.
VISCAM	.DBD	Optional default database file for the default Camera database component.
VISCAM	.MNU	Menu pages for the Camera database.
VISCAM	.RFD	Record definition file for the Camera database.
VISGEN	.HLP	Help database for VISGEN.MNU.
VISGEN	.MNU	General record type menu pages for VisionWare.
VISICON	.DAT	Vision Module icon definitions.
VISINI	.DB	Vision Module initialization database.
VISINI	.MNU	Menu pages for the vision initialization database.
VISLOG	.MNU	Menu page for vision data logging.
VISNEW	.MNU	Menu pages for selecting new record types in VisionWare.
VISOCR	.HLP	Help database for VISOCR.MNU.
VISOCR	.MNU	OCR record types menu pages.
VISRES	.HLP	Help database for VISRES.MNU.
VISRES	.MNU	Vision Results (pull-down) menu pages.
VISTOOLS	.HLP	Help database for VISTOOLS.MNU.
VISTOOLS	.MNU	Menu pages for Vision Tool record types.
VISUTIL	.HLP	Help database for VISUTIL.MNU.
VISUTIL	.MNU	General-use menu pages for the Vision Module.
VSFRM	.MNU	Menu page for Conditional Frame.

Table G-4
Data Files for the Vision / VisionWare Module (Continued)

File Name		Description of Contents
VWCTL	.001	Part of the VisionWare Module VWCTL for control panels.
VWCTL	.002	
VWCTL	.003	
VWCTL	.004	
VWCTL	.005	
VWCTL	.006	
VWINI	.DB	VisionWare Module initialization database.
VWMOD	.DB	VisionWare Module database.
VWRTINI	.DB	VisionWare record type initialization database.
VWSAM	.001	Sequence database for the sample VisionWare Module VWSAM.
VWSAM	.VA	Variable database for sample VisionWare Module VWSAM.
VWSAM	.VI	Vision database for sample VisionWare Module VWSAM.
VWTUTOR	.001	Sequence database for the Tutorial Module VWTUTOR.
VWTUTOR	.VA	Variable database for Tutorial Module VWTUTOR.
VWTUTOR	.VC	Vision calibration database for Tutorial Module VWTUTOR.
VWTUTOR	.VI	Vision database for Tutorial Module VWTUTOR.

Appendix H
Modification of Custom Record Types

This appendix is for customizers who have created custom record types for their VisionWare version 2.x systems and would like to use them with VisionWare version 3.0. Although current record types will work, there are several enhancements in VisionWare version 3.0 that may require you to update your current record types to take advantage of them.

H.1 Updating Version 2.0 to Version 2.2

The process of updating version 2.0 or version 2.1 custom record types to version 2.2 is fully described in the *AIM Vision/VisionWare Module Reference Guide* , Part # 00712-02200, Rev. A. Refer to Appendix H of that publication for details.

H.2 Updating Version 2.2 to Version 2.3

The process of upgrading from version 2.2 to version 2.3 is fully described in the *AIM Version 2.3 Release Notes,* Part # 00712-03020, Rev. A. Refer to Chapter 4 of that publication for information on the Vision / VisionWare module.

> **NOTE:** Except for the new features and improvements mentioned in the release notes, there are no additional changes to AIM 2.3 that would affect a normal user with no customizations. Furthermore, only those customizations made to public files will need attention, as with any other upgrade.

H.3 Updating Version 2.3 to Version 3.0

The process of upgrading your system to version 3.0 is fully described in the *VisionWare User's Guide,* Part # 00713-00230, Rev. A. Refer to Appendix A of that publication for details.

To update version 2.3 custom record types to version 3.0:

1. Make the following execution routine changes:

```
v**.exec(data[],results[]) change to
     v**.exec(data[],results[],vw.data[,],vw.res[,])[1]

ve.clr[cls,draw.code]=>ve.cls.data[cls,draw.code]
```

1. Refer to Table I-1 for a summary of data array index changes.

2. Make the following definition routine changes:

```
def[vw.td.id]=0  change to
     def[vw.td.flags]=0
Possible bit values for this flag word:
vw.flg.clean=1       ;Set if the execution graphics
                     ;produce no position-specific
                     ;effects. This will mean that
                     ;when the tool shape is being
                     ;picked up to drag it, it will
                     ;not have to be "eval'd" to erase
                     ;it correctly. Dry.run is ok.
vw.flg.no.eval=2     ;Set if the record (and sources)
                     ;should NOT be automatically
                     ;evaluated at each redraw.
vw.flg.cal.rt=4      ;Set if the record is a calibration; L360
                     ;record type
```

3. Place the execution and editing support routines into their own .SQU file.
4. Place the definition routine into an overlay (.OVR) file.
5. Create a record-type initialization database record in the USERINI.DB file or other custom initialization database file. (We recommend that you COPY and PASTE existing record-type records to reduce the amount of work and to maintain consistency.)

