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Video Savant® 4.0 User's Guide

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Original printing January 16, 2003

PRINTED IN CANADA

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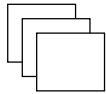
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Welcome to Video Savant

Thank you for choosing IO Industries **Video Savant**[®] digital video recording software. When installed on a computer system with a compatible operating system and compatible hardware, Video Savant can record real-time¹ image sequences to a computer's memory or hard disk subsystem.

Video Savant is compatible with the following operating systems:

- Microsoft[®] Windows[®] XP Professional
- Microsoft[®] Windows[®] 2000 Professional
- Microsoft[®] Windows[®] NT 4.0 SP6¹

For a list of supported camera interfaces (e.g. frame grabbers), visit IO Industries on the Internet at <http://ioindustries.com>.

❖ The Video Savant 4.0 Family:

❑ Video Savant Basic 4.0

- Interactive software for video recording, and playback.

❑ Video Savant Pro 4.0

- Interactive software for video recording, and playback;
- Recording and playback/viewing of additional data streams;
- Real-time or static image processing; and
- Centralized control of multiple computers, each running Video Savant, over a local area network.

¹ IO Industries *DVR Express* camera interface is supported under Windows XP Pro and Windows 2000 Pro, but not under Windows NT 4.0.

❑ **Video Savant SDK (Software Development Kit) 4.0**

- Software libraries for development of custom solutions for video record/playback, data record/playback, and image processing.

❑ **Video Savant RTL (Runtime License) 4.0**

- Semi-interactive software that allows applications and Processing Libraries created using Video Savant SDK (Software Developer's Kit) to be executed. Standard user-interface controls for video recording and playback are not included.

❑ **Video Savant Viewer 4.0**

- Low-cost software license for playback of video files and data streams recorded by Video Savant Basic, Pro, or SDK custom applications.

Detailed Comparison of Features

Feature	Basic	Pro	Viewer	RTL
Video recording to system memory or a hard disk subsystem (uncompressed or compressed)	Yes	Yes	N/A	SDK
Video playback	Yes	Yes	Yes	SDK
Video recording and playback from Python scripts	Yes	Yes	N/A	N/A
Recording of additional data streams	SDK	Yes	N/A	SDK
Playback/viewing of additional data streams	SDK	Yes	Yes	SDK
Static image processing	SDK	Yes	N/A	SDK
Real-time (host-based) image processing	SDK	Yes	N/A	SDK
Frame and line scan (waterfall) image display - with zoom in/out, thumbnail display, and full-screen/windowed display modes	Yes	Yes	Yes	SDK

Interactive Output Look Up Table controls with multiple tables and real-time LUT switching	Yes	Yes	Yes	SDK
Centralized control of multiple computers on a local area network, each running Video Savant Basic, Pro or RTL	SLAVE	MASTER or SLAVE	N/A	SLAVE
Image file import and export	Yes	Yes	Yes	SDK
Camera interface controls	Yes	Yes	N/A	SDK

Notes:

- SDK Indicates that the Video Savant SDK must be used to develop an application to provide access to the feature
- SLAVE Indicates this Video Savant license can be controlled from another computer on the local area network
- MASTER Indicates this Video Savant license can control SLAVE computers on the local area network
- N/A Indicates this feature is not available

Understanding computer-based vision systems

❖ **A complete computer-based vision system is composed of four general components:**

- ☐ An *Image Capture Device*, such as a video camera, which outputs image information as an electronic signal;
- ☐ A *Device/Computer Interface* which takes the electronic signal containing the image information and converts it (if necessary) to binary data that the computer can directly manipulate and store;
- ☐ A *Computer System* which operates as the master controller of the vision system; and
- ☐ *Application Computer Software* containing a set of instructions which are issued to the host computer system and relayed to its

devices in order to receive, process, store and/or display image information for some useful purpose.

Image Capture Device

Video Savant is most often used in vision systems which use a video camera as the image capture device. A basic understanding of how this device operates is beneficial.

A sensor in the video camera is exposed to light and generates an electrical response. The set of electrical responses registered over the surface of the sensor forms an electronic picture of the camera's field of view. The camera outputs the electronic picture as an electronic signal, or *video signal*, over a time interval together with additional synchronization signals to mark the electronic start and end of each picture or *video frame*.

Many different types of video cameras have been designed for a variety of vision applications.

❖ Four defining characteristics of video cameras are:

- ❑ *Wavelength Sensitivity.* The wavelength of light that the sensor responds to. Infra-Red sensors are popular for applications such as night vision and surveillance. However, most video cameras are designed to detect visible light. Visible light sensors are available for capturing monochrome or color pictures.
- ❑ *Image Resolution.* Also referred to as *Frame Size*, this is the spatial sampling frequency of the field of view. At higher resolutions, a more detailed representation of the field of view can be seen. For instance, high-resolution sensors are used in medical X-Ray imaging systems because a high degree of spatial precision is required.
- ❑ *Frame Rate.* The temporal sampling frequency of pictures. This refers to how many pictures are taken by the camera over a period of time. Higher frame rate sensors produce a more detailed record of motion in the camera's field of view. For example, an object is moving at a speed of 1 meter/second directly across a camera's 1

meter field of view. If a non-interlaced² camera takes pictures at a frame rate of 30 frames/second, then it will capture 30 frames showing the object. A 200 frames/second camera with the same field of view would capture 200 frames showing the object, thereby generating a much more detailed record of the object's motion. If the object was moving faster than 30 meters/second, the 30 frames/second camera would capture at most 1 frame showing the object.

- *Video Format.* The video format describes both the electronic signal type and the timing of the video signal output by the video camera. There are two electronic signal types that video cameras use to transmit their electronic image information: *Digital Signals* and *Analog Signals*. Analog type cameras output a signal that must be converted (digitized) by the Device/Computer Interface into a binary signal defining each pixel³ in the picture. Digital type cameras perform the digitization step internally and output a binary signal defining each pixel in the picture. Interestingly, some video cameras output both signal types. Analog cameras differ from one another with respect to timing and synchronization of the electronic signal they output. The same is true for digital cameras.

Device/Computer Interface

The Device/Computer Interface (camera interface) *captures* or *acquires* frames output by the video camera. The camera interface has evolved into

² A non-interlaced camera frame is composed of a single scan of the field of view. An interlaced camera frame is composed of two scans separated in time, generating two sub-frames called an even field, and an odd field. The fields mesh together to form the even and odd lines of the field of view. At faster speeds of motion, the time lag between even and odd frames results in a blurring phenomenon known as the *Interlaced Effect* which is undesired when trying to record motion.

³ A pixel (picture element) is a number (or combination of numbers) describing the light measured at a point in an image. Pixels are sampled at regularly spaced intervals forming a matrix of data describing the complete field of view. A pixel is the smallest logical unit of visual information that can be used to build an image. The more pixels that are in an image, the higher its resolution.

many different forms in order to accommodate the different video formats produced by video cameras.

Until recently, standard computer I/O ports were either not compatible or were too slow to function as camera interfaces for video cameras. Therefore a specialized class of devices, known as *Frame Grabbers*, was designed to be the camera interface in vision systems with video cameras. Frame grabbers are plug-in computer hardware modules which function mainly as non-standard computer I/O ports⁴.

New standards for video interfacing to computers such as Camera Link and Firewire[®] (IEEE-1394) are rapidly becoming the most popular methods for interfacing video cameras to computer systems. Firewire requires an extremely low-cost camera interface card, and is even a standard port on some computers. Camera Link is a higher speed, more sophisticated standard that requires a more expensive camera interface card. Not all cameras can be adapted to use these new camera interface standards, and specialized frame grabbers will continue to be used in many situations.

IO Industries now offers a frame grabber, the IO Industries *DVR Express*[®], that is useful for video recording from very high data rate cameras. The DVR Express can acquire from Camera Link and LVDS digital video formats. An onboard SCSI controller chip transfers video data directly to SCSI disk(s) attached to the card. The DVR Express allows systems to be configured for continuous video recording to hard disk at data rates exceeding 1 GByte/sec. Visit the IO Industries website for more information.

Communication between Video Savant and the camera interface (standard or non-standard) is handled by a special software module called a device driver. Video Savant issues high-level instructions to the device driver such as *capture a video frame*. The device driver responds by issuing a low-level set

⁴ Early frame grabbers did much more than acquire frames from video cameras. They had additional onboard capabilities such as memory for storing images, an image display capability, and a programmable processor for processing image data. The increased peripheral bus bandwidth and computing power of modern computer systems has resulted in the computer system providing image storage, display and processing. Some vision systems still require the use of frame grabbers with special capabilities, but the demand is declining as system computing power continues to increase.

of instructions, which tell the camera interface exactly how to carry out the task.

Computer System

The computer system is the master controller of the vision system. It directs the flow of image information into the system by passing instructions to the camera interface. Today's vision systems are increasingly reliant on the resources of the computer system (as opposed to resources built into the camera interface). For this reason, the selection of a computer system with the correct configuration is critical.

The computer system processor, memory (RAM), hard disk storage, display and peripheral I/O bus must be selected to match the requirements of the vision application. IO Industries can make recommendations for an appropriate configuration or direct you to a competent third party who can help. Contact IO Industries, or visit our website to find a sales representative in your area.

Application Computer Software

Video Savant running with a compatible operating system is the application computer software component of a computer-based vision system.

Video Savant has been designed for vision systems requiring real-time digital video recording, video playback, real-time video processing and video post-processing.

Video Savant presents a consistent user-interface to the operator of the vision system, independent of the camera interface and video camera used. This device independence is achieved by the device driver software layer in the Video Savant architecture.

A device driver has been designed for each camera interface that Video Savant supports. Visit the IO Industries website to see the current list of supported camera interfaces (e.g. frame grabbers). The most recent versions of these device drivers can be downloaded from our website free of charge.

Understanding real-time imaging

Real-time imaging requires that a host computer system be able to perform some type of storage or processing operation on every frame of an incoming video stream. In the following discussion, a series of examples are given for which Video Savant can provide a solution.

A common example of real-time imaging is to simply capture and store a raw video stream. Here, every frame in the video stream is sent either to system memory (RAM), or directly to a hard disk subsystem with no processing or display of the incoming stream. This is the default video recording mode of Video Savant. Viewing video during the recording process is an optional feature.

Another common example is to append some additional data, such as the system time clock data, to the image data of each frame and then store the combined or *mixed* data streams. In this case only two data streams are mixed and stored, however there are cases when more than two streams must be mixed and stored. For instance, a user may wish to record video, GPS⁵, and sound data simultaneously.

A more sophisticated use of real-time imaging is to process the frames of the incoming video stream, for example a background subtraction for an industrial part alignment operation, and then store the processed video stream. It may be required to mix in an additional data stream, such as status information describing whether the part is aligned or not, and store this information together with the video stream.

Understanding image capture to memory or hard disk

When video is captured by the host computer system, it must be stored somewhere. Video Savant has two storage modes: *Memory* mode and *Disk* mode.

⁵ GPS refers to Global Positioning System. Latitude, longitude and current time is received by the host computer via a satellite communication system.

In *Memory* mode, Video Savant stores the video frames in volatile system memory (RAM). In *Disk* mode, Video Savant stores the video frames in a hard disk subsystem.

Memory mode has a higher maximum input bandwidth than *Disk* mode and can therefore accommodate video streams containing a higher data rate. High-resolution cameras and high frame rate cameras sometimes produce data rates which can only be recorded in *Memory* mode.

Disk mode has a much larger storage capacity than *Memory* mode. *Memory* mode is typically used to record seconds of a video stream. *Disk* mode is used to record minutes or hours of a video stream.

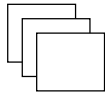
Understanding image buffers

The frames of a video stream are stored in *Image Buffers* on the host computer. The data for image buffers is located in volatile system memory (*Memory* mode) or in a video file in a hard disk subsystem (*Disk* mode). Normally each image buffer contains a single video frame, however, in some special cases an image buffer can contain more than one video frame.

There are some important considerations to be noted depending on which storage mode Video Savant is operating in.

After Video Savant is started, the initial contents of the image buffers are normally set to zero in *Memory* mode. In *Disk* mode, the contents are the same as the last time the video file was used by Video Savant. When a new video file is created, the contents are initialized to zero.

When Video Savant is closed, the contents of the image buffers are normally lost if operating in *Memory* mode. However, if you are running Video Savant in *Memory* mode and you wish to keep all of the images in the buffers for the next time you launch Video Savant, you need to change the *Storage Type* settings of your video file to not *Disable save of RAM buffers to disk on shutdown*. In *Disk* mode, the contents of image buffers are preserved in the video file and are accessible the next time Video Savant is started. (see Chapter 2, section Modifying the video file settings)



Getting Started

Before you begin using Video Savant, the hardware and software of the vision system must be configured. The first step is to select a video camera and install a compatible camera interface in the computer system. After the hardware is installed, the vision system software must be configured.

This chapter describes the procedures for configuring the vision system software. An introduction to the operation and features of Video Savant is included.

Preparing to use your video camera and camera interface

If your video camera has multiple modes of operation, you must ensure you have selected the desired mode. Some cameras have mode controls on the camera. Others have a computer communication interface for remotely selecting the desired mode. Consult the camera user manual for instructions.

The camera interface for your vision system is either a standard computer I/O port (e.g. USB, Firewire/IEEE-1394, Ethernet), or a frame grabber. If you are using a standard computer I/O port, the camera user manual should describe how to configure the computer system port to work with the camera. If you are using a frame grabber, follow the steps given below.

❖ Setting up the frame grabber:

1. Ensure that the frame grabber is compatible with the operating system you wish to use.
2. Install the operating system.
3. Log in to the operating system as *Administrator*.

4. Install the software provided by the frame grabber manufacturer. Make note of the manufacturer's software version number for future reference in case of difficulties.
5. Configure the software provided by the frame grabber manufacturer to work with your video camera. Refer to the documentation provided by the frame grabber manufacturer.
6. Run the frame grabber manufacturer's test software and verify that frames can be captured from the video camera.
7. If you cannot successfully complete the above steps, contact the company from whom the frame grabber was purchased for assistance.

Installing Video Savant

If you have successfully completed the above steps, you are now ready to install Video Savant.

❖ Installation procedure:

1. Log in to the operating system as *Administrator*.
2. Locate the software protection key that came in the package along with the Video Savant CD-ROM. The key will be compatible with either a 25-pin parallel port or a USB port. Attach the key to the appropriate port.
3. If you have attached a USB software protection key for the first time, the *Found New Hardware Wizard* will appear. Follow the instructions in the section *Configuring the computer for a USB software protection key* in this chapter before proceeding with step 4 below if the *Found New Hardware Wizard* appears.
4. Insert the Video Savant CD-ROM in the computer's CD-ROM drive.

5. Wait a few seconds and the Video Savant setup program should automatically start. If the Video Savant setup program has not started after waiting 30 seconds, manually start the program by pressing **Start** button on the Windows desktop, choosing **Run...**, and opening SETUP.EXE in the root-directory on the Video Savant CD-ROM.
6. In the Video Savant setup program, choose **Install Video Savant** and follow the on-screen instructions to install Video Savant.
7. Install the driver for the Video Savant software protection key. If this driver is not correctly installed, Video Savant will not detect the presence of the key when started, and will operate in a restricted demonstration mode. We recommend that you install the driver for the key at this time. However, you can install it from the Video Savant CD-ROM at a later time.
8. Re-launch the Video Savant setup program if it is not already running (see steps 4 and 5 above). Choose **Install Software Key Driver**.
9. The *Rainbow Technologies Sentinel* window will appear. Access the *Functions* menu and select **Install Sentinel Driver**.
10. Press **OK** to accept the suggested path of the Sentinel files.
11. A message box will appear indicating that the driver has been installed. Click **OK** to close the message box.
12. If you are using a parallel port software protection key, close the *Rainbow Technologies Sentinel* window. You are now ready to use Video Savant! If you are using a USB port key, continue following these instructions.
13. Access the *Functions* menu and select **Configure Sentinel Driver**.
14. A list of all locations that the system driver will be looking for software protection keys will be displayed.

15. Double click on an entry in the list to view its settings. If the *Port Type* of this entry is **USB**, change the *Use this port?* setting to **Yes**, otherwise change the *Use this port?* setting to **No**.
16. Press **OK** to confirm your changes.
17. Repeat steps 15 and 16 for each entry in the list.
18. Press **OK** to close the list of locations that the system driver will be looking for software protection keys.
19. Close the *Rainbow Technologies Sentinel* window. You are now ready to use Video Savant.

Configuring the computer for a USB software protection key

If you will be using a USB software protection key instead of a parallel port software protection key, and have just plugged the USB key into the USB port on your computer for the first time, the *Found New Hardware* wizard will appear. Follow the steps below to install the driver for the USB software protection key.

❖ Installation procedure:

1. On the opening screen of the *Found New Hardware* wizard, press **Next** to continue.
2. Select **Search for a suitable driver for my device (recommended)**.
3. Press **Next** to continue.
4. In the *Optional Search Locations*, choose **CD-ROM drives**.
5. Insert the Video Savant CD-ROM into the computer's CD-ROM drive.
6. The Video Savant installer will launch automatically. Click **Exit** to close the Video Savant setup program.

7. On the *Optional Search Locations* screen of the *Found New Hardware* wizard, press **Next** to continue.
8. Windows may find the sntnusb.inf driver file on the Video Savant CD-ROM. If not, browse to the \sentinel\win_nt\i386 directory of the Video Savant CD-ROM.
9. Press **Next** to accept the driver.
10. Press **Finish** to close the *Found New Hardware* wizard.

Working with Device Selector

❖ Uses of Device Selector:

- ☐ Selecting the default camera interface (i.e. frame grabber) driver;
- ☐ Viewing the camera interface driver release notes; and
- ☐ Installing an unlisted or updated driver

Before using a driver for the first time, it is recommended that you view the driver release notes to verify that the camera interface manufacturer's software installed on the computer has the same version number as is specified in the Video Savant driver release notes.

Selecting the default camera interface

When Video Savant is started, it selects the *Default Camera Interface* as the active camera interface.

❖ To select the Default Camera Interface:

1. Highlight the name of the camera interface you wish to use.

2. Press the **Set As Default** button.

Viewing camera interface driver release notes

❖ The camera interface Driver Release Notes describe:

- ☐ The driver version;
- ☐ The required version of the camera interface manufacturer's software;
- ☐ The revision history of the driver;
- ☐ Supported features of the camera interface;
- ☐ General configuration instructions;
- ☐ Video format configuration instructions; and
- ☐ Special programming notes for Video Savant SDK users.

❖ To view the driver release notes:

1. Highlight the name of the camera interface you wish to use.
2. Press the **Release Notes** button.

Installing an unlisted or updated camera interface driver

There are two methods used to install an unlisted or updated driver.