Appendix I
Customizer-Related Software Changes

This section provides an overview of the significant “customizer-related” software changes to VisionWare in AIM version 3.0.

I.1 Classes

- Previously, when a new source record was created, and the class for that source record had more than one record type in it, you were given a menu page with a name field and several radio buttons for selecting the record type for the new record. Now this page will have a scrolling window that displays the record type choices. There is also a brief explanation of how each record type is used within its class.
- When adding a record type to a class, it can now optionally include a descriptive string of up to 45 characters. This string is displayed when a new record (of a specific class) is being created (see above). This feature requires a new parameter in the calling sequence for **vw.add.to.class( )**. See **vw.add.to.class( )** on page 186.
- The CAMERA class has been eliminated for vision records. You must modify any existing custom records that use CAMERA class records. Refer to the Picture record for details.
- The Results format for the PICTURE class has changed. Therefore, you must update the settings of the results values if you are using record types in the PICTURE class.

I.2 Record Types

This section summarizes the new features and changes in VisionWare version 3.0 for record types.

Modification of Existing Custom Record Types

- Existing custom record types will work as they are. However, there are several enhancements in VisionWare version 3.0 that may require you to update your current record types to take advantage of them. See Appendix H for more details.

Creating Custom Record Types

- The name for a record type may now be up to 30 characters long.
- When adding a record type to a class, you may want to add the optional descriptive string. For test-a-value class records, the string should describe the items that are testable.
- Previously, you were not required to specifically add a record type to the test-a-value class (this was done automatically). However, if you wish to use the new descriptive string feature, you will need to add

```
CALL vw.add.to.class (ve.tst.class,...
```

to the end of your definition routine using the new syntax.

- Previously, if you wanted a record type to be included in the Vision Tool class, you had to use the **vw.add.to.class( )** routine. This is now done automatically when the **def[vw.td.vtool]** element is TRUE. This means you can eliminate the CALL to **vw.add.to.class( )** located at the bottom of the record type definition routines.

  > **NOTE:** This CALL does not have to be eliminated. It will simply be a harmless redundancy that may increase your application's start-up time. (This may become obsolete in the future.)

- In the **vw.typ.def[,]** array, a previously unused element is now being used. There also is a new name for the index variable. The old index variable was vw.td.id and was marked as "unused" in the public record-type definition routines. The new index variable is **vw.td.flags** and the element is now used for various bit flags. The only bit flag currently defined is **vw.flg.clean**. When this new bit is set, it signifies that the execution graphics do not contain results-dependent items. Consequently, this means that when a shape tool is clicked on to drag, it does not have to fully execute the tool to erase it before going to **dry.run** mode for the drag. This will erase "Reference frame" and other graphics. (The Window and Image Processing records use this feature.)
- A record type may now have optional source records. This is specified by giving the "class" for that source as –1 times the normal value when filling in the **src.classes[,]** array in the definition routine. For instance, if a custom record type specified one or more (up to eight) Frame class records for averaging, sources 2 through 8 would have "–ve.frm.class" and source 1 would have class "ve.frm.class". Of course, this means that if any of these are missing at link time, there will be *no* errors.
- If a record type has a shape (or is a vision tool), the reference frame record *or* the first source must be present. This is necessary for determining the "reference picture" of the shape tool's or vision tool's coordinate frame. This feature allows the new Conditional Frame record type to be useful when just the reference frame is specified without inspections.

Installing Custom Record Types

- Previously, when installing a custom record type, you had to add code to several public files and modify several existing "new record" menu pages. Now, you simply need to name some routines and files in a certain way, and add a new record to one of the .INI database files that executes during startup. Inclusion of the record type in the appropriate "new record" selection pages is automatic. Additionally, you can load or unload the record type using a check-box. See the section "Installation" on page 52 for more details.

I.3 Data Logging

This information is for customizers who have written custom routines that work with the data logging (for example, a special format output routine such as **qc.trans.stats( )** in the public file QCLOG.V2).

- The automatic data-logging feature has been updated to work with multiple vision tasks. In the Log Results pop-up, you now specify the destination (serial line or file name) for each of the vision tasks you are using. (There is only one vision task per system.)
- To handle this, the following logging-related variables are now arrays, indexed on "TASK( )" (the vision task):

```
qc.log.lun      =   qc.log.lun[TASK( )]
qc.log.change   =   qc.log.change[TASK( )]
```

- The task number for each of the two vision tasks (one for each vision system) is accessed as follows:

```
vision.task.1   =   ai.tsk[ti.vis1, ai.tsk.task]
vision.task.2   =   ai.tsk[ti.vis2, ai.tsk.task]
```

- New "ai.ctl[ ]" values have been added:

New $ai.ctl[ ] Index	**Description**
cs.log.file2	New "vision task 2" output file / serial line name.

New ai.ctl[ ] Index	**Description**
cv.log.flush2	New "vision task 2" output buffer flush flag.