If you are installing a driver from the *Video Savant CD-ROM*, press the **Install Unlisted ...** button in *Device Selector* (Start, Programs, Video Savant, Device Selector). Follow the on-screen instructions to install the driver.

❖ **To install a driver from a file that was downloaded from the IO Industries website:**

1. Press the **Start** button on the Windows desktop.
2. Choose **Run**.
3. Browse or enter the path to the driver file (this is a self-extracting executable).
4. Press the **OK** button and follow the on-screen instructions.

Working without a camera interface

The *Virtual Frame Grabber* is a special camera interface which simulates video capture from a video camera. During the installation of Video Savant, this driver is automatically installed.

If you have not installed a camera interface device, or will not be using one, the Virtual Frame Grabber driver will allow you to start Video Savant for viewing and processing image data already stored on the computer.

❖ **The Virtual Frame Grabber supports the following image types:**

- ☐ 8 bit grayscale
- ☐ 16 bit grayscale (used for 9...16-bit pixel depths)
- ☐ 24 bit color RGB (8:8:8)
- ☐ 32 bit color RGBx (8:8:8:x)
- ☐ 16 bit color RGBx (5:5:5:1)
- ☐ 16 bit color RGB (5:6:5)
- ☐ 16 bit color YUV (4:2:2)

- ☐ 8 bit color Bayer mosaic

Preparing a hard disk for video recording



This procedure differs when using the DVR Express camera interface. Please consult the DVR Express User's Manual.

In this section, recommendations are made on how to configure a disk volume for video recording.

Video recording to hard disk requires the use of a disk volume which is able to sustain a very high write speed. The sustained write speed must be faster than the data rate of the incoming video so that no video data is lost when recording to the volume.

The most common method for optimizing write speed is to divide the write operation over a set of disks working in parallel. This technique is referred to as *Disk Striping*, or *RAID 0*.

❖ Three common disk configurations are:

- ☐ A single disk.
- ☐ A group of disks configured as a volume using Windows NT 4.0 Disk Administrator⁶ or Windows 2000 Pro / Windows XP Pro Computer Management⁷.
- ☐ A group of disks configured as a volume using a hardware RAID⁸ controller.

⁶ To start Disk Administrator: push the desktop *Start* button; select *Programs*; select *Administrative Tools*; and then select *Disk Administrator*.

⁷ To start Computer Management: push the desktop *Start* button; select *Settings*; select *Control Panel*; double-click *Administrative Tools*; double-click *Computer Management*.

⁸ RAID is an acronym, which stands for "Redundant Array of Independent Drives."

In all of these configurations, the disks should only be used for storing the video files generated by Video Savant. The disks should not be used to store program or data files from other applications.

The following procedures will erase the contents of the video drive(s). If the video drives contain useful data, be sure to backup this data before proceeding.

Single disk configuration

❖ To configure a single disk configuration in Windows XP Pro or Windows 2000 Pro:

1. Start *Computer Management*.
2. Select **Disk Management** from the tree on the left.
3. Right-click on the rectangular graphic located to the right of the disk corresponding to the video drive and select **Create Volume**.
4. Click **Next**; select **Simple Volume** as the *Volume Type*; and click **Next** again.
5. Choose a *Drive Letter* and click **Next**.
6. Choose **Format this volume as follows**, select the **NTFS** file system, choose allocation units of **4096**, enter the desired volume label, and ensure that *file and folder compression* is **disabled**.
7. To skip scanning for bad sectors in the partition during formatting, enable **Quick Format**. Scanning for bad sectors is a very time-consuming process, but it is recommended when using a new disk.
8. Click **Next**; verify your selected settings; and click **Finish**.
9. Close *Computer Management* and *Control Panel*.

10. Right-click on the *Recycle Bin* folder on the Windows desktop and select **Properties**.
11. Click the **Global** tab, and choose **Configure drives independently**.
12. Click on the tab associated with the video drive and choose **Do not move files to the Recycle Bin. Remove files immediately when deleted**.

❖ **To configure a single disk configuration in Windows NT 4.0:**

1. Start *Disk Administrator*.
2. On the *View* menu, select **Disk Configuration**.
3. Identify the disk to be used as the video drive.
4. Select the video drive disk by left-clicking on the rectangular graphic located to the right of the disk corresponding to the video drive. The appearance of a bold black border around the rectangle indicates the disk has been selected.
5. On the *Partition* menu, select **Delete** (The *Delete* operation will not be available if the disk is not currently assigned to a disk volume. In this case, this operation is not needed).
6. Select the video drive again (see above step 4).
7. On the *Partition* menu, select **Create**.
8. On the *Partition* menu, select **Commit Changes Now**.
9. Select the video drive again (see above step 4).
10. On the *Tools* menu, select **Format**.
11. Under *File System*, select **NTFS**.
12. Under *Allocation Unit Size*, select **4096**.

13. To skip scanning for bad sectors in the partition during formatting, enable **Quick Format**. Scanning for bad sectors is a very time-consuming process, but it is recommended when using a new disk.
14. **Enable Compression** should be disabled.
15. A **Volume Label** can be entered, although it is not required to do so.
16. Verify again that all settings for the format operation are correct.
17. Press the **Start** button to format the video drive.
18. Close *Disk Administrator*.
19. Right-click on the *Recycle Bin* folder on the Windows NT desktop and select **Properties**.
20. Click the **Global** tab, and choose **Configure drives independently**.
21. Click on the tab associated with the video drive, and choose **Do not move files to the Recycle Bin. Remove files immediately on delete**.

Disk set managed by Disk Administrator / Computer Management

❖ To configure a disk set managed by Computer Management in Windows XP Pro or Windows 2000 Pro:

1. Start *Computer Management*.
2. Select **Disk Management** from the tree on the left.
3. In the lower portion of the display, locate the disks that you wish to include in the set and ensure that they are all indicated as being *Dynamic*.

4. If any of the disks are indicated as being *Basic*, right-click on them and select **Upgrade to Dynamic Disk**.
5. Right-click on one of the disks to be included in the set and select **Create Volume**.
6. Click **Next**; select **Striped Volume** as the *Volume Type*; and click **Next** again.
7. Select all of the disks to be included in the set by left-clicking them in the list on the left and clicking **Add**. When you have selected all of the disks for the set, click **Next**.
8. Choose a *drive letter* and click **Next**.
9. Choose **Format this volume as follows**; select the **NTFS** file system; choose allocation units of **4096**; enter the desired volume label; and ensure that *file and folder compression* is **disabled**.
10. To skip scanning for bad sectors in the partition during formatting, enable **Quick Format**. Scanning for bad sectors is a very time-consuming process, but it is recommended when using a new disk.
11. Click **Next**, verify your selected settings, and click **Finish**.
12. Close *Computer Management* and *Control Panel*.
13. Right-click on the *Recycle Bin* folder on the Windows desktop and select **Properties**.
14. Click the **Global** tab, and choose **Configure drives independently**.
15. Click on the tab associated with the video drive and choose **Do not move files to the Recycle Bin. Remove files immediately when deleted**.

❖ **To configure a disk set managed by Disk Administrator in Windows NT 4.0:**

1. Start *Disk Administrator*.
2. On the *View* menu, select **Disk Configuration**.
3. Identify the set of disks to be used as the video drive.
4. Select the first video drive disk in the set of disks by left-clicking on the rectangular graphic located to the right of the disk. The appearance of a bold black border around the rectangle indicates the disk has been selected.
5. On the *Partition* menu, select **Delete** (The **Delete** operation will not be available if the disk is not currently assigned to a disk volume. In this case, this operation is not needed).
6. Repeat the above steps 4 and 5 for each of the other disks in the set of disks assigned to the video drive.
7. Select the complete set of disks to be used as the video drive by pressing and holding down the *Control* key on the keyboard while left-clicking on the rectangular graphic located to the right of each video drive disk. The appearance of a bold black border around the set of rectangles indicates the disks have been selected.
8. On the *Partition* menu, select **Create Stripe Set**.
9. On the *Partition* menu, select **Commit Changes Now**.
10. Select the video drive again (see above step 4).
11. On the *Tools* menu, select **Format**.
12. Under *File System*, select **NTFS**.
13. Under *Allocation Unit Size*, select **4096**.

14. To skip scanning for bad sectors in the partition during formatting, enable **Quick Format**. Scanning for bad sectors is a very time-consuming process. It is recommended when using a new disk.
15. **Enable Compression** should be disabled.
16. A **Volume Label** can be entered, although it is not required to do so.
17. Verify again that all settings for the format operation are correct.
18. Press the **Start** button to format the video drive.
19. Close *Disk Administrator*.
20. Right-click on the *Recycle Bin* folder on the Windows NT desktop and select **Properties**.
21. Click the **Global** tab, and choose **Configure drives independently**.
22. Click on the tab associated with the video drive, and choose **Do not move files to the Recycle Bin. Remove files immediately on delete**.

Disk set managed by a hardware RAID controller

Hardware RAID controllers generally allow a selection of RAID levels. A software RAID configuration utility, provided by the RAID controller manufacturer, allows the RAID level to be selected along with other operational parameters.

For video recording, RAID level 0, also referred to as *Disk Striping*, is recommended because it provides the fastest write speed, although no data redundancy⁹ is implemented.

⁹ Data redundancy allows data on a disk volume to be recovered in the event of a catastrophic failure of one or more of the disks in the disk volume. The different RAID levels offer varying degrees of protection.

If data redundancy is required, other levels of RAID can be used. In general, increased data redundancy reduces both the effective storage capacity of the disk volume and the write speed of the disk volume.

Other operational parameters which affect write speed include *Stripe Size*, and *Write Back Cache*. *Stripe Size* should be set to the highest possible value. *Write Back Cache* should be enabled. Refer to the documentation supplied by the RAID controller manufacturer for a discussion of these and other parameters which affect performance.

Once the RAID set is configured using the manufacturer's software utility, the set of disks will appear as a single disk entry under Windows Disk Administrator. The procedure for preparing the disk volume is the same as is listed above for a *Single Drive Configuration*.

Starting Video Savant

If you have successfully performed the hardware and software configurations required for your vision system as described in the preceding sections, then you are ready to start Video Savant. Be sure that your camera interface (e.g. frame grabber) is specified as the default camera interface in the *Device Selector* utility.

To start Video Savant, open the Video Savant folder, and then open the Video Savant application.

If Video Savant starts without any warning or error messages, you may proceed with the remaining sections of this chapter. If you are experiencing problems starting Video Savant, see Chapter 9 for guidelines on troubleshooting.

Exploring the work area

This section is intended as a brief introduction to the features of Video Savant.

The Video Savant work area appears as shown below.

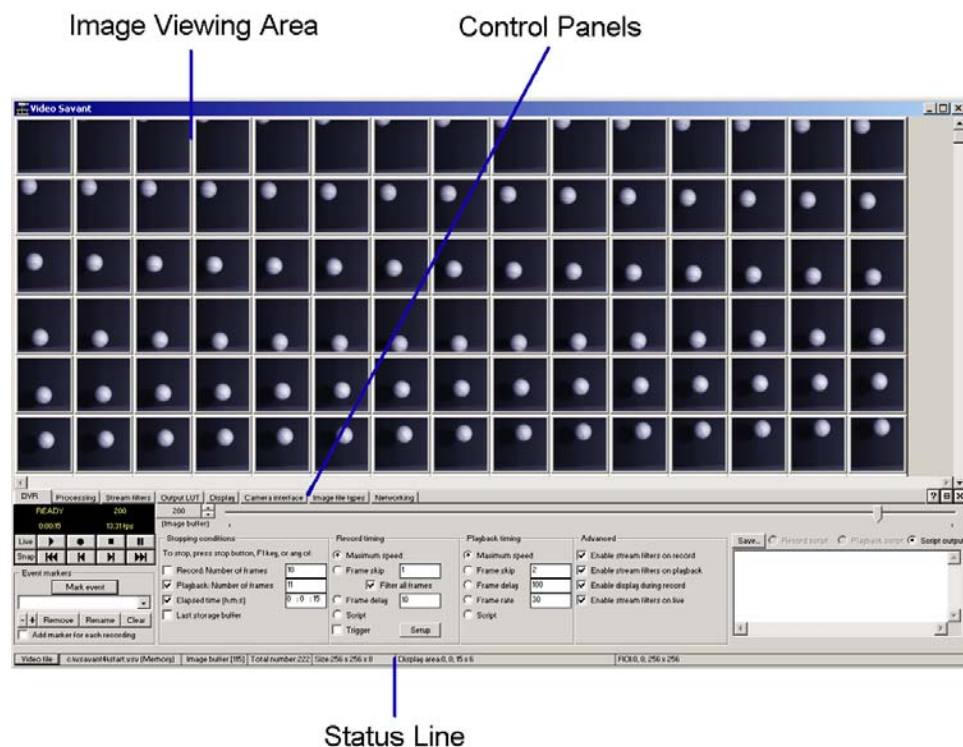


Figure 2.1: The Video Savant work area.

Image Viewing Area

The *Image Viewing Area* can display image thumbnails or full size images. Full size images can be zoomed in or out by different magnification factors.

Control Panels

The primary point of control in the Video Savant user-interface is the set of control panels located at the bottom of the Video Savant window.

❖ **The purpose of each control panel is as follows:**

- ❑ *DVR (Digital Video Recording) Control Panel.* Supports the following operations: video recording; video playback; live image capture (live); and single frame image capture (snap).
- ❑ *Processing Control Panel.* Provides image processing and analysis functions. The standard processing libraries described in Chapter 6 will only work in Video Savant Pro. However, custom processing libraries developed using Video Savant SDK will work in the Pro, Basic, and RTL installations of Video Savant.
- ❑ *Stream filters Control Panel.* Provides management of stream filter modules. Stream filters allow recording and playback of additional data streams, real-time image processing, and image processing during video playback. This control panel is available only in Video Savant Pro and Video Savant Viewer. In Video Savant Viewer the operation is restricted to the playback of data streams.
- ❑ *Output LUT Control Panel.* Provides controls for adjusting the output look up tables. Output look up tables affect the appearance of images displayed on the computer monitor.
- ❑ *Display Control Panel.* Provides controls for configuring the display of images. Controls are included for specifying video playback in *frame* mode or *line scan* mode; specifying the layout of image thumbnails; and selecting full screen or windowed image display during video playback.
- ❑ *Camera interface Control Panel.* Provides information describing the current camera interface and access to special configuration settings unique to the camera interface.
- ❑ *Image file types Control Panel.* Provides management of image file import/export modules (file filters). Image files can be imported and exported.
- ❑ *Networking Control Panel.* Provides management of *Slave* computers running Video Savant (Basic, Pro, or RTL) on a local area

network from the *Master* computer running Video Savant Pro. Once a *Slave* is selected video recording, playback, and image processing operations can be invoked on it from Video Savant Pro running on the *Master*.

Displaying multiple Control Panels

Video Savant can be configured to simultaneously show some or all of the available control panels.

❖ There are two ways to open a new control panel:

1. Click on the *Add Control Panel* button , located in the upper right corner of an already open panel. A new panel opens on the screen.
2. Access the *Quick Menu* by right-clicking inside the image viewing area and select *Add control panel*. A new panel opens on the screen.

To change the currently open control panel, simply click on the tab of the panel you wish to open.



Networking note: The *Master* cannot add or remove control panels on a *Slave*.

DVR Control Panel

The *DVR Control Panel* is used for image capture, video recording and video playback operations.

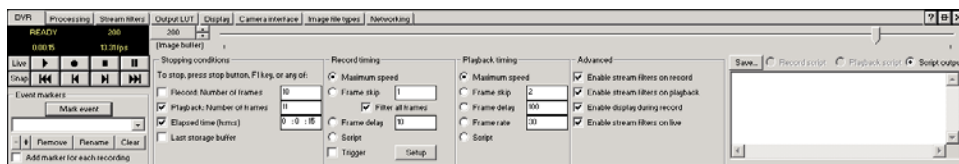


Figure 2.2: DVR Control Panel.

The *DVR Control Panel* allows the user to set specific **Stopping Conditions** for recording and playback. These stopping conditions include how many images to process, how long to record/playback images, and whether or not to stop recording/playing back images when the last buffer has been reached.

As well, the user can set up triggers, frame skips, and write Python scripts to control the recording of playback of images (see Chapters 4 and 5).

DVR Status Box

The *DVR Status Box* is located in the upper left corner of the *DVR Control Panel*. It is used to display recording and playback information.

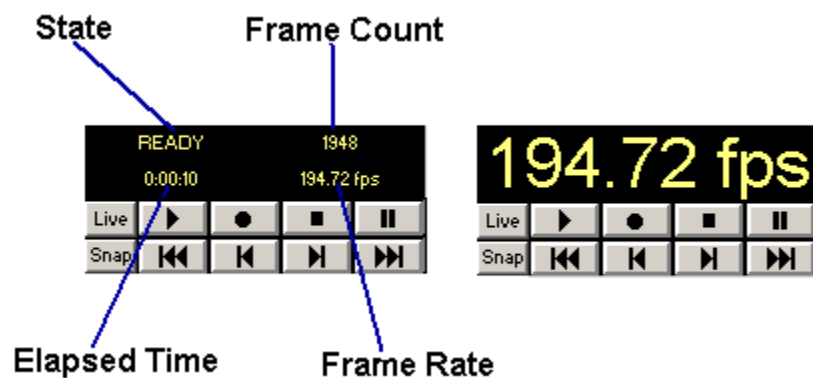


Figure 2.3: DVR Status Box.

❖ The DVR Status Box reports:

- ❑ *State.* The operating state is reported as **READY**, **RECORD** (video recording in progress), **PLAY** (video playback in progress), or **LIVE** (live video capture in progress).
- ❑ *Frame Count.* The number of frames captured or played. This counter is reset at the start of each *live*, *record* or *playback* operation.

- ❑ *Elapsed Time.* The elapsed time since the start of a *live*, *record*, or *playback* operation. This timer is reset at the start of the operation.
- ❑ *Frame Rate.* The instantaneous frame rate during a *live*, *record* or *playback* operation. At the conclusion of the operation, the last measured frame rate is displayed.

By clicking on any of the statistics in the *DVR Status Box*, that statistic alone will be shown in the *DVR Status Box* as shown above. To return to viewing all of the entries, simply click anywhere in the *DVR Status Box*.

See Chapter 4 for complete discussion of video recording.

See Chapter 5 for a complete discussion of video playback.

Processing Control Panel

The *Processing Control Panel* is typically used for image processing and analysis operations.

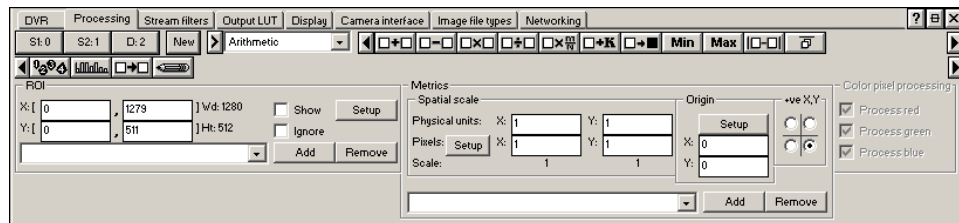


Figure 2.4: Processing Control Panel.

The *Processing Control Panel* allows the user to perform many operations on images such as arithmetic, analysis, and transformation operations. Custom operations can be added which perform image capture and display.

Programmers add custom operations to the *Processing Control Panel* using the Video Savant SDK (Software Development Kit). See Chapter 8.

The *ROI* (Region of Interest) limits the area within an image affected by image processing and analysis operations.

The *Metrics* settings allow a custom image coordinate system to be specified.

The *Color pixel processing* settings control which color components are affected by processing operations on color images.

See Chapter 6 for a full description of the *Processing Control Panel* and the standard image processing libraries in Video Savant Pro.

Stream Filters Control Panel

The *Stream filters Control Panel* is used for managing stream filters.

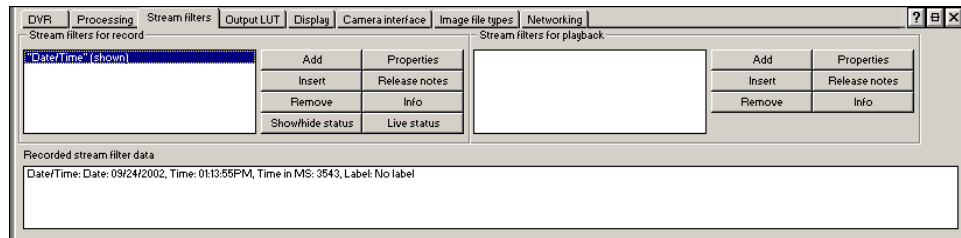


Figure 2.5: Stream filters Control Panel.

Stream filters allow recording (during video recording) and playback (during video playback) of additional data streams. Stream filters can also provide image processing during video recording or playback operations.

The *Stream filters Control Panel* is divided into two sections, one for recording and one for playback. For example, the user can configure a *Recording* stream filter to add information such as a time stamp to each image; and configure a *Playback* stream filter to perform an operation during playback of images such as overlaying a graph on top of the images as they are played back.

See Chapter 4, section Recording additional data streams and real time image processing.

Output LUT Control Panel

The *Output LUT Control Panel* is used to control the look up tables that are used for image display.

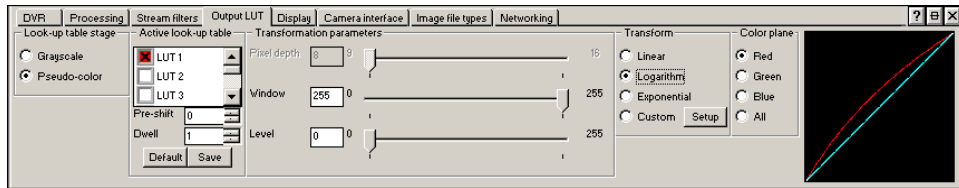


Figure 2.6: Output LUT Control Panel.

The *Output LUT Control Panel* provides the use of 8 separate look up tables to control image display.

The functionality of this control panel depends on the image type.

For 8-bit grayscale images, a pseudo color operation can be performed which transforms the grayscale pixel into a 24-bit RGB pixel.

For 9 to 16-bit grayscale images, there are two look up table stages. In the first stage (*Grayscale* stage), the 9 to 16-bit grayscale pixel is transformed to an 8-bit grayscale value. In the second stage (*Pseudo-color* stage), the 8-bit grayscale value is transformed into 24-bit RGB pixel.

For RGB color 24-bit images or any of the 16-bit RGB color image types, look up tables are not available.

Interactive controls are provided for adjusting the look up tables. As well, look up tables can be loaded from a file.

See Chapter 5, section Setting output look up tables.

Display Control Panel

The *Display Control Panel* is used for configuring settings related to image display.

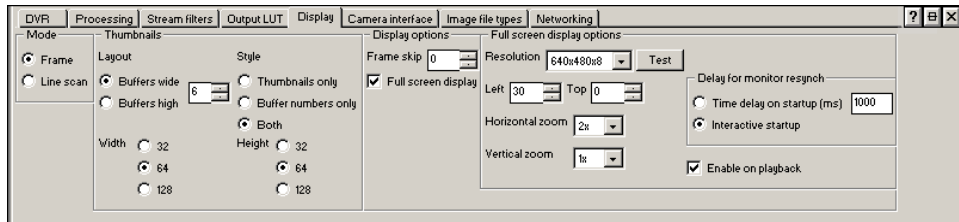


Figure 2.7: Display Control Panel.

The *Frame* and *Line scan* controls determine how video is advanced during video playback. *Frame* is normally used for cameras which capture images as two dimensional frames; playback shows the video as a movie. *Line scan* is normally used for line scan cameras. Line scan cameras capture one line of video at time. In *Line scan* mode, the video is continuously scrolled upward, displaying a *waterfall* effect.

The *Full screen-display* control causes the entire display screen surface to be used for displaying video during video recording and playback operations. After the recording or playback operation has completed, the display will revert to the normal Windows desktop. See Chapter 4, section Displaying live video at full screen size while recording.

Images can be displayed in Video Savant's image viewing area as full images or as thumbnails. Controls are provided in this control panel for configuring the layout and size of image thumbnails. See Chapter 2, sections Selecting an image viewing mode and Setting thumbnail size, layout, and display mode.

Camera Interface Control Panel

The *Camera Interface Control Panel* is used to report information such as camera interface driver version, driver release notes, etc. Special configuration settings unique to the currently selected camera interface can be made from this control panel.

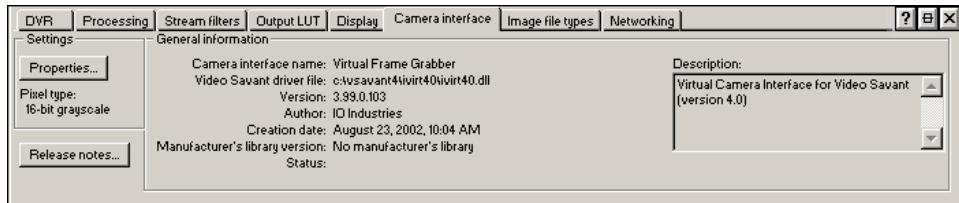


Figure 2.8: Camera interface Control Panel.

The **Properties** button in this control panel provides access to the special configuration window specifically designed for the camera interface. The possible configuration settings are discussed in the release notes for the camera interface. The release notes can be viewed by pressing the **Release Notes...** button in this control panel.

See Chapter 4, section Setting special camera interface configuration options.

Image File Types Control Panel

The *Image File Types Control Panel* is used to import and export images to image files, and to manage *File Filter* modules.

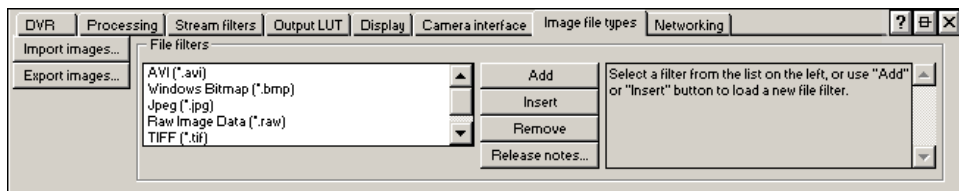


Figure 2.9: Image file types Control Panel.

The available image file types can be configured in this control panel. For each of the supported image file type, a Video Savant *File filter* module is installed. This control panel allows the management of file filters.

Video Savant includes file filters for the following image file types: AVI, Windows Bitmap, TIFF, JPEG, Raw Binary, and ASCII text. Custom file filters can be created using the Video Savant SDK. See Chapter 8.

See Chapter 3 for a complete discussion of working with image files.

Networking Control Panel

The *Networking Control Panel* manages the use of other computers running Video Savant on a local area network.

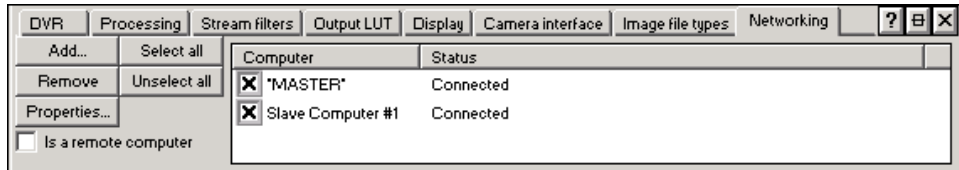


Figure 2.10: Networking Control Panel.

Once a computer (*Slave*) is selected for control by the *Master* computer, video recording, video playback, and image processing operations can be controlled by the *Master*. Commands issued using the Video Savant control panels of the *Master* will be invoked on all *Slaves*.

See Chapter 7 for a complete discussion of networking operations with Video Savant.

Status Line

The *Status Line* provides video file management operations and general status information.

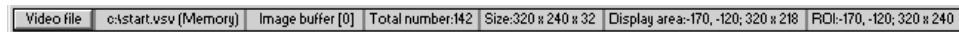


Figure 2.11: Video Savant Status Line.

Pressing the **Video file** button activates a menu from which video files can be opened, created, and have properties altered. This menu also lists an *Administrator* operation where advanced configuration operations are performed such as setting Video Savant's memory management parameters.

The general information reported on the *Status Line* includes the name of the active video file, the currently displayed or selected (in thumbnail mode) image buffer number, the number of image buffers available, the image buffer size, the display area size, and the region of interest position and size.

When interacting with an image during an image cursor operation, the status line shows information related to the cursor operation.

Quick menu

The *Quick menu* provides access to several common operations used in Video Savant.

To access the *Quick menu*, right click on the image viewing area of Video Savant.

❖ Quick menu options:

- ☐ Image buffer sequence selection (range, row, column, or all)
- ☐ ROI (Region of Interest) operations (select, ignore, show outline of, full ROI)
- ☐ Zoom in/out image display
- ☐ Import image(s) from a foreign image file type
- ☐ Import image(s) from a Video Savant stream file
- ☐ Import a stream filter data stream from a stream filter stream file
- ☐ Export image(s) to a foreign image file type
- ☐ Export image(s) to a Video Savant stream file
- ☐ Export a stream filter data stream to a stream filter stream file
- ☐ Print image(s)
- ☐ Clear image(s)
- ☐ Help
- ☐ Add a Control Panel

- ☐ Configure Control Panels (force control panels to be the same height)
- ☐ Set as master / slave

Setting the camera interface video format

The following procedure is necessary to allow the camera interface to communicate properly with the camera, and for Video Savant to communicate properly with the camera interface.

❖ Steps for setting the video format:

1. Read the driver release notes. See the section *Working with Device Selector...* Viewing camera interface driver release notes in this chapter. A section in the driver release notes describes the video format configuration instructions for your camera interface.
2. Close the Video Savant application.
3. The video format configuration instructions discussed in the driver release notes lists the name of the manufacturer's configuration application.
4. Refer to documentation supplied by the camera interface manufacturer for instructions on how to run the configuration application.
5. When the necessary configuration is made, close the configuration application.
6. Open the Video Savant application.
7. Open the *Camera Interface Control Panel* (see Chapter 2, section *Exploring the work area...Control panels*).

8. Press the **Properties** button. Make the settings described in the driver release notes.



Networking note: The video format can only be set on the local computer.

Creating new video files



This procedure differs when using the DVR Express camera interface. Please consult the DVR Express User's Manual.

❖ To create a new video file:

1. Press the **Video file** button. This button is located on the status line, in the lower left corner of the Video Savant window. To the immediate right of this button, the full path and name of the current video are displayed.
2. Choose **Open / create...** from the menu.
3. Choose the name and location of your new video file. It will be given the .vsv extension for "Video Savant Video" file
4. Press the **Open** button .
5. A window appears asking "Selected file does not exist. Create?". Press **OK** to continue.
6. To create your video file, you must provide some information. The first piece of information is the author name. Click **Next** to proceed.
7. Next you must choose the type of storage on your computer. **System memory** will allow image processing to run faster, but a limited amount of storage space is available in **System memory**. **Real-time disk** storage will not run as fast as **System memory**, but the storage space is only limited by the capacity of your video disk drive. If you

choose to use **System** memory, but you don't need to store your image buffers upon exiting Video Savant, check the **Disable save of RAM buffers to disk on shutdown** checkbox. Click **Next** to proceed.

8. Enter the size of the video file in Megabytes. If your storage space is **System memory**, Video Savant will suggest an appropriate size for the video file. Click **Next** to proceed.
9. Now you must specify whether your images will be compressed or not. If you want to store compressed image data, press the **Select compression...** button. The *Select compression filter* window will appear. If the compression filter you want is in the list, select it and press the **OK** button. Otherwise, press the **Add** button. If the **Add** button is pressed, a *Browse* window will appear in which the compression filter file must be located. Once you have selected a compression filter file, a configuration window will appear. Use this window to set the options specific to your particular compression filter. Before setting the compression settings of the video file, review the limitations of Video Savant when using compression. See Chapter 4, section Using image compression. Click **Next** to proceed.
10. Now you must decide if a conversion filter is needed. A conversion filter is used to convert foreign image formats such as Bayer color, and multi-tap formats to Video Savant's native image formats. See Chapter 5, section Working with foreign image formats (Bayer color, multi-tap, etc.). Press the **Select conversion...** button if you want to select a conversion filter. Once you have selected a conversion filter, a configuration window will appear. Use this window to set the options specific to your particular conversion filter. Click **Next** to proceed.
11. Finally, enter in any notes specific to this video file. Click **Finish** to start creating the video file.
12. A summary of your video file selections appears. Press **OK** to proceed.

13. The *Video File Initialization* window will appear, and initialization will begin. This procedure may take several minutes depending on the size of the video file, and the write-speed of the video drive.
14. A statistical summary of the write-speed of the video file will be generated. The write-speed is listed for each 1 Gigabyte (=1024 Megabytes) section of the video file. The write-speed statistics serve as a rough guide in determining if the video drive is fast enough to record video from the camera.
15. Close the window after video file initialization is completed.

If the above steps were successfully completed, the video file is now ready to use.

The below section *Measuring video drive write-speed* provides a more detailed analysis of the write-speed of the video drive.



Networking note: New video files can only be created on the local computer.

Opening an existing video file



This procedure differs when using the DVR Express camera interface. Please consult the DVR Express User's Manual.

❖ To open an existing video file:

1. Press the **Video File** button. This button is located on the status line, in the lower left corner of the Video Savant window. To the immediate right of this button, the full path and name of the current video are displayed.
2. Choose **Open / Create...** from the list provided.
3. Locate your existing **VSV** file and left-click to select it.

4. Click **Show Info** to display information about the settings of the selected video file before committing to using it.
5. Press the **Open** button.
6. A summary of the selected video file will appear on the screen. Press **OK** to use the selected video file.

If a valid video file was selected, the video file will now be ready to use.



Networking note: Video files can only be opened using the local computer.

Modifying the video file settings



This procedure differs when using the DVR Express camera interface. Please consult the DVR Express User's Manual.

❖ To modify the current video file settings:

1. Press the **Video File** button. This button is located on the status line, in the lower left corner of the Video Savant window. To the immediate right of this button, the full path and name of the current video are displayed.
2. Select **Current Video File Properties....**
3. A window appears allowing you to change the Author, Storage type, Size, Compression, Conversion, and Notes. To change any of these settings, press the **Setup** button next to the setting that you want to change. Before changing the compression settings of the video file, review the limitations of Video Savant when using compression. See Chapter 4, section Using image compression.

4. Press the **OK** button to accept your changes.



Networking note: The video file settings on a *Slave* computer cannot be altered from the *Master*. Video file settings can only be specified on the local computer.

Deleting video files



This procedure differs when using the DVR Express camera interface. Please consult the DVR Express User's Manual.

Delete a video file as you would any other file. Make sure that the setting for the *Recycle Bin* on the video drive is **Do not move files to the Recycle Bin. Remove files immediately on delete.**



Networking note: It is recommended that video files be deleted on the local computer, since new video files can only be created on the local computer.

Measuring video drive write-speed



This procedure differs when using the DVR Express camera interface. Please consult the DVR Express User's Manual.

An accurate measure of the write-speed of the video drive can be obtained. Note that the contents of the current video file will be **overwritten** by the following procedure:

1. Press the **Video File** button. This button is located on the status line, in the lower left corner of the Video Savant window. To the immediate right of this button, the full path and name of the current video are displayed.
2. A menu appears. Choose **Administrator....**

3. Press the **Benchmark video file** button. A confirmation window will appear informing you that the current video file will be overwritten by this operation. Press **OK** to continue.
4. The *Video File Benchmark* window will appear.
5. Enter the size of the portion of the video file in Megabytes (MB) over which the write-speed will be measured. The size entered must be less than or equal to the size of the current video file.
6. Next, select the block size to use for write-speed measurement. There are two options: measurement at *Multiple block sizes*; and measurement at a *Single block size*. Write-speed varies as a function of the block size. If you want to measure the write-speed for the block size corresponding to your video camera frame size, select *Single block size*, and enter the size of the video camera frame in Kilobytes. Selecting measurement at *Multiple block sizes* will measure the write-speed using a series of predefined block sizes.
7. Press the **Start** button to begin write-speed measurement.

The time required to perform the write-speed test is directly related to the video file size portion over which the measurement is performed. The write-speed test may take several minutes to complete.

The statistical summary generated by the write-speed measurement lists the write-speed as both a function of position in the video file; and frame data block size.

To determine if the video drive is fast enough to handle the data output rate of your video camera, you should perform the write-speed test using *Single block size*, setting the block size to match the size of your camera's video frame. If the write-speed at this data block size is less than the data output rate of your video camera, it will not be possible to record video in real-time.

The write-speed of the video drive can usually be increased by adding additional disks to the video drive disk set or by obtaining faster hard disks. If neither of these suggestions succeed, you will have to record video to

system memory instead of a video file. See the above section. Higher data rates can be recorded to system memory than a video drive.



Networking note: Video drive write speed can only be measured on the local computer.

Selecting the camera mode

Video Savant must have the camera mode set to **Frame** or **Line scan**.

❖ To select the mode of the camera:

1. Open the *Display Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Mode* control group, choose either **Frame** or **Line scan** depending upon your camera type and settings.
3. A window will appear asking you to confirm the switch to the selected mode. Press **OK** to continue.

Changing the display of the DVR Status Box

Video Savant allows for different Recording and Playback statistics to be shown in the *DVR Status Box*. See Chapter 2, section Exploring the work area...DVR Status Box.

❖ To view all of the DVR Status Box statistics:

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. If the *DVR Status Box* is only showing a single statistic (state, frame rate, frame count, or elapsed time), click on the statistic to show all of the statistics again.