- The global variable **$qc.log.file** has been eliminated.
- The meaning of the global variable **ai.ctl[cv.log.flush]** has changed:

Old	**New**
–1, 0, >0	–1 or 0 only (see below)

Users that took advantage of data-logging in VisionWare version 2.2 may notice the "time interval to flush" option is not offered in version 3.0. Because of this, the variables **ai.ctl[cv.log.flush]** and **ai.ctl[cv.log.flush2]** are now Boolean (–1 = YES, 0 = NO). They can no longer represent a buffer-flush interval.

I.4 Statement Preruntime Routines

This information is for customizers who have implemented custom statements in VisionWare using the preruntime statement feature.

- Previously (in VisionWare 2.∗), preruntime routines and / or runtime routines could be optionally included to support a statement. A statement with *only* a preruntime routine (and no runtime routine) could be used to simply do one-time set-up activities. In VisionWare 3.0, this is still possible. However, each statement *must* have a runtime routine even if there is nothing done at runtime. Therefore, if you plan to have a statement that is just used for preruntime activity, you must create a dummy routine with the same name as the statement. It must follow the correct calling sequence for a statement routine.

  NOTE: To improve efficiency, you can prevent the dummy routine from being called at runtime by "disabling" the step (see below).

- You can disable a sequence step from within the statement's preruntime routine. Previously (in VisionWare 2.∗), you set the **args[0]** value to –1. In VisionWare 3.0, you set **args [0]** to 0.

  NOTE: args[ ] is an input array argument to all preruntime routines.

  This method is effective when a statement happens to have arguments that would make it unnecessary to the runtime operation, or if the statement's only purpose is to perform runtime start-up operations (such as loading configuration data from a file).

I.5 Data Structures

The most significant changes to VisionWare in this release are the combined support for dual vision within one AIM system, and the support for multiple vision runtimes within the new module structure.

To accomplish this, many data structures now have an additional “left-hand” index for the database number, vision system number, or task number. These are listed in Table I-1.

Table I-1
Summary of Data Array Index Changes

Old	New
Database Indexed db = vi.db[TASK( )][1]	
vw.data[,]	vw.data[db,,]
$vw.data[,]	$vw.data[db,,]
vw.res[,]	vw.res[db,,]
$vw.res[,]	$vw.res[db,,]
vw.vis.sys	vw.vis.sys[db]
vw.num.pics	vw.num.pics[db]
vw.multi.pics	vw.multi.pics[db]
vw.runtime.disp	vw.runtime.disp[db]
vw.run.disp	vw.run.disp[db]
vw.cur.pic	vw.cur.pic[db]
vw.ei.max	(not in use)
vw.ei.max.list	vw.ei.max.list[db]
vw.eval.list[,]	vw.eval.list[db,,]
vw.cu.elists[ ]	vw.cu.elists[db,]
vw.pics[,]	vw.pics[db,,]
vw.moves[,]	vw.moves[db,,]
vw.dependents[,]	vw.dependents[db,,]
vw.stt.done	vw.stt.done[db]
vw.stt.more	vw.stt.more[db]
vw.tree.done	vw.tree.done[db]
vw.pp.list[ ]	vw.pp.list[db,]
vw.ping.pong	vw.ping.pong[db]
vw.pp.primed	vw.pp.primed[db]
vw.pp.ptr	vw.pp.ptr[db]
vi.proto.change	vi.proto.change[db]
vi.font.change	vi.font.change[db]
vi.tmpl.change	vi.tmpl.change[db]

Table I-1
Summary of Data Array Index Changes (Continued)

Old	New
Vision System Indexed vsys = vw.vis.sys[vi.db[TASK( )]][1]	
vw.cal.to.cam[ ]	vw.cal.to.cam[vsys,]
vw.cur.buf	vw.cur.buf[vsys]
vw.pic.waiting	vw.pic.waiting[vsys]
vw.buf.list[ ]	vw.buf.list[vsys,]
vw.buf.pic[ ]	vw.buf.pic[vsys,]
vw.buf.ptr	vw.buf.ptr[vsys]
vw.next.aoi	vw.next.aoi[vsys]
vw.next.vc	vw.next.vc[vsys]
Task Number Indexed tsk = TASK( )[1]	
vw.cancel	vw.cancel[tsk]
vw.tmp.aoi	vw.tmp.aoi[tsk]
qc.log.lun	qc.log.lun[tsk]
qc.log.change	qc.log.change[tsk]

Note:

1. The array variable has been assigned to a scalar variable for efficiency. When writing custom code, it must be shown in its long form or else passed to a scalar variable within your program.

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Adept User's Manual Comment Form

We have provided this form to allow you to make comments about this manual, to point out any mistakes you may find, or to offer suggestions about information you want to see added to the manual. We review and revise our manuals on a regular basis, and any comments or feedback you send us will be given serious consideration. Thank you for your input.

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