❖ **To view a particular DVR Status Box statistic in full size:**

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. If the *DVR Status Box* is showing all of the statistics (state, frame rate, frame count, and elapsed time), click on any statistic and it will be displayed in full size.

Capturing a single video frame

If the preceding sections were successfully completed, you are now ready to begin capturing frames from your video camera.

❖ **To capture a frame in full-size imaging viewing mode:**

Push the **Snap** button on the *DVR Control Panel*. The currently displayed image buffer will receive the new video frame.

❖ **To capture a frame in thumbnail image viewing mode:**

1. Select the image buffer to receive the video frame by left-clicking on the associated thumbnail.
2. Push the **Snap** button on the *DVR Control Panel*.

Capturing continuous (live) video frames

To capture a live image when Video Savant is in full-size image viewing mode, press the **Live** button on the *DVR Control Panel*.

❖ **To capture an image when Video Savant is in thumbnail image viewing mode:**

1. Select the image buffer to receive the video frames by left-clicking on the associated thumbnail.

2. Press the **Live** button on the *DVR Control Panel*.
3. To stop live image display, push the **Live** button again.
4. During live image display, the frame rate (frames per second) will be displayed in green in the *DVR Status Box*.

Capturing a sequence of video frames

❖ To capture a sequence of video frames:

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Select thumbnail image viewing mode (see the section Selecting an image viewing mode in this chapter).
3. Select the first buffer in the sequence of buffers that you wish to record to.
4. In the *Record timing* control group, select **Maximum speed** to set up for real-time video recording.
5. In the *Stopping conditions* control group, check only the **Record: Number of frames** check box. In the **Record: Number of frames** box, enter the number of frames you want to capture.
6. To start video recording, press the *Record*  button.
7. Wait for video recording to complete. The mouse pointer will return to the normal pointer type when recording is complete.
8. Recording information will be displayed during the record operation in the *DVR Status Box*. The number of images recorded, the elapsed time and the recording frame rate (frames per second) will be displayed in green. When recording has completed, the recording information will be displayed in yellow.

Capturing consecutive lines from a line scan camera

In *Line Scan* mode, all image captures are stored in image buffers in the same way that frames are stored in image buffers in *Frame* mode. Because of this similarity, the steps for recording images in *Line Scan* mode are the same as the steps for capturing in *Frame* mode (see the section Capturing a sequence of video frames in this chapter).

Playing back a video frame sequence

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Select thumbnail image viewing mode (see the section Selecting an image viewing mode in this chapter).
3. Select the first buffer in the sequence of buffers that you wish to play back.
4. In the *Playback timing* control group, press the **Maximum speed** button to set up for playback of all frames in the sequence at the fastest speed.
5. In the *Stopping conditions* control group, check only the **Playback: Number of frames** check box. In the **Playback: Number of frames** box, enter the number of frames you want to play back.
6. To start video playback, press the *Play*  button.
7. Wait for video playback to complete. The mouse pointer will return to the normal pointer type when playback is complete.
8. Playback information will be displayed during the play operation in the *DVR Status Box*. The number of images played back so far, the playback frame rate (frames per second) and the elapsed time since the playback operation started will be displayed in green. When playback has completed, the playback information will be displayed in yellow.

Playing back a video line scan sequence

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Select thumbnail image viewing mode (see the section Selecting an image viewing mode in this chapter).
3. Select the first buffer in the sequence of buffers that you wish to playback.
4. In the *Playback timing* control group, press the **Maximum speed** button to set up for playback of all lines in the sequence at the fastest speed.
5. In the *Stopping conditions* control group, check only the **Playback: Number of lines** check box. In the **Playback: Number of lines** box, enter the number of lines you want to play back.
6. To start video playback, press the *Play*  button.
7. Wait for video playback to complete. The mouse pointer will return to the normal pointer type when playback is complete.
8. Playback information will be displayed during the play operation in the *DVR Status Box*. The total number of lines that have been displayed, the playback frame rate (lines per second) and the elapsed time since playback started will be displayed in green. When playback has completed, the playback information will be displayed in yellow.

Selecting an image viewing mode

❖ Video Savant offers two methods for viewing images:

- ☐ Full-size image viewing mode; and
- ☐ Thumbnail image viewing mode.

In *full-size image viewing* mode, the contents of one image buffer can be viewed. This mode is used to view images at full spatial resolution. Images can be zoomed in to show increased detail. See *Zooming image display* in this chapter.

In *thumbnail image viewing* mode, the contents of many image buffers can be viewed at the same time. The size of the thumbnail images can be controlled to increase or decrease the number of visible thumbnails. See *Setting thumbnail size, layout and display mode* in this chapter.

To toggle between image viewing modes, double-click anywhere in the imaging viewing area.

Setting thumbnail size, layout, and display mode

Image thumbnails are the small pictures displaying the contents of the image buffers in *thumbnail image viewing* mode.

❖ To set the size, layout and display mode of thumbnail images:

1. Open the *Display Control Panel* (see Chapter 2, section *Exploring the work area...Control panels*).
2. The **Width** and **Height** controls allow the width and height of the thumbnails to be set.

3. The **Layout** controls allow the number of displayed thumbnails to be constrained in the horizontal or vertical direction. To set the layout to a fixed number of vertical columns, select the **Buffers wide** control and enter the number of columns in the number entry box. To set the layout to a fixed number of horizontal rows, select the **Buffers high** control and enter the number of rows in the number entry box.
4. The **Style** controls provide three display styles:
 - *Thumbnails only*. The image buffers are shown. The image buffer number overlays are not shown.
 - *Buffer numbers only*. The image buffers are not shown. The image buffer number overlays are shown.
 - *Both*. The image buffers are shown. The image buffer number overlays are shown.

Zooming image display

❖ To zoom in the image display:

1. Select the image to zoom. If thumbnail image viewing mode is active, left click on the image to zoom. If full size image viewing mode is active, set the image display to the image buffer to be zoomed.
2. Activate the *Quick menu* (see the section Exploring the work area...Quick menu).
3. Choose **Zoom in** on the *Quick menu*. A second pop-up menu will appear from which you can choose to zoom by a preset magnification factor; or zoom by selecting area to magnify.
4. To zoom in by a preset magnification factor in both image dimensions, choose **×2**, **×4**, **×8**, or **×16** on the pop-up menu. Zooming is complete.

5. To zoom in on a specific area, choose **Select** on the pop-up menu.
6. Move the mouse (or use the arrow keys on the keyboard) to the position of one corner of the desired area to zoom (zoom area). Click the left mouse button (or press the *Space-bar* key) to set this position.
7. Move the mouse to set positions of the three other corners of the desired zoom area. Click the left mouse button (or press the *Space-bar* key) to set this position.
8. Move the mouse if you wish to translate the position of the zoom area.
9. If you wish to reset the zoom area position, left click and return to step 6 above; *or* if you wish to cancel the zoom area setting operation, press the *Escape* key; *or* if you wish to accept the selected zoom area, click the right mouse button (or press the *Enter* key).

❖ **To zoom out the image display:**

1. Select the image to zoom out. If thumbnail image viewing mode is active, left click on the image to zoom out. If full size image viewing mode is active, set the image display to the image buffer to be zoomed out.
2. Activate the *Quick menu* (see the section Exploring the work area...Quick menu).
3. Choose **Zoom out** on the *Quick menu*. A second pop-up menu will appear from which you can choose to zoom out by a preset magnification factor; or choose to return to **No zoom**.
4. To zoom out by a preset magnification factor in both image dimensions, choose **×1/2**, **×1/4**, **×1/8**, or **×1/16** on the pop-up menu. Zooming out is complete.

5. To return to a non-zoomed image, choose **No zoom** on the pop-up menu.

Erasing images

The entire contents (or a sub-window) of the image buffers can be erased (filled with pixel values of 0).

In thumbnail image viewing mode you can erase the contents of a sequence of image buffers. In full size image viewing mode, you can erase only the contents of the currently displayed image buffer.

❖ To erase images in thumbnail image viewing mode:

1. Select the image area to erase (see Chapter 6, section Setting a region of interest for image processing).
2. Select thumbnail image viewing mode (see the section Selecting an image viewing mode in this chapter).
3. Select the set of image buffers containing the images to erase (see the section Selecting an image buffer sequence in this chapter).
4. Activate the *Quick menu* (see the section Exploring the work area...Quick menu).
5. Choose **Clear images** (or press the *Delete* key). Pixels in the region of interest of the selected image buffer(s) will be erased.

❖ To erase images in full size image viewing mode:

1. Select the image area to erase (see Chapter 6, section Setting a region of interest for image processing).
2. Select full size image viewing mode (see the section Selecting an image viewing mode in this chapter).
3. Set the display to the image buffer you wish to erase.

4. Activate the *Quick menu* (see the section Exploring the work area...Quick menu).
5. Choose **Clear image** (or press the *Delete* key). Pixels in the region of interest of the currently displayed image buffer will be erased.

Printing images

Video Savant allows images to be output to a printer.

❖ To print an image:

1. Select the image area to print (see Chapter 6, section Setting a region of interest for image processing).
2. Select thumbnail image viewing mode (see the section Selecting an image viewing mode in this chapter).
3. Select the set of image buffers containing the images to send to the printer (see the section Selecting an image buffer sequence in this chapter).
4. Activate the *Quick menu* (see the section Exploring the work area...Quick menu).
5. Choose **Print images**. The *Print Images* window will appear.
6. The system printer to be used is listed. Press the **Setup...** button to choose paper size, orientation, tray, and other device specific options. The **Setup...** button will allow you to choose another system printer.
7. The set of image buffers to be printed can be modified using the **Print Range** controls. The options are:
 - *All ... images*. All image buffers will be printed.

- *Selection*. Only the selected image buffers will be printed.
 - *Images*. A range of image buffers as specified in the associated **From** and **To** controls will be printed.
8. If you are working with color images, but wish to produce monochrome output on a color printer, check the **Print color as monochrome** control box.
 9. The size of the image on the printed page can be modified with the **Scale** control.
 10. The printing resolution can be specified using the **Print quality** control.

Selecting an image buffer

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Press the **Image Buffer** button.
3. Enter the buffer number of the image you want to select.
4. If you are in thumbnail image viewing mode, the image buffer that you selected will be highlighted. If you are in full-size image viewing mode, the image buffer that you selected will be displayed.

Selecting an image buffer sequence

Many operations in Video Savant can be performed on a sequence of image buffers. Different techniques are available for making an image buffer selection.

❖ **To select a consecutive sequence of image buffers:**

1. Switch to *thumbnail image viewing* mode (see Selecting an image viewing mode in this chapter).
2. Activate the *Quick menu* (see the section Exploring the work area...Quick menu).
3. Choose **Select image range**.
4. Enter the first and last image buffers in the range. The selection will be highlighted with a red border around the thumbnails.

❖ **To select a sequence of image buffers using the mouse:**

1. Switch to *thumbnail image viewing* mode (see Selecting an image viewing mode in this chapter).
2. Click and drag using the left mouse button to make a selection of image buffers in the thumbnail viewer. The selection will be highlighted with a red border around the thumbnails.

❖ **To select a sequence of image buffers using the keyboard:**

1. Switch to *thumbnail image viewing* mode (see Selecting an image viewing mode in this chapter).
2. Press and hold down the *Shift* key on the keyboard. At the same time, use the arrow keys to make the selection. The selection will be highlighted with a red border on the thumbnails.

The *Quick menu* offers additional menu items for selecting: a single row; a single column; and all image buffers.

Finding an image

The image selector (below) is used to scroll through images at the user's pace.

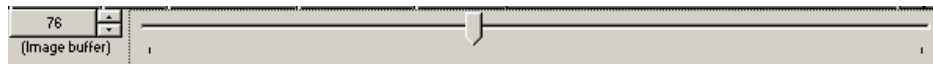
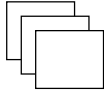


Figure 2.12: DVR Image Selector.

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Switch to *full-size image viewing* mode (see Selecting an image viewing mode in this chapter).
3. Click and hold down the mouse button on the image selector position marker.
4. Drag the position marker to the left to scroll through images in reverse and drag the position marker to the right to scroll through images in the forward direction.



Working with Image Files

Image files provide permanent storage of image data, and are the most basic mechanism for image interchange between Video Savant and other application software programs. This chapter discusses all aspects of working with image files. The *Image file types* control panel appears as shown below.

A Video Savant software module called a *file filter* handles image file import and export operations for an image file type. A separate file filter exists for each image file type.

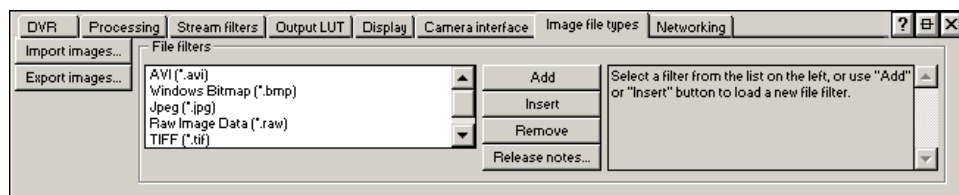


Figure 3.1: Image file types Control Panel.



Networking note: Images files can be imported and exported on the computers selected on the *Networking Control Panel*.

Importing images from files

❖ To import (read) an image or sequence of images from an image file:

1. Select the area within the image buffer(s) to receive the image data (see Chapter 6, section Setting a region of interest for image processing).

2. Select thumbnail image viewing mode (see Chapter 2, section Selecting an image viewing mode).
3. Select the set of image buffers which will receive the image(s) imported from the image file (see Chapter 2, section Selecting an image buffer sequence).
4. Activate the *Quick menu* (see Chapter 2, section Exploring the work area...Quick menu) and choose **Import, Import from image file**. Alternatively, open the *Image file types Control Panel* (see Chapter 2, section Exploring the work area...Control panels) and press the **Import images...** button.
5. The *Import from Image File* window will appear.
6. Select the folder containing the file to import.
7. In the **Files of type** control, select the type of image file you wish to open.
8. To obtain some additional information describing the contents of an image file before you open it, highlight the name of the image file, and press the **Show info** button. Press the **Close** button to return to the previous window.
9. Open the image file by highlighting the name of an image file and pressing the **Open** button. Alternatively, enter the name of the image file in the **File name** control, and press the **Open** button. If the file you have attempted to open contains a sequence of images, a window will appear in which you can select individual images to load. If the file does not contain an image sequence, the image will be loaded immediately.



Networking note: The selected computers will each attempt to import images from an image file with the same filename as that which is selected in the *Import from Image File* window. The search location depends on whether or not the *Master* computer is one of the selected computers:

- If the *Master* is selected, the *Master* will import from the image file at the specified path while the *Slaves* will each attempt to import from an image file with the same filename and path on its own local storage.
- If the *Master* is not selected, the *Import from Image File* window will open to the root directory of the first *Slave* computer in the list of selected computers on the *Networking Control Panel*. The *Master* must have file sharing permissions on the *Slave*.

Exporting images to files

❖ To export (write) an image or sequence of images to an image file:

1. Select the image buffer area to export image data from (see Chapter 6, section Setting a region of interest for image processing).
2. Select thumbnail image viewing mode (see Chapter 2, section Selecting an image viewing mode).
3. Select the image buffer(s) containing the image(s) which will be exported to the image file (see Chapter 2, section Selecting an image buffer sequence).
4. Activate the *Quick menu* (see Chapter 2, section Exploring the work area...Quick menu) and choose **Export, Export to image file**. Alternatively, open the *Image file types Control Panel* (see Chapter 2, section Exploring the work area...Control panels) and press the **Export images...** button.
5. The *Export to Image File* window will appear.
6. If you are in 16-bit grayscale mode and you want to save the images as 8 bit grayscale images using the current Output LUT settings, check the **Use Output LUTs to translate images to 8-bit** checkbox.

7. Select the folder to export the image file to.
8. In the **Save as type** control, select the type of image file you wish to create. If you are saving an image sequence, you may wish to select a file type that supports saving a sequence of images to a single file. To determine which file types support saving an image sequence (streaming), see the section Supported standard image file types in this chapter.

Alternatively, each image in the image sequence can be exported to a separate image file, with automatic name generation, by checking the **Save as multiple files** control.

9. Enter the name of the image file in the **File name** control, or select an existing image file from the current folder, and press the **Save** button. If you selected an existing image file, you may be given the option to append to the image data to the end of the image file. For some file types, a window may appear showing additional file save options.



Networking note: Images can only be exported from the first computer selected on the list of computers in the *Networking Control Panel*. To direct a *Slave* to export images to its local storage, deselect the *Master* on the *Networking Control Panel*, and enable file sharing permissions for the *Master* on the *Slave*.

Supported standard image file types

Video Savant supports many of the standard image file types common to other application software programs.

The supported standard file types are:

File Type	ASCII, American Standard Code for Information Interchange
Image Types	8-bit grayscale; 24-bit color 9 ...16-bit grayscale converted to 8-bit grayscale
Multi-Image	Yes
Compression	No
Compatibility	Standard text type

File Type	AVI, Audio Video Interleave
Image Types	8-bit grayscale; 24-bit color 9 ...16-bit grayscale converted to 8-bit grayscale
Multi-Image	Yes
Compression	Optional; Lossy and lossless; Uses installed video compression codecs
Compatibility	Standard Windows movie file type

File Type	BMP, Windows Device Independent Bitmap
Image Types	8-bit grayscale; 24-bit color 9 ...16-bit grayscale converted to 8-bit grayscale
Multi-Image	No
Compression	No
Compatibility	Standard Windows graphic file type

File Type	JPEG, Joint Picture Experts Group
Image Types	8-bit grayscale; 24-bit color 9 ...16-bit grayscale converted to 8-bit grayscale
Multi-Image	No
Compression	Yes; Lossy; Adjustable compression ratio
Compatibility	Popular in graphics and photo editing application software

File Type	RAW, Raw binary stream
Image Types	8-bit grayscale; 9 ...16-bit grayscale; 24-bit color
Multi-Image	Yes
Compression	No

Compatibility	Popular in image processing application software
File Type	TIFF, Tagged Image File Format
Image Types	8-bit grayscale; 9 ...16-bit grayscale; 24-bit color
Multi-Image	Yes
Compression	Optional; Lossless; LZW compression
Compatibility	Revision 5.0; Popular in graphics, photo editing, and image processing application software

Importing images from unknown or unsupported file types

If you are attempting to open an image file not listed in the section Supported standard image file types in this chapter, you may still be able to read image data from the file.

❖ For image data to be read data from an unsupported image file type, the following conditions must be true:

- ☐ The image file cannot be compressed; and
- ☐ The pixel format must be:
 - 8-bit grayscale (1 byte/pixel);
 - 9...16-bit grayscale (2 bytes/pixel); or
 - 24-bit color (3 bytes/pixel), red-green-blue or blue-green-red.

❖ To read the image file data:

1. Follow the instructions in the section Importing images from files in this chapter, setting the file type to *RAW*.
2. Proceed to open the image file. After pressing the **Open** button in the *Import from Image File* window, the *Choose Raw File Format*

window will appear. The following discussion describes the remaining procedure for importing image data from the file.

There are two methods for importing the image data from the file. In the first method, the user directly specifies file format information such as the image size and the starting location of image data in the file. In the second method, file format information is read from the header section of the image file.

❖ **Method 1: Read image data without using file header information**

1. Press the **All** button so that no image data be will be read from a header.
2. Set the type of pixel in the **Pixel type** control.
3. Set the width of the images in the **Image width** control.
4. Set the height of the images in the **Image height** control.
5. Set the **Byte offset** control. This is the offset of the image data from the start of the file.
6. Set the **Number of images** control. Set this value to 1 if the file has only 1 image, or if only the first image in a multi-image file is to be read.
7. If you wish to save the settings you have entered, press the **Save file format** button, and save the settings to a configuration file for later use.
8. Press the **OK** button in the *Choose Raw File Format* window when all the settings have been set.
9. A window will appear allowing you to select images from the file you wish to import.

If the file does not load correctly, you can repeat the above procedure, experimenting with different settings.

❖ **Method 2: Read image data using file header information**

1. Press the **None** button so that all image information will be read from the header or footer (If some of the image information is not stored in the header/footer, check the appropriate box and specify the proper values).
2. In the **Header location** control, select **Start of file** if your image file has a header or **End of file** if your image file has a footer.
3. In the field controls, specify which fields (pieces of information) are stored in the header/footer. The fields are used for Image Width, Image Height, Bits per Pixel and Number of Images. For each field, you must set the number of bytes used to store each value. Use the field setting Reserved/Unused for portions of the header that are not used. After all fields are set, the **Total size of header in bytes** value must match the actual number of bytes in the header.
4. If you already have a saved header/footer format, press the **Load Header Format** button, and load the settings from your saved configuration file.
5. If you wish to save the settings you have entered, press the **Save Header Format** button, and save the settings to a configuration file for later use.
6. Press the **OK** button in the *Choose Raw File Format* window when all settings have been set.

Exporting images to RAW file type

❖ To store the image file data:

1. Follow the instructions in the section Exporting images to files in this chapter, setting the file type to *RAW*.
2. Proceed to save the image file. After pressing the **Save** button in the *Export to Image File(s)* window, the *File Save - Header/Footer Information* window will appear. The following discussion describes the remaining procedure for exporting image data to the file.

There are two methods for exporting the image data to the file. In the first method, no header or footer is created. In the second method, the user saves file format information such as the image size and the starting location of image data as a header or footer in the image file.

❖ Method 1: Save image data without creating a file with header/footer information

1. In the Header/Footer Location control, select **None (File contains raw data only)**
2. Set the type of pixel you wish to save the images as in the **Pixel Depth** control.
3. Press the **OK** button to finish saving the file.

❖ Method 2: Save image data creating a file with header/footer information

1. In the Header/Footer Location control, select **Start of File (Header)** if you want to store image information in a file header, or **End of File (Footer)** if you want to store image information in a file footer.

2. Set the type of pixel you wish to save the images as in the **Pixel Depth** control.
3. In the Header/Footer Details control, using the field controls, specify which fields (pieces of information) you want to store in the header/footer. The fields are used for Image Width, Image Height, Bits per Pixel and Number of Images. For each field, you must set the number of bytes used to store each value. Use the field setting Reserved/Unused for portions of the header/footer that are not used.
4. If you already have a saved header/footer format, press the **Load Header Format** button, and load the settings from your saved configuration file.
5. If you wish to save the settings you have entered, press the **Save Header Format** button, and save the settings to a configuration file for later use.
6. Press the **OK** button to finish saving the file.

Adding new or updated file types

New or updated file types can be added to the list of file types shown in the *file type* control in the *Import from Image File* and *Export to Image File* windows.

❖ To add the new or updated file type:

1. Open the *Image file types Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Press the **Add** button to add a file filter to the end of the **File filters** list. To insert a file filter before the end of the list, highlight an item in the list of filters, and press the **Insert** button to insert the new filter. The *Select File Filter DLL* window will appear.
3. Select the file filter DLL file.

4. Press the **Open** button.



Networking note: When a file filter is selected for installation on a *Slave*, the *Slave* will attempt to locate the file filter DLL file on the *Slave* computer's hard drive where Video Savant is installed. The *Slave* will search for the file filter in the Video Savant installation directory and its subdirectories.

❖ **Note: If you are unable to view files of type .dll:**

1. Start the Windows file exploring application by right-clicking on the Windows **Start** button and choosing **Explore**;
2. Choosing **Tools** on the main menu;
3. Choosing **Folder Options** on the pop-up menu;
4. Clicking on the **View** tab in the *Options* window; and
5. Selecting **Show hidden files and folders** in the *Hidden files and folders* control group.

Removing file types

File types can be removed from the list of file types shown in the *file type* control in the *Import from Image File* and *Export to Image File* windows.

❖ **To remove a file type:**

1. Open the *Image file types Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Highlight the file type you wish to remove from the **File filters** list.
3. Press the **Remove** button.



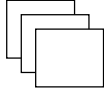
Networking note: The file filter will be removed from the file filter list on the selected computers.

Viewing file filter release notes

File filter release notes can be viewed from the list of file types shown in the *Image file types Control Panel*.

❖ To view file filter release notes:

1. Open the *Image file types Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Highlight the file type you wish to see the release notes for in the **File filters** list.
3. Press the **Release Notes ...** button.



Video Acquisition and Recording

The principal use of Video Savant is real-time uncompressed digital video recording. A variety of tools for video recording have been included, which in the simplest case allow the user to start and stop video recording by pushing a *Record* and *Stop* button, and in sophisticated applications allow control via an external trigger signal; simultaneous recording of additional data streams; real-time image processing; and automation of a series of video recording tasks by using a script language.

❖ The topics discussed in this chapter are:

- ❑ User controlled video recording;
- ❑ Trigger controlled video recording;
- ❑ Simultaneous recording of additional data streams (e.g. GPS, IRIG-B, data acquisition, and sound);
- ❑ Real-time image processing of a video stream;
- ❑ Video recording using image compression;
- ❑ Automating a set of video recording tasks; and
- ❑ Advanced camera interface configuration.

All video recording and playback operations are performed using the *DVR* control panel, shown below.

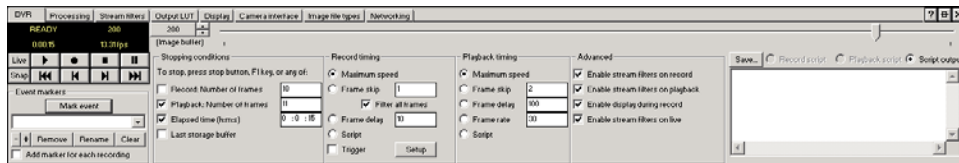


Figure 4.1: DVR Control Panel.



Networking note: Unless otherwise indicated in this chapter, changing a setting for video recording on the *Master* computer will affect the selected *Slave* computers. Video recording operations will be executed on the computers selected on the *Networking Control Panel*.

The *DVR Status Box* is located in the upper left corner of the *DVR Control Panel*. See Chapter 2, section Exploring the work area...DVR Status Box for a discussion of the *DVR Status Box*.

Recording a video stream

The procedure for user-controlled recording of a real-time video stream is described in Chapter 2, section Capturing a sequence of video frames.

Video Savant can be configured for uncompressed or compressed video recording. To learn more about recording with image compression, please read the section Using image compression in this chapter.

The following sections discuss the methods for controlling the video recording frame rate, stopping a recording, displaying video while recording, and marking events of interest that occur during recording.

Setting the recording rate

In many situations, it is desirable to record a video stream at speeds slower than real-time. Video Savant includes a control for setting the video recording speed. Before learning how to use this control, a basic understanding of camera operating modes is required.

There are two general operating modes for video cameras: *free run* and *single shot*. In *free run* mode, the camera captures and transmits frames to the

camera interface at a constant rate. In *single shot* mode, the camera waits for a control signal from the camera interface to tell it when to capture a frame. It is important to know the operation mode of your camera to properly control the video recording speed.

❖ **To set the video recording speed:**

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Record timing* control, there are five options for controlling the rate at which frames are recorded: **Maximum speed**, **Frame skip**, **Frame delay**, **Trigger**, and **Script**. The purpose of each control is discussed below.
 - **Maximum speed** control. Choose this option to record video at the frame rate (or line rate for line scan cameras) of the camera.
 - **Frame skip** control. Choose this option for precise recording speed selection when operating a camera in *free run* mode.

For example, setting the control to 1 causes every second frame to be recorded, while frames in between are discarded. In general, if the frame rate of the camera is F frames per second, and the value for frames to skip is S frames, then the effective recording speed is $F \div (S + 1)$ frames per second.

This control should not be used for cameras running in *single shot* mode.

The **Filter all frames** control is used in conjunction with the **Frame skip** control. If the **Frame skip** is set to 1, normally all of the stream filters will only be applied to every second frame. However, if you want to apply the

stream filters to every incoming frame from the camera, check the **Filter all frames** checkbox.

- **Frame delay** control. Choose this option to specify a time delay between each image capture. This value is specified in milliseconds and should be at least twice the frame time. Please note that using the frame delay feature will not guarantee that there is an equal amount of time between every captured frame.

Precise control of arbitrary frame delay is only possible for cameras with an asynchronous frame reset capability. A camera operating in asynchronous frame reset mode will acquire a new frame immediately upon receiving an electronic trigger. Some cameras require that the camera interface supply the electronic trigger over the camera data cable while others have a separate external trigger input.

Please consult the camera user's guide to determine if the camera has an asynchronous frame reset capability. To determine if your camera interface supports triggering, see Chapter 4, section Setting special camera interface configuration options.

- **Trigger** control. This checkbox enables the user to control video recording by the use of a trigger. The **Trigger** feature can be used with the **Maximum Speed**, **Frame skip**, or **Frame delay** controls. For detailed information on how to use the triggering feature see section Video recording control using an external trigger in this chapter.
- **Script** control. Choosing this option will cause a series of tasks in a script to be executed whenever the *Record* button is pressed. For detailed information on how to use the scripting feature, see the section Automating a set of video recording tasks using Python scripts in this chapter.

Stopping a recording (or playback)

Video Savant provides the user with many different ways to set a stopping condition for recording or playback. If more than one stopping condition is selected, the recording or playback operation will halt after any one of the selected stopping conditions occurs.

Stopping conditions are ignored when the *Record timing* or *Playback timing* is set to **Script**.

The *F1* key on the computer keyboard and the *Stop*  button can always be used to stop video recording and playback, as well as the stopping conditions discussed below.

❖ To set the stopping conditions:

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the Stopping conditions control, there are four conditions that can be set as stopping conditions for recording/playback operations: **Record: Number of frames**; **Playback: Number of frames/lines**; **Elapsed time (h:m:s)**; and **Last storage buffer**. These stopping conditions can be set in any combination.

The purpose of each control is discussed below:

- **Number of frames** control. Sets the maximum number of frames that should be recorded before stopping the record operation.
- **Number of frames/lines** control. If Video Savant is set to **Frame** mode, (see Chapter 2, section Selecting the camera mode) the **Playback: Number of frames** control is used to set the maximum number of frames that should be played before stopping the playback operation. Otherwise, if Video Savant is set to **Line scan** mode, the **Playback: Number of lines** control is used to set the maximum number of lines that should be played before stopping the playback operation.

- **Elapsed time (h:m:s)** control. This control is used to specify the maximum amount of time that the record/playback operation should take before stopping. The user must specify the hours, minutes, and seconds in the control.
- **Last storage buffer** control. This control is used to specify that the record/playback operation should stop after recording or playing the last storage buffer. Leave this control unchecked if you want the record/playback operation to loop around to the first storage buffer and continue the operation after reaching the last storage buffer.

Displaying live video while recording

❖ To display video while recording:

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the Advanced control, check the **Enable display during record** control. To disable this feature, simply uncheck the control box.

Attention! Avoiding Frame Drops During Recording:



This discussion differs when using the DVR Express camera interface. Please consult the DVR Express User's Manual.

Displaying live video during recording can result in some frames not being recorded (i.e. frame drops). When this occurs, it is because the computer system lacks sufficient computing power to perform both image display and video recording, simultaneously.

After *live video display during recording* is enabled, it is important to note the impact on frame rate. Check the *Frame Rate* indicator in the *DVR Status Box* during or after a video recording operation to see if the recording frame rate

has been reduced. See Chapter 2, section Exploring the work area...DVR Status Box for details on the *DVR Status Box*.

If the recording frame rate is lowered after *live video display during recording* has been enabled, then frame drops are occurring.

Frame drops can be reduced and sometimes completely eliminated, by lowering the rate at which frames are displayed. Lowering the display frame rate reduces the load on the computer system, leaving more resources for the video recording operation. Video recording will proceed independently at the frame rate specified in the *Record timing* controls on the *DVR Control Panel*.

❖ **To set the display frame rate:**

1. Open the *Display Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Display options* control area, locate the **Frame skip** control and enter the number of consecutive frames to skip between each captured frame that is displayed. A setting of 0 means that all frames will be displayed. A setting of 1 indicates every other frame will be displayed. A setting of n indicates 1 frame in every $(n+1)$ captured frames will be displayed.

Displaying live video at full screen size while recording

During record and playback operations, images can be displayed using the full screen, hiding the Windows desktop.

The *Display Control Panel*, shown below, provides the controls for configuring full screen display.

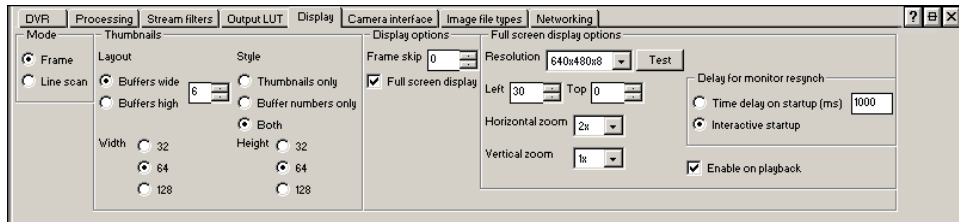


Figure 4.2: Display Control Panel.



Networking note: An attempt will be made to apply the settings on the *Display Control Panel* to each of the computers selected on the *Networking Control Panel*.

❖ **To use the full screen display for record/playback:**

1. Open the *Display Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Display options* control, check the **Full screen display** control.
3. Set the monitor resolution of the screen (see below for details).
4. Select the portion of the image that you want to view (see below for details).

❖ **To set the monitor resolution:**

1. Open the *Display Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Full screen display options* control, locate the **Resolution** control, and select the monitor resolution (width × height × pixel depth) that you want to use for full screen display.
3. In order to test if the selected monitor resolution will work on your monitor, press the **Test** button. A test screen will appear.

The solid line in the test screen represents the display area of the monitor. The dotted line represents where on the monitor the image is going to be displayed in full screen display.

If you do not see a dotted line on all four sides of the screen, the full image will not fit on the screen using the selected resolution setting. This test ignores the horizontal and vertical zoom settings.



Networking note: If a screen resolution is selected on the *Master* that is not available on a *Slave*, the closest resolution will be selected on the *Slave*.

❖ To set the sub-area of the image to view:

In full screen display mode, Video Savant can display a sub-area of an image buffer. This is useful when the size of an image buffer exceeds the monitor resolution.

1. Open the *Display Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Under the *Full screen display options* control, locate the **Left** control, and enter the offset, in pixels, to the left edge of the image sub-area to be displayed.
3. In the **Top** control, enter the offset, in pixels, to the top edge of the image sub-area to be displayed.

❖ To zoom in the image display:

1. Open the *Display Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Under the *Full screen display options* control, locate the **Horizontal zoom** control, and select the horizontal zoom factor.
3. In the **Vertical zoom** control, select the vertical zoom factor.

❖ To set a delay before starting full screen image display:

In full screen display mode, there is certain latency, typically 1 to 3 seconds, required for the monitor to resynchronize after the screen resolution is changed. Video Savant allows the display of video to be suspended until the monitor is resynchronized.

1. Open the *Display Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Under the *Delay for monitor resynch* control, select one of the following options:
 - i. **Time delay on startup (ms)**: Image display will commence after a specified period of time elapses. The time is specified in milliseconds; or
 - ii. **Interactive startup**: A prompt will appear requiring confirmation by the user before commencing with image display.



Networking note: When using full screen display, the selected *Slaves* must always have the *Delay for monitor resynch* set to **Time delay on startup(ms)**. If *Interactive startup* is selected, and a record or playback operation is performed, the *Slaves* will not be able to be controlled because the *Interactive startup* cannot be started by the *Master*.

Marking events of interest while recording

Video Savant provides the ability to mark events while recording so that the image buffer where an event occurred can be quickly accessed after a recording operation completes.

An event marker can be set manually during recording, or automatically whenever a recording is started.



Networking note: The only event marker operations that can be used on the *Master* computer to control the *Slave* computer is the **Mark event** operation

and the **Clear** events operation.

The -, +, **Remove**, and **Rename** operations affect only the *Master* computer. If an event marker is selected from the *Event markers* drop down list, the selection will only be applied to the *Master* computer.

❖ **To set an event marker while recording:**

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Press the *Record*  button to start recording
3. In the *Event markers* control, press the **Mark event** button. The current image buffer is now marked as an event.

❖ **To insert event markers whenever a recording is started:**

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Event markers* control, check the **Add marker for each recording** control. Each time a recording starts, the first image buffer recorded to will be inserted into the event marker list. These event markers are automatically assigned the name *Record*.

❖ **To display the image buffer for an event marker:**

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Event markers* drop down list control, select the event marker marking the image buffer that you want to view. Press the  button, and the  button to increment and decrement the selected event marker.

❖ **To rename an event marker:**

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Select the event marker to rename from the *Event markers* drop down list control.
3. Press the **Rename** button.
4. Enter the new name for the event marker.

❖ **To remove an event marker:**

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Event markers* control, open the drop down list and select the image buffer that you wish to remove as an event.
3. Press the **Remove** button.

Video recording control using an external trigger

In some situations, it is desirable to start and stop video recording by means other than the *Record* and *Stop* buttons on the *DVR Control Panel*. This external input is referred to as an external trigger.

❖ **External triggers can be categorized based on which device in the vision system they are connected to:**

- ☐ Triggers sent directly to the camera;
- ☐ Triggers sent directly to the camera interface; and
- ☐ Triggers sent to the computer (and not the camera interface).

This section discusses the third case listed above, *Triggers sent to the computer*.

To configure a trigger to work directly with a camera or camera interface, separate procedures must be followed for configuring the trigger. These procedures are outlined below.

❖ **To configure a trigger to work directly with a camera:**

1. Consult the documentation supplied by the camera manufacturer for information on how to connect a trigger to the camera.
2. For some cameras, a camera configuration application supplied by the manufacturer must be run to configure the camera to work with the external trigger.
3. It may be necessary to configure the camera interface (i.e. frame grabber) to operate in a *free run* mode where it slaves to the output of the camera. Consult the documentation supplied by the camera interface manufacturer.
4. To acquire images in Video Savant, press the *Record*  button on the *DVR Control Panel*. A single image will be acquired whenever a trigger is sent to the camera.

❖ **To configure a trigger to work directly with a camera interface:**

1. Consult the documentation supplied by the camera interface manufacturer for information on how to connect a trigger to the camera interface (i.e. frame grabber).
2. Open Video Savant.
3. Select the *Camera Interface Control Panel*.
4. Press the *Properties* button.

5. In the *Properties* window, locate the controls associated with triggering. If none are apparent, view the camera interface driver release notes (see Chapter 2, section Working with Device Selector... Viewing camera interface driver release notes).
6. To acquire images in Video Savant, press the *Record*  button on the *DVR Control Panel*. A single image will be acquired whenever a trigger is sent to the camera interface.

The following subsections describe the procedures for configuring a trigger input to the computer.

Accessing the trigger configuration controls

❖ To access the controls for configuring an external trigger:

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Record timing* control group, check the **Trigger** checkbox.
3. Press the **Setup** button next to the **Trigger** checkbox.

The *Record triggering* controls are shown below.

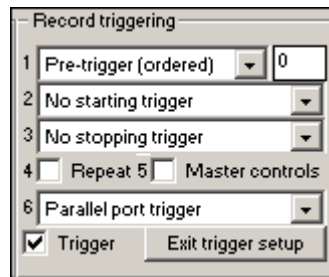


Figure 4.4: The Record triggering controls.

A trigger can be designated as occurring on the rising edge or the falling edge of a trigger pulse. The following diagram illustrates this concept.



Figure 4.3: Trigger Pulses.

Selecting the external trigger type

❖ The following types of external triggers inputs to the computer are supported:

- ☐ Electronic signal (TTL pulse) connected to parallel port;
- ☐ Passive electronic switch connected to parallel port; and
- ☐ Keyboard keys **Esc**, **Space Bar**, **F2** through **F9**.

❖ To select the external trigger type:

1. Access the trigger configuration controls. See the above section Accessing the trigger configuration controls.
2. Control **6** lists the possible triggers. Select a trigger type from the list.
3. This trigger will be used as the starting and stopping trigger.

Connecting an external trigger to the parallel port

The parallel port *LPT1*: can be monitored to sense an external trigger.

A schematic drawing of the parallel port triggering circuit is shown below. There are two possible configurations: *trigger by closing switch*; and *trigger using a TTL signal*.

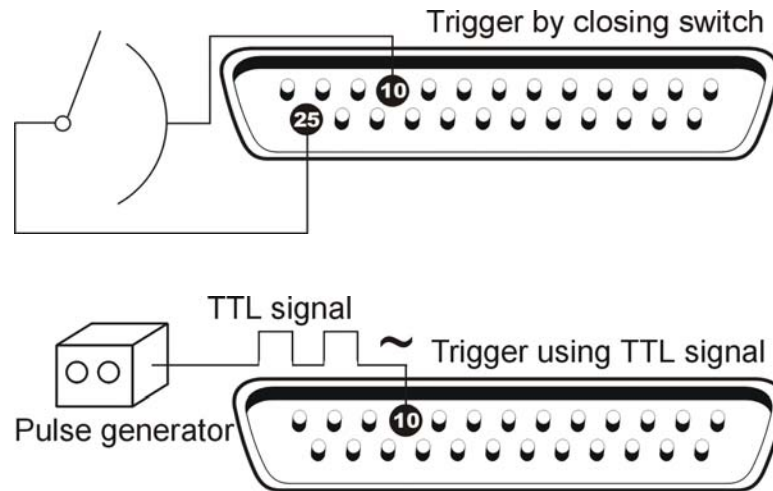


Figure 4.5: Parallel port connection diagrams for passive switch, and pulse generator trigger sources.

❖ **To set up for an external trigger to the parallel port:**

1. A special driver must be installed to allow for parallel port triggering. The steps for installing this driver are:
 - Close the Video Savant application.
 - Choose **Run** from the **Start** button on the Windows desktop.
 - Open the INSTTRIG.EXE application in the Video Savant installation directory.
 - Re-start Windows after installation is complete.
2. Access the trigger configuration controls. See the above section Accessing the trigger configuration controls.
3. In the *Record triggering* control group, open control **6**. Select **Parallel port trigger**.

4. To set the starting trigger settings, follow the steps for *Starting recording on external trigger* in this chapter.
5. To set the stopping trigger settings, follow the steps for *Stopping recording on external trigger* in this chapter.
6. Press the **Record**  button. Recording will commence according to the trigger settings in response to triggers sent to the parallel port.

Starting recording on external trigger

1. Access the trigger configuration controls. See the above section *Accessing the trigger configuration controls*.
2. Control **2** lists the options to specify a starting trigger for recording. If you want to start recording immediately when the *Record* button is pressed, select **No starting trigger**. If you want to start recording on the rising edge of the trigger pulse, select **Record on rising edge**. If you want to start recording on the falling edge of the trigger pulse select **Record on falling edge**.
3. To set the actual trigger to use as the starting trigger, see section *Selecting the external trigger type* in this chapter.
4. If you want to use the recording trigger continuously until the *Stopping conditions* are met, check the **Repeat** checkbox.
5. Press the *Record*  button. Recording will start when the selected starting trigger event occurs and recording will stop when the *Stopping conditions* are met or the selected stopping trigger event has occurred. If the **Repeat** checkbox is checked, recording will continuously start and stop based on the selected starting and stopping trigger events, and recording will finally stop when any one of the *Stopping conditions* is met.



Networking note: To enable triggers sent to the *Master* to also trigger the *Slave* computers, check the **Master controls** checkbox control. To set *Slave* computers to respond only to triggers sent directly to the *Slave* computers, uncheck the **Master controls** checkbox control.

Stopping recording on external trigger

1. Access the trigger configuration controls. See the above section *Accessing the trigger configuration controls*.
2. Control **3** lists the options for a stopping trigger for recording. If you do not want to use a stopping trigger, select **No stopping trigger**. If you want to stop recording on the rising edge of the trigger pulse, select **Stop on rising edge**. If you want to stop recording on the falling edge of the trigger pulse select **Stop on falling edge**. If you want to stop recording as soon as a single buffer is captured, select **Stop after one image** buffer. It is important to note that the *Stopping conditions* still apply even if you are using a stopping trigger.
3. To set the actual trigger to use as the stopping trigger, see section *Selecting the external trigger type* in this Chapter.
4. If you want to use the recording trigger continuously until the *Stopping conditions* are met, check the **Repeat** checkbox.
5. Press the *Record*  button. Recording will start when the selected starting trigger event occurs and recording will stop when the *Stopping conditions* are met or the selected stopping trigger event has occurred. If the **Repeat** checkbox is checked, recording will continuously start and stop based on the selected starting and stopping trigger events, and recording will finally stop when any one of the *Stopping conditions* is met.

Recording video frames prior to a starting trigger

When using a trigger to start recording, you can setup Video Savant to record to a separate set of “pre-trigger” image buffers before receiving a trigger.

After a video frame is captured and stored to the last of a set of image buffers, the process can be automatically repeated to provide *circular* video recording. The circular video recording begins at the current buffer and the number of buffers in the circular video is configurable. The user can choose to reorder the buffers after the recording has finished, if desired.

1. Access the trigger configuration controls. See the above section Accessing the trigger configuration controls.
2. Control **1** lists the Pre-trigger buffer options. If you do not want to use Pre-trigger buffers, select **No pre-trigger**. Otherwise, if you want to use Pre-trigger buffers, select **Pre-trigger (ordered)** or **Pre-trigger (unordered)**. If you select the "ordered" option, the images in the Pre-trigger buffers will be reordered after the recording has ended. The "unordered" option will leave the images in the buffers they were captured in.
3. The Pre-trigger buffers edit box will be active if a **Pre-trigger** option is selected. Enter in the number of buffers that you want to use for the **Pre-trigger** buffers.
4. If you want to use the recording trigger continuously until the *Stopping conditions* are met, check the **Repeat** checkbox.
5. Press the *Record*  button. Recording will start when the selected starting trigger event occurs and recording will stop when the *Stopping conditions* are met or the selected stopping trigger event has occurred. If the **Repeat** checkbox is checked, recording will continuously start and stop based on the selected starting and stopping trigger events, and recording will finally stop when any one of the *Stopping conditions* is met.

Recording additional data streams and real-time image processing

It is sometimes necessary to perform additional operations while recording or playing back video.

❖ **Types of operations that occur simultaneously with video recording/playback:**

- ☐ Processing frames from the video stream (i.e. image averaging, background subtraction); and
- ☐ Recording additional data streams such as GPS (Global Positioning System) along with the video stream.

The Video Savant imaging engine invokes special software modules known as *Stream Filters* to perform operations that occur simultaneously with video recording/playback.

❖ **There are two ways in which stream filters can interact with the video stream:**

- ☐ Read and/or modify frame data in the video stream; and
- ☐ Append data to each frame in the video stream.

As shown in the diagram below, the video stream passes into the host computer memory, and is then directed through each stream filter before being recorded to memory or disk during recording, or displayed during playback

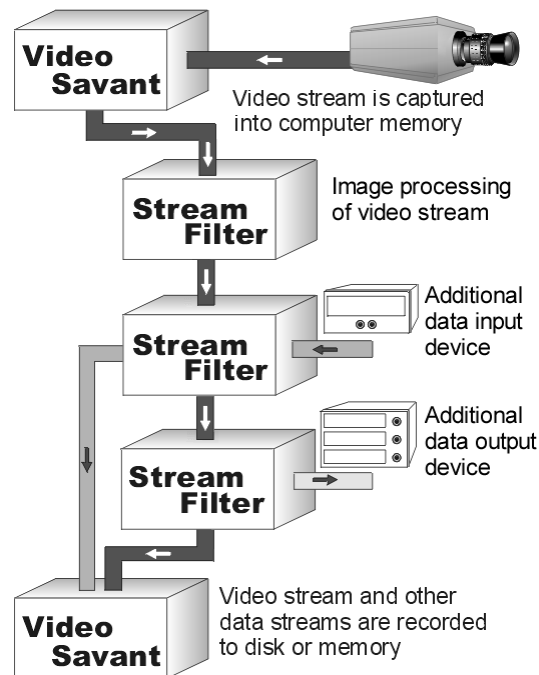


Figure 4.6: Real-time image processing and data stream I/O using stream filters.

Multiple stream filters can be present; the order in which the stream filters are accessed is configurable. For example, two stream filters could be configured to perform a background subtraction, displaying the processed frames. The first stream filter performs the subtraction, modifying the frame data; the second filter displays the modified frame data. Video Savant includes stream filters for both of these operations. For a description of these and other stream filters, see the section *Stream filter library* in this chapter.

Some stream filters which record additional streams of data can have the data visualized in the **Recorded stream filter data** list in the *Stream filters Control Panel* of Video Savant (see sections *Viewing stream filter data after recording* and *Viewing stream filter data during live video capture* in this chapter). The *Stream filters* control panel appears as shown below.

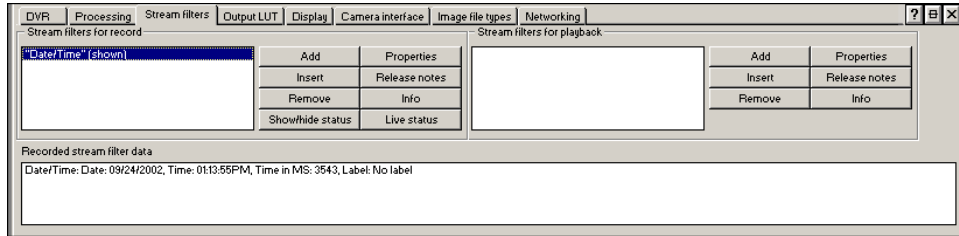


Figure 4.7: Stream filters Control Panel.



Networking note: The *Master* can install, remove, and configure stream filters on *Slaves*.

Installing a stream filter

❖ To install a stream filter:

1. Open the *Stream filters Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Stream filters for record* or *Stream filters for playback* control group, press the **Add** button to add a stream filter to the end of the list (To insert a stream filter before the end of the list, highlight an item in the list of filters, and press the **Insert** button to insert the new filter). The *Add Stream Filter DLL* window will appear.
3. Select the stream filter DLL file.
4. Press the **Open** button.



Networking note: When a stream filter is selected for installation on a *Slave*, the *Slave* will attempt to locate the stream filter DLL file on the *Slave* computer's hard drive where Video Savant is installed. The *Slave* will search

for the stream filter in the Video Savant installation directory and its subdirectories.

❖ **Note: If you are unable to view files of type .dll:**

1. Start the Windows file exploring application by right-clicking on the Windows **Start** button and choosing **Explore**;
2. Choosing **Tools** on the main menu;
3. Choosing **Folder Options** on the pop-up menu;
4. Clicking on the **View** tab in the *Options* window; and
5. Selecting **Show hidden files and folders** in the *Hidden files and folders* control group.

Removing a stream filter

❖ **To remove a stream filter:**

1. Open the *Stream filters Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Stream filters for record* or the *Stream filters for playback* control group, highlight the stream filter item you wish to remove from the list.
3. Press the **Remove** button.



Networking note: The stream filter will be removed from the stream filter list on the selected computers.

Configuring a stream filter

A stream filter may have configuration options.

❖ To view and set stream filter configuration options:

1. Open the *Stream filters Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Stream filters for record* or the *Stream filters for playback* control group, highlight the stream filter you wish to configure.
3. Press the **Properties** button (or double-click on the name of the stream filter). The stream filter release notes may provide additional information for setting stream filter properties (see section Viewing stream filter release notes in this chapter).



Networking note: Configuration settings will be applied to the stream filter on the selected computers.

Viewing stream filter data after recording

After video recording is complete, the data recorded by a stream filter may, in some cases, be viewed as text information on a line in the **Recorded stream filter data** control. When a frame is selected for viewing, the data associated with the stream filter(s) is formatted and displayed.

❖ To view the stream filter data:

1. Open the *Stream filters Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. The stream filter data for the currently selected image is displayed in the **Recorded stream filter data** control.

3. If the data is not displayed in the **Recorded stream filter data** control, select the stream filter in the list and press the **Show/hide data** button. Pressing the **Show/hide data** button again will hide the stream filter data.

Viewing stream filter data while recording

Using the *Stream filters* control panel, you can choose to view stream filter data as it is recorded (during sequence recording and in live image capture). This option is selected individually for each active stream filter.

1. Open the *Stream filters Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Select a stream filter from the *Stream filters for record* list.
3. Press the *Live status* button.

When a stream filter is configured for live data display during recording, the word “live” appears at the beginning of that stream filter’s line in the **Recorded stream filter data** control. Only stream filters used for recording will have their data shown in this box. During playback, recorded stream filter data is always updated for every stream filter with each frame displayed.

Viewing the stream filter data as text is useful for some stream filters, but not applicable for others. Some stream filters, therefore, do not display any information in the **Recorded stream filter data** control. For stream filters such as the *GPS* stream filters, which records data values for global position and time, displaying the stream filter data is applicable. However for stream filters such as the *Process* stream filter, which is used only for processing images in the video stream, there are no data values to be viewed.

Exporting stream filter data to a file

Stream filters which record a data stream can have the data stream exported to a separate data file after recording is finished.

❖ **To export the stream filter data:**

1. Select the image buffers with associated stream filter data intended for export.
2. Activate the *Quick menu* (see Chapter 2, section Exploring the work area...Quick menu).
3. Choose **Export** on the *Quick menu*. A second menu will appear.
4. Choose **Export to stream file...** on the second menu.
5. If only one data stream recording stream filter is active, a window will appear allowing you to save the stream filter data. If more than one data stream recording stream filter is active, a preliminary window will appear allowing you to specify the data streams to export. Once the streams are selected, a window will appear for each data stream to allow the filename to be chosen for each data stream independently.

Importing stream filter data from a file

Stream filters which has been exported to a file can then be imported into selected buffers at a later time.

❖ **To import the stream filter data:**

1. Select the image buffers for which you want to import stream filter data.
2. Activate the *Quick menu* (see Chapter 2, section Exploring the work area...Quick menu).
3. Choose **Import** on the *Quick menu*. A second menu will appear.
4. Choose **Import from stream file...** on the second menu.

5. If only one data stream recording stream filter is active, a window will appear allowing you to open the stream filter data file. If more than one data stream recording stream filter is active, a preliminary window will appear allowing you to specify the data streams to import. Once the streams are selected, a window will appear for each data stream to allow the stream filter data file to be opened for each data stream independently.

Viewing stream filter release notes

Additional configuration and usage information may be found in the release notes document accompanying each stream filter.

❖ To view the stream filter release notes:

1. Open the *Stream filters Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Stream filters for record* or the *Stream filters for playback* control group, highlight the stream filter of interest.
3. Press the **Release notes** button.

Viewing stream filter general information

The stream filter general information can include such information as author, location, creation date, version number, size of data and description of the stream filter.

❖ To view the stream filter general information:

1. Open the *Stream filters Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Stream filters for record* or the *Stream filters for playback* control group, highlight the stream filter of interest.

3. Press the **Info** button. The general information for the selected stream filter will be displayed in a window.

Enabling/Disabling stream filters during recording

❖ To enable/disable the record operation stream filters:

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Advanced* control group, check the **Enable stream filters on record** control to enable the operation of stream filters during recording, or uncheck the control to disable the operation of stream filters during recording. The **Enable stream filters on playback** and **Enable stream filters on live** controls operate in the same way.

Enabling/Disabling stream filters during live video capture

❖ To enable/disable the record operation stream filters:

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Advanced* control, check the **Enable stream filters on live** control to enable the operation of stream filters during live video acquisition, or uncheck the control to disable the operation of stream filters during live video acquisition. The **Enable stream filters on playback** and **Enable stream filters on record** controls operate in the same way.

Stream filter library

Stream filters can be divided into two groups: Stream filters for recording additional data streams from data input devices; and Stream filters for real-time image processing.

The following tables list the stream filters that were included with Video Savant at the time this manual printed. For a current list, visit our website at <http://ioindustries.com>.

❖ Stream filters for data input devices:

Data Input Device	Filename	Data type
Computer clock (high-precision performance counter)	DATETIME.DLL	date, time in ms, user-defined text label
JXI2 Inc., <i>SyncClock-16</i> (GPS receiver; ISA card)	SYNCLK16.DLL	GPS (global position, time, # satellites, etc.)
JXI2 Inc., <i>SyncClock-32</i> (GPS receiver; PCI card)	SYNCLK32.DLL	GPS
Novatel Inc. 3951 (GPS receiver; ISA card; uses RS-232 serial port for data input)	NOVATEL.DLL	GPS
Satloc Inc. <i>SLX GPS</i> (GPS receiver; RS-232 serial port interface)	SATLOC.DLL	GPS
Trimble Inc. <i>AG132</i> (GPS receiver; RS-232 serial port interface)	TRIMBLE.DLL	GPS
TrueTime Inc. <i>GPS PCI 2</i> (GPS receiver; PCI card)	TRUETIME.DLL	GPS
TrueTime Inc. <i>PCI-SG 2</i> (IRIG-B receiver; PCI card)	TRUETIME.DLL	IRIG-B (broadcast time)
JXI2 Inc., <i>SyncClock-16</i> (IRIG-B receiver; ISA card)	SYNCLK16IRIG.DLL	IRIG-B

Laser Atlanta Inc. (Altimeter; RS-232 serial)	LASERALTIMETER.DLL	Altitude
Watson Industries Inc. (Inertial navigation measurement; RS-232 serial)	WATSONBOX.DLL	Inertial navigation data
Data Translation Inc., <i>DT-300 Series</i> (Analog data acquisition; PCI card)	DTFILT.DLL	Analog data samples; 8-bit or 16-bit; sampling rate up to 100 KHz; multiplexed channels
Agilent Technologies 34970A (Analog data acquisition/switch unit with National Instruments GPIB PCI card)	MUXFILT.DLL	Analog data samples; 120 channels; 6½ digit DMM (22 bits) resolution; 250 ch/sec
Sound card (Windows compatible)	SOUND.DLL	Mono or stereo sampling; multiple sampling rates up to 44.1 KHz

❖ **Stream filters for real-time image processing:**

Filename	Processing operation
PROCESS.DLL	Real-time image processing: arithmetic; Boolean logic; binarize; morphology; and convolution
AVERAGE.DLL	Real-time image averaging

	Stream filters which process the incoming video stream can be used, but only unprocessed image data will be stored on the DVR Express's hard disks.
---	--

See the release notes for a stream filter for detailed information describing the configuration and operation of the stream filter. To view the release notes, see Recording additional data streams and real-time image processing... Viewing stream filter release notes in this chapter.

Using image compression



Image compression is not available when using the DVR Express camera interface.

By default, Video Savant stores image data in a video file in the uncompressed data format that is captured by the camera interface. In some applications, the storage configuration required to store all of the uncompressed image data captured from a video camera may be too costly, or physically too large. To address this problem, Video Savant allows images to be stored using image compression.

Image compression can greatly reduce image storage requirements. For example, when the *Wavelet* image compression technique included with Video Savant is configured for a 10:1 compression ratio on typical images (e.g. a human face) and the images are decompressed for viewing, there is an almost indiscernible difference to the human eye as compared to viewing an uncompressed version of the same image.

Image compression can be *lossy* or *lossless*. With lossless compression, the decompressed image data is identical to the image data originally captured from the camera interface. With lossy compression, the decompressed image data differs from the original image data. Video Savant supports both lossy and lossless compression techniques.

Compression filters are the plug-in DLL modules in Video Savant which provide image compression and decompression. The procedures for selecting, configuring, adding and removing compression filters are discussed in the sections below.

❖ The following observations and limitations apply when using image compression:

- ❑ *CPU performance requirement.* The computer's CPU (central processing unit) speed must be fast enough to perform the image compression operation in real-time. If it is not, frames will be missed during recording.

The time required to compress an image can be affected by the content of an image. It is therefore recommended that test recordings be performed on imagery that is closely representative of the application. After making a test recording, the images should be examined to determine if frames were dropped.

- ❑ *Recordings sequentially stored.* New image recordings must always be appended to the end of the video file. Images from previous recordings cannot be overwritten.
- ❑ *No image overwriting.* Images in a compressed video file cannot be processed and overwritten. Images cannot be imported from an image file. Images can be exported to image files.

Selecting a compression filter

A compression filter is normally selected when a video file is first created. The procedure for creating a video file and selecting a compression filter is described in Chapter 2, section *Creating new video files*. In most cases, selecting a new compression filter will result in the current images being destroyed.

❖ To select a compression filter after a video file has been created:

1. Press the **Video file** button on the *Status* bar. A pop-up menu will appear.
2. Choose **Current video file properties** on the pop-up menu. The *Video file properties* window will appear.
3. Find the **Setup** button associated with **Compression**, and press it. The *Select/configure Compression filter* window will appear.
4. Press the **Select compression...** button. The *Select Compression Filter* window will appear.

5. In the list of installed compression filters, select a compression filter by clicking on it.
6. Press the **OK** button to select the filter or press **Cancel** to cancel the operation.
7. If the compression filter has any settings associated with it, a window will appear allowing you to make settings for the compression filter.
8. Press **OK** in each of the open windows to accept changes.

Configuring a compression filter

❖ To configure a compression filter:

1. Press the **Video file** button on the *Status* bar. A pop-up menu will appear.
2. Choose **Current video file properties** on the pop-up menu. The *Video file properties* window will appear.
3. Find the **Setup** button associated with **Compression**, and press it. The *Select/configure Compression filter* window will appear.
4. Press the **Configure compression...** button. A window will appear from which settings can be made for the current compression filter.
5. Make the appropriate settings in the compression filter configuration window.
6. Press **OK** in each of the open windows to accept changes.

NOTE: Some settings may require the current images to be erased. Video Savant will warn the user before destroying any images.

Adding a compression filter

❖ To add a new compression filter:

1. Press the **Video file** button on the *Status* bar. A pop-up menu will appear.
2. Choose **Current video file properties** on the pop-up menu. The *Video file properties* window will appear.
3. Find the **Setup** button associated with **Compression**, and press it. The *Select/configure Compression filter* window will appear.
4. Press the **Select compression...** button. The *Select Compression Filter* window will appear.
5. Press the **Add...** button. A window will appear from which the compression filter DLL file can be selected.
6. Select the compression filter DLL and press the **Open** button.
7. Press **OK** in each of the open windows to accept changes.

❖ Note: If you are unable to view files of type .dll:

1. Start the Windows file exploring application by right-clicking on the Windows **Start** button and choosing **Explore**;
2. Choosing **Tools** on the main menu;
3. Choosing **Folder Options** on the pop-up menu;
4. Clicking on the **View** tab in the *Options* window; and
5. Selecting **Show hidden files and folders** in the *Hidden files and folders* control group.

Removing a compression filter

❖ To remove a compression filter:

1. Press the **Video file** button on the *Status* bar. A pop-up menu will appear.
2. Choose **Current video file properties** on the pop-up menu. The *Video file properties* window will appear.
3. Find the **Setup** button associated with **Compression**, and press it. The *Select/configure Compression filter* window will appear.
4. Press the **Select compression...** button. The *Select Compression Filter* window will appear.
5. In the list of compression filters, select a compression filter by clicking on it.
6. Press the **Remove** button. The selected compression filter is removed.

Compression filter library

Below is a list of compression filter(s) that were included with Video Savant at the time this manual was printed. Please visit the IO Industries website for a current list of compression filters.

❖ Compression filters included with Video Savant:

Filename	Compression method
WAVELET.DLL	Wavelet transform; lossy; 8 quality settings; supports 8-16 bit grayscale, 24-bit RGB, and 16-bit YUV

Automating a set of video recording tasks using Python scripts

In cases where a set of video recording tasks must be repeatedly executed, for example, a well-defined experimental procedure, the tasks can be defined in a script, and the script can be invoked from the *DVR Control Panel* in Video Savant.

Scripts can be created and edited using the *DVR Control Panel*. The script language used is *Python*. For general information about the Python script language, refer to <http://www.python.org>. A basic knowledge of computer programming is sufficient to be able to develop Python scripts.

Video Savant extends the Python script language with a special set of functions that control much of the functionality of Video Savant. Functions are available for video recording, video playback, image file import/export, and image processing.

See the document *Video Savant Python Library* installed in the Video Savant folder for a complete list of Video Savant Python functions.

Script commands

Video Savant includes a comprehensive set of functions to control video recording, video playback, image file import/export and image processing from a Python script.

The following table summarizes the Video Savant Python functions for image capture.

Video Savant Python Functions for Image Capture	
iRecord	Capture a single frame or sequence of frames. Supports triggering, frame skipping, and frame delays.
iRecordUntilElapsedTime	Capture an image sequence at maximum frame rate for a specified amount of time.

iRecordUntilLastStorageBuffer	Capture an image sequence at maximum frame rate until the last storage buffer has been reached.
iRecordUntilNumberOfFrames	Capture an image sequence at maximum frame rate until the number of frames specified have been captured.
iGrabContinuousStart	Start live video display.
iGrabContinuousStop	Stop live video display.
iGrabFrame	Capture a single frame.

Please refer to the document *Video Savant Python Library* installed in the Video Savant folder for a complete list of Video Savant Python functions.

Creating a new script

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Record timing* control group, choose **Script**.
3. The *Record timing* control group has been replaced by the *Record script* control group.
4. Press the **New** button.
5. Locate the edit box control on the far right of the control panel. Enter the script in this edit box.

Opening an existing script

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Record timing* control group, choose **Script**.

3. The *Record timing* control group will have been replaced by the *Record script* control group. If the desired script has been opened before, it will be shown in the drop down list. If the desired script is shown in the drop down list, select it and skip to step 7 below.
4. Press the **Select script ...** button.
5. A window appears allowing the user to browse for a saved Python script. Python scripts always have the file extension *.py*.
6. After the saved script is located, press **Open**.
7. The script appears in the edit box on the far right of the control panel. The script can be directly edited here.

Saving a script

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Record timing* control group, choose **Script**.
3. Select **Record script**. This control is located near the top right corner of the control panel.
4. Press the **Save...** button. If the script has been saved before, a message will appear asking the user if the script should be saved under the same name. Otherwise a *Browse* window will appear in which the filename and folder where the script will be saved can be specified.

Running a script

1. Follow the instructions in the above section of Creating a new script or Opening an existing script.
2. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).

3. Press the *Record*  button. The selected record python script will begin to execute. The script will run until all lines of code have been executed. *Stopping conditions* are not used to determine when the script will end.
4. To view the python script output, select **Script output**. You can switch back to the record script by selecting **Record script**.

Viewing script output messages

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Above the scripting edit box on the far right of the control panel, choose **Script output**.
3. To save the script output, press the **Save** button. A window will appear which will enable the user to select an appropriate file name for the script output.

Example script

The following python script demonstrates video recording.

```
import vspython
print "This example captures two sequences of 6"
print "images each and adds them together."
print "Recording Source 1 sequence of images"
iRecordUntilNumberOfFrames(0, 6)
print "Recording Source 2 sequence of images"
iRecordUntilNumberOfFrames(6, 6)
print "Performing Arithmetic Addition operation"
iAdd(0, 5, 6, 11, 12, 17)
```

First, the script captures 6 images in buffers 0 through 5 and then captures 6 images in buffers 6 through 11. Next, the script performs an arithmetic **Add** on the two sequences of 6 buffers and stores the resulting images in buffers 12 through 17.

For additional example scripts, refer to the document *Video Savant Python Library* installed in the Video Savant folder.

Setting special camera interface configuration options

All camera interfaces have the ability to acquire images from at least one type of camera. However, some camera interfaces provide additional functionality to adapt to special camera modes, or to manipulate image pixel values before an image is sent to the host computer memory for processing and storage by the Video Savant imaging engine.

The *Camera interface Control Panel* in Video Savant provides access to controls for configuring the specialized features of a camera interface. Press the **Properties** button to show the *Properties* window which contains the controls for configuring specialized features.

The *Properties* window for a camera interface varies widely between frame grabbers. An attempt has been made to categorize the controls under consistently named tabs in the window.



Networking note: Settings for a *Slave's* camera interface cannot be made using the *Camera interface Control Panel* on the *Master*. A *Slave's* camera interface must be configured locally.

❖ Specialized features commonly found on camera interfaces and the *Properties* window tabs used to access them:

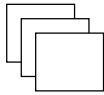
- ☐ *General tab*. Typical settings are: selection of the active camera interface in systems where more than one of this camera interface type is installed; active video input connector for camera interfaces with multiple video inputs; pixel type specification; and acquisition timeout period.
- ☐ *ADC tab*. Some camera interfaces that capture from analog video cameras can precondition the video signal before it is digitized. Typical settings are: gain; offset; brightness; contrast; saturation; and hue.

- ❑ *Camera Select tab.* This tab is intended for specification of a video format possibly by the selection of a video timing configuration file.
- ❑ *Input Look up Table tab.* This tab provides access to controls for setting the *Input Look up Table*, if present, on a camera interface. An *Input Look up Table* reassigns pixel values in the captured image according entries in a table.
- ❑ *Acquisition Scaling tab.* These controls are used to set the number of rows and columns in the captured image.

The *Properties* window for a particular camera interface may include some or all of the tabs described above. Additional tabs may be present to control other unique features of the camera interface.

❖ To control specialized features:

1. Open the Video Savant application.
2. Open the *Camera interface Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
3. Press the **Properties** button. The *Properties* window will appear. Information describing the purpose of each tab can be found in the preceding discussion and in the release notes for the camera interface driver. To view the release notes, see Chapter 2, section Working with Device Selector... Viewing camera interface driver release notes.



Video Display and Playback

Video display and playback are key aspects of Video Savant. As such controls have been provided to adjust video playback timing, set output look up tables, and manage the conversion of foreign image formats into formats that can be displayed by Video Savant.

Data recorded by stream filters during video recording can in many cases be simultaneously displayed on the *Stream filter Control Panel* during video playback. Stream filters can also be used to process images during playback to reveal additional information about each image.

In situations where a series of playback operations must be repeatedly performed, the procedure can be automated using a script language.

❖ The topics discussed in this chapter include:

- ❑ Additional controls for playback;
- ❑ Displaying stream filter data during playback;
- ❑ Processing images in the video stream during playback;
- ❑ Setting output look up tables;
- ❑ Working with foreign image formats; and
- ❑ Automating a set of video playback tasks.

Video playback operations are performed using the *DVR* control panel, shown below.

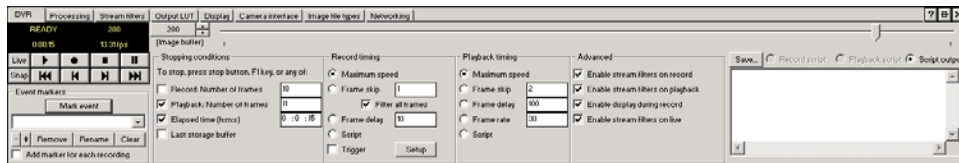


Figure 5.1: DVR Control Panel.



Networking note: Unless otherwise indicated in this chapter, changing a setting for video playback on the *Master* computer will affect the selected *Slave* computers. Video playback operations will be executed on the computers selected on the *Networking Control Panel*.

Playing back a video stream

The procedure for user-controlled playback of a video stream is described in Chapter 2, sections Playing back a video frame sequence and Playing back a video line scan sequence.

The following sections discuss advanced methods for controlling video playback.

Basic controls for video playback

The basic controls for video playback are found on the *DVR Control Panel* and are shown below.

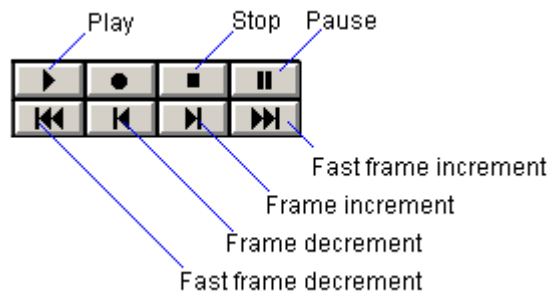


Figure 5.2: Basic controls for video playback as found on the *DVR Control Panel*.

❖ **Purpose of the basic video playback controls:**

Control	Operation
 Play	Press to initiate playback.
 Stop	Press to stop playback.
 Pause	Press to suspend playback. Press again to resume playback.
 Frame increment	Press and hold to slowly increment the displayed image buffer.
 Fast frame increment	Press and hold to display every tenth image buffer.
 Frame decrement	Press and hold to slowly decrement the displayed image buffer.
 Fast frame decrement	Press and hold to display every tenth image buffer, decrementing the image buffer number.

Setting the playback frame rate

The maximum rate of video playback is dictated by the performance capabilities of the computer system and video storage media. In many situations, it is desirable to playback a video stream at rates slower than the maximum possible rate. Video Savant includes a control for setting the video playback rate.

❖ **To set the playback frame rate:**

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Playback timing* control group, there are five options for controlling the rate at which frames are played: **Maximum speed**; **Frame skip**; **Frame delay**; **Frame rate**; and **Script**. The purpose of each option is discussed below.
 - **Maximum speed** control. Choose this option and the playback frame rate will be as fast as the computer system allows.

- **Frame skip** control. This control is used to increase the apparent playback rate by skipping frames during the playback process.

If this control is set to 1, every other frame will be excluded from playback, and playback will occur at an apparent rate of approximately twice the maximum rate possible when no frames are skipped. As is the case with the other controls for selecting speed, the maximum frame rate that can be achieved depends on the hardware performance of components in the computer system.

In general, setting the value for frames to skip to S frames, results in an apparent playback rate of approximately $((S + 1) \cdot M)$ frames per second; where M is the maximum rate possible when no frames are skipped.

- **Frame delay** control. This control is used to specify a precise delay between each image that is played back. This value is specified in milliseconds.
- **Frame rate** control. This control is used to set the playback speed to 1 frame per second or faster.

The maximum frame rate which can be achieved depends on the hardware performance of components in the computer system. The key factors are CPU speed, display controller performance, and when operating in *Disk* recording mode, the video drive speed. If a frame rate is requested which exceeds the hardware capabilities of the computer system, the actual playback rate will be reduced.

- **Script** control. This control enables the user to control video playback by the use of a Python script. For detailed information on how to use the scripting feature see the section Automating a set of video playback tasks using Python scripts in this chapter.

Increasing the apparent playback frame rate by skipping frames

The apparent playback rate can be increased by periodically skipping frames in the sequence of frames to be played. For instance, by skipping every other frame, the apparent playback rate will double.

The setting for skipping frames that are displayed during playback (or record) are found on the *Display Control Panel*, shown below.

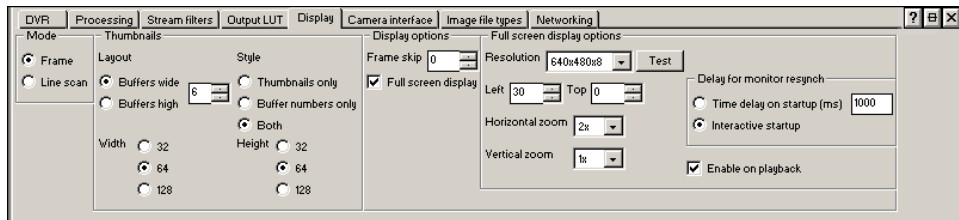


Figure 5.3: Display Control Panel.



Networking note: An attempt will be made to apply the settings on the *Display Control Panel* to each of the selected computers on the *Networking Control Panel*.

❖ To set frame skipping:

1. Open the *Display Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Display options* control area, locate the **Frame skip** control and enter the number of consecutive frames to skip between each frame that is displayed. A setting of 0 means that all frames will be displayed. A setting of 1 indicates every other frame will be displayed. A setting of n indicates 1 frame in every $(n+1)$ frames will be displayed.

The preceding discussion applies when the display mode is set to *Frame* mode, but not when the display mode is set to *Line scan* mode.

Setting the playback line rate

The *Playback timing* controls can also be used for setting the line rate during video playback.

❖ To set the playback line rate:

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Playback timing* control group, there are five options for controlling the rate at which frames are played: **Maximum speed**; **Line skip**; **Line delay**; **Line rate**; and **Script**. The purpose of each control is discussed below.
 - **Maximum speed** control. Choose this option and the playback frame rate will be as fast as the computer system allows.
 - **Line skip** control. This control is used to increase the apparent playback rate by skipping lines during the playback process.

If this control is set to 1, every other line will be skipped during playback, and playback will occur at an apparent rate of approximately twice the maximum rate possible when no lines are skipped. As is the case with the other controls for selecting speed, the maximum line rate which can be achieved depends on the hardware performance of components in the computer system.

In general, setting the value for lines to skip to S lines results in an apparent playback rate of approximately $((S + 1) \cdot M)$ lines per second; where M is the maximum rate possible when no lines are skipped.

- **Line delay** control. This control is used to specify a precise delay between each line that is played back. This value is specified in milliseconds.
- **Line rate** control. This control is used to set the playback speed to 1 line per second or faster.

The maximum line rate which can be achieved depends on the hardware performance of components in the computer system. The key factors are CPU speed, display controller performance, and when operating in *Disk* recording mode, the video drive speed. If a line rate is requested which exceeds the hardware capabilities of the computer system, the actual playback rate will be reduced.

- **Script** control. This control enables the user to control video playback by the use of a Python script. For detailed information on how to use the scripting feature see the section Automating a set of video playback tasks using Python scripts in this chapter.

Stopping playback

See Chapter 4, section Recording a video stream...Stopping a recording (or playback) for a detailed discussion of stopping video playback.

Displaying video at full screen size

The procedure for setting video display to use the full screen during playback is the same as described in Chapter 4, section Displaying live video at full screen size while recording.

Playing back video with automatic repeat

❖ To playback video with automatic repeat:

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the Stopping conditions control, uncheck all of the control boxes.
3. Press the *Play*  button.
4. To stop video playback press the *Stop*  button or the press the *FI* key.

Displaying stream filter data during playback

Stream filters are special Video Savant plug-in modules used for recording additional data streams and real-time image processing during video recording. Usually a stream filter is designed to record a specific type of data.

❖ Video Savant Pro includes stream filters that record:

- ☐ Computer date/time data;
- ☐ GPS data from a variety of GPS receiver devices;
- ☐ IRIG-B time data from a variety of IRIG-B receiver devices;
- ☐ Inertial navigation data;
- ☐ Altimeter data;
- ☐ Sound data from a standard sound card; and
- ☐ General-purpose analog data sampled using an analog data acquisition card.

See Chapter 4, section Recording additional data streams and real-time image processing...Stream filter library for a complete listing of stream filters included with Video Savant Pro.

During or after video recording, it may be useful to display the additional data stream(s) recorded by stream filter(s). The *Stream filters Control Panel* provides the controls for both enabling the display of stream filter data; and displaying the stream filter data. The following Figure shows the *Stream filters Control Panel*.

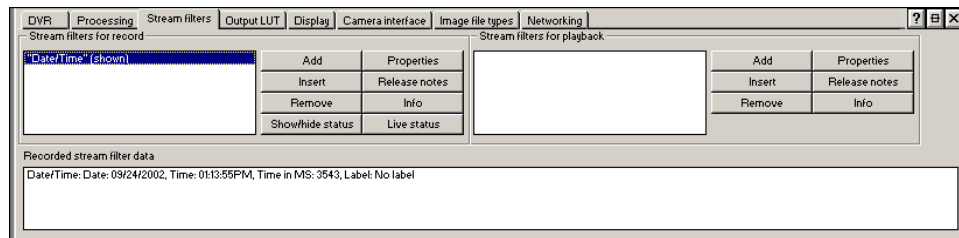


Figure 5.4: Stream filters Control Panel

Stream filters which record data will be listed in the **Stream filters for record** list control. A stream filter which records data can normally display its data in some form of textual representation. Do not add the stream filter to the **Stream filters for playback** list control.

❖ To display stream filter data after recording:

Refer to Chapter 4, section Recording additional data streams and real-time image processing...Viewing stream filter data after recording.

❖ To display stream filter data while recording:

Refer to Chapter 4, section Recording additional data streams and real-time image processing...Viewing stream filter data while recording.

Processing images during playback

Besides recording data streams and real-time image processing during video recording, stream filters can also be used to process images in a video stream during playback.

For instance, while frames are being played back, a stream filter could process each frame to track the motion of an object of interest. A color graphic could be written to the color overlay plane which Video Savant superimposes on images during playback.

In another example a stream filter could be created which performs some time of processing operation which overwrites, partially or completely, the image displayed by Video Savant during playback.

Stream filters used to process images during playback must be added to the **Stream filters for playback** list control.

❖ **To install a stream filter for image processing during playback:**

Refer to Chapter 4, section Recording additional data streams and real-time image processing...Installing a stream filter.

❖ **To remove a stream filter:**

Refer to Chapter 4, section Recording additional data streams and real-time image processing...Removing a stream filter.

❖ **To configure a stream filter:**

Refer to Chapter 4, section Recording additional data streams and real-time image processing...Configuring a stream filter.

Enabling/Disabling stream filters during playback

❖ **To enable/disable stream filters during playback:**

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).

2. In the *Advanced* control, check the **Enable stream filters on playback** control to enable the operation of stream filters during playback, or uncheck the control to disable the operation of stream filters during playback.

Setting output look up tables

The output look up table feature is only available when working with a camera interface in a grayscale mode. The *Output LUT* control panel appears as shown below.

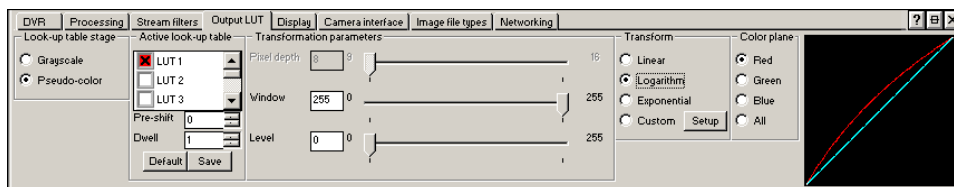


Figure 5.5: Output LUT Control Panel.



Networking note: Changes made to the output look up table settings will be applied to each of the computers selected on the *Networking Control Panel*.

❖ To set the output look up table entries:

1. Open the Video Savant application.
2. Open the *Output LUT Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
3. Several controls for modifying look up table entries are available. The operation of these controls is described below.

❖ There are two stages in setting the output look up table:

1. *Grayscale* stage. This is the first look up table stage. The grayscale image is converted from a 9 ... 16-bit grayscale image to an 8-bit

grayscale image (256 gray shades). The reduction in grayscale resolution is necessary because VGA adapters typically show only 8 bits of grayscale resolution.

2. *Pseudo-color* stage. This is the second look up table stage. The 8-bit grayscale image output from the first stage is converted to a pseudo color image. The pseudo color image is composed of three color planes, red, green and blue, which are generated by three independent look up tables.

For 9 ... 16-bit grayscale images, first select the **Grayscale** option in the *Look up table stage* control group, and perform the steps below to set the look up table. Second, select the **Pseudo-color** stage, and perform the steps below to set the look up tables for the red, green and blue color planes.

Look up table entries can be interactively assigned or read from a file.

Interactively setting a look up table

❖ To interactively assign look up table entries:

1. In the *Active look up table* control group, select one of the eight look up tables provided for editing. The red mark indicates which look up table is being edited. The check mark indicates which look up table is the active look up table used by Video Savant when displaying images.
2. This step depends on which pixel type you are using and the *Look up table stage* that is currently set.
 - *8-bit grayscale images; pseudo color stage of 9 ... 16-bit grayscale images.* In the **Color plane** control group, the options are **Red**, **Green**, **Blue**, or **All**. Select the pixel color plane to modify the look up table associated with that color plane. If you want to create identical look up tables for all three color planes, select **All**.

- *Grayscale stage of 9 ... 16-bit grayscale images.* The options are: 9-bit, ... 16-bit. Select the pixel depth that corresponds to the pixel depth of the video camera. For instance, if your video camera is a 10-bit camera, you would specify a 10-bit pixel depth in the **Pixel depth** control.
3. Locate the **Transform** control, and select a transformation function. You may select **Linear**, **Logarithmic**, or **Exponential**. Do not select **Custom**.
 - Linear transform:
 $y(x) = mx + b$;
 where m, b are constants
 - Logarithmic transform:
 $y(x) = \log_e(x) + b$;
 where e is the natural base of logarithms; and
 b is a constant
 - Exponential transform:
 $y(x) = e^x + b$;
 where e is the natural base of logarithms; and
 b is a constant
 4. The look up table entries are displayed as an analytical plot of $y(x)$; where x is the incoming pixel value (look up table index); and y is the transformed pixel value (table entry at table index).
 5. The curve generated by the transformation function can be adjusted using the **Window** and **Level** controls (found in the *Transformation parameters* control group). The *Window* and *Level* values determine the constants in the transformation functions.
 6. If you want to shift the bits of the images to the right prior to performing the look up table transformation on the images, locate the **Pre-shift** control.
 7. Enter the number of bits to pre-shift to the right in the **Pre-shift** control.

Resetting a look up table

❖ Resetting a look up table to the default settings:

1. In the *Active look up table* control group, select one of the eight look up tables provided for editing. The red mark indicates which look up table is being edited. The check mark indicates which look up table is the active look up table used by Video Savant when displaying images.
2. In the *Color plane* control group, select the color plane that you want to set to the default settings. If you want to set all of the color planes for this look up table to the default settings, select the **All** control.
3. In the *Active look up table* control group, press the **Default** button. The Pre-shift, Dwell, Transformation parameters, and Transform settings of the look up table have been set to the default settings.

Setting a look up table from a file

❖ To read look up table entries from a file:

1. In the *Active look up table* control group, select one of the eight look up tables provided for editing. The red mark indicates which look up table is being edited. The check mark indicates which look up table is the active look up table used by Video Savant when displaying images.
2. This step depends upon the current image pixel type:
 - *8-bit grayscale images; pseudo color stage of 9 ... 16-bit grayscale images.* The *Color plane* control group specifies the options: **Red**, **Green**, **Blue**, or **All**. Only the selected pixel color plane will receive the look up table when read from a file. To have all three color planes receive the look up table when read from a file, select the **All** option.

- *Grayscale stage of 9 ... 16-bit grayscale images.* The options are: 9-bit, ... 16-bit. Select the pixel depth that corresponds to the pixel depth of the video camera. For instance, if your video camera is a 10-bit camera, you would specify a 10-bit pixel depth in the **Pixel depth** control. This LUT will receive the look up table from the file.

3. Locate the *Transform* control group, and select **Custom**.
4. Press the **Setup** button next to the **Custom** control. The *Select Custom Look up Table* window will appear.
5. If you do not specify a custom look up table, the default look up table will transform all values in the color plane specified to zero.

There are two look up table file types: *look up table values (.luv)*; and *look up table index (.lui)*.

Look up table values (.luv) file format

ASCII file type;

One decimal number on each line;

$2^{\text{pixel bit depth}}$ lines in file;

The n^{th} line (starting at 0) contains the n^{th} look up table entry as follows:

table entry₀

table entry₁

table entry₂

.

.

.

table entry_n

<u>Pixel bit depth</u>	<u>Number of table entry values(n)</u>
8	256
9	512
10	1024
11	2048
12	4096
13	8192
14	16384
15	32768

16

65536

Look up table index (.lui) file format

ASCII file type;

Two comma separated decimal numbers on each line as follows:

table index₁, table entry at index₁

table index₂, table entry at index₂

...

The table indices need not be in any order; if a table index is repeated, the last occurrence will be used. Table indices not listed will have the value zero assigned as the table entry.

6. The look up table entries are displayed as an analytical plot of $y(x)$; where x is the incoming pixel value (look up table index); and y is the transformed pixel value (table entry at table index).
7. The **Window** and **Level** controls cannot be used to alter the look up table entries when a look up table is read from a file.



Networking note: Each of the selected computers will search for the LUT file on local storage. The *Slaves* will search the same local path for the LUT file as was specified on the *Master*. If the file cannot be found, the *Slaves* will attempt to find the file in their respective Video Savant installation directories and subdirectories. If the LUT file is not found on a *Slave*, the LUT settings will not be applied to that *Slave*.

Saving a look up table to a file

- ❖ To save look up table entries to a file:

1. In the *Active look up table* control group, select one of the eight look up tables provided for editing. The red mark indicates which look up table is being edited. The check mark indicates which look up table is the active look up table used by Video Savant when displaying images.
2. Set the look up table settings (see section Setting output look up tables...Interactively setting a look up table in this chapter).
3. In the *Active look up table* control group, press the **Save** button.
4. The *Save Custom Look up Table* appears. Specify a location and filename to save your look up table.
5. Press **Save** when you are finished.



Networking note: The LUT will only be saved for the first computer selected on the *Networking Control Panel*. To save a LUT on a *Slave*, the *Master* must have file sharing permissions on the *Slave*.

Automatically switching between look up tables during record/playback

During video record and playback operations, the images are displayed using the *Active look up table*. In some situations it is desirable to cycle between look up tables automatically after each new image is captured or played.

For instance, in a life sciences application known as *Calcium Imaging* alternate images are illuminated with a different wavelength of light. It is therefore desirable to alternate between two output look up tables to view images in the desired way.

❖ To cycle between look up tables during recording or playback:

1. Select each look up table in the *Active look up table* control group that will be used. Double-click on the checkbox associated with each look up table to select it. A checkmark indicates a look up table is selected.

2. Set the **Dwell** setting associated with each of the selected look up tables to the number of consecutive images that you want processed with a specific look up table.

Working with foreign image formats (Bayer color, multi-tap, etc.)

Video Savant has built-in support for several common image formats, referred to as Video Savant's *native* image formats. However, there are many image formats, referred to as *foreign* image formats, that Video Savant does not recognize internally (e.g. Bayer color and multi-tap formats).

Video Savant is able to work with foreign image formats by means of a special image conversion module known as a *conversion filter*. A conversion filter converts a foreign image format into a native image format recognized by Video Savant.

❖ Native image formats:

- ☐ 8 bit grayscale
- ☐ 16 bit grayscale (used for 9...16-bit pixel depths)
- ☐ 24 bit RGB (8:8:8) color
- ☐ 32 bit RGB (8:8:8:x) color
- ☐ 16 bit RGB color (5:5:5:1)
- ☐ 16 bit RGB color (5:6:5)
- ☐ 16 bit RGB color (YUV 4:2:2)

Before an image is displayed, exported to an image file, or processed, the image data is transformed by a conversion filter into one of Video Savant's native image formats.

Conversely, after an image is imported from an image file, or processed, the image data is reverse transformed by the conversion filter into the foreign image format and stored in a Video Savant image buffer.

The following diagram shows the flow of image data through conversion filters.

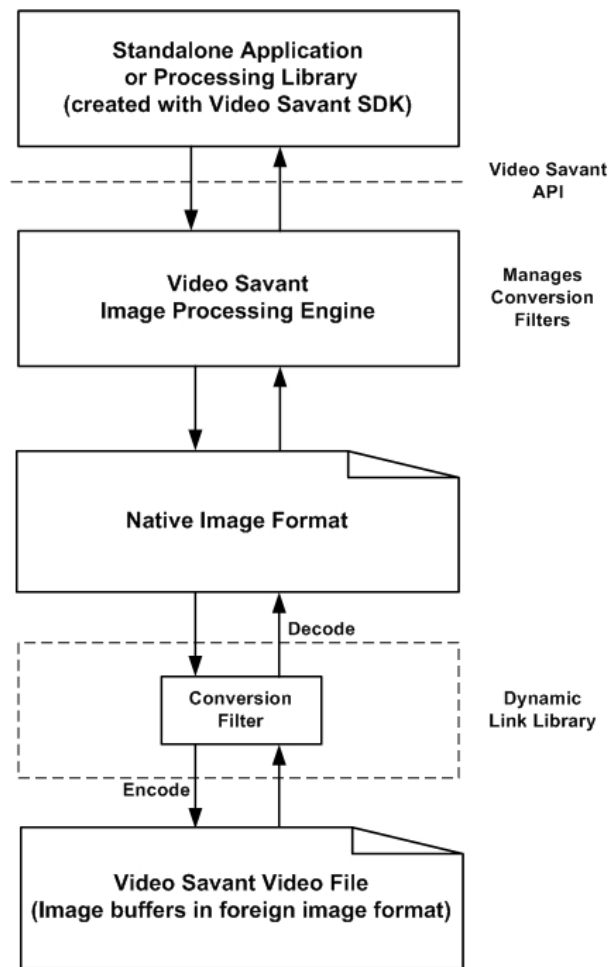


Figure 5.6: Image data flow with conversion filters.

❖ **Conversion filters can be generally classed into the following groups:**

- ❑ Conversion filters which perform *Geometric* transformations;
- ❑ Conversion filters which perform *Color Space* transformations; and
- ❑ Conversion filters which perform *Geometric and Color Space* transformations.

Geometric conversion

A *Geometric Conversion* must be performed when image pixels are not organized in computer memory addresses using a standard memory mapping of image pixels.

In the standard memory mapping of pixels, consecutive image rows, starting at the top row of the image, are stored in consecutive chunks of computer memory. The size of each memory chunk matches the combined size of all the pixels on a row. The pixels on each row are incremented from left to right through consecutive computer memory addresses.

Consider a multi-tap camera with 4 taps, that captures grayscale images at $640(W) \times 480(H) \times 8\text{-bit}$. This situation is represented graphically below.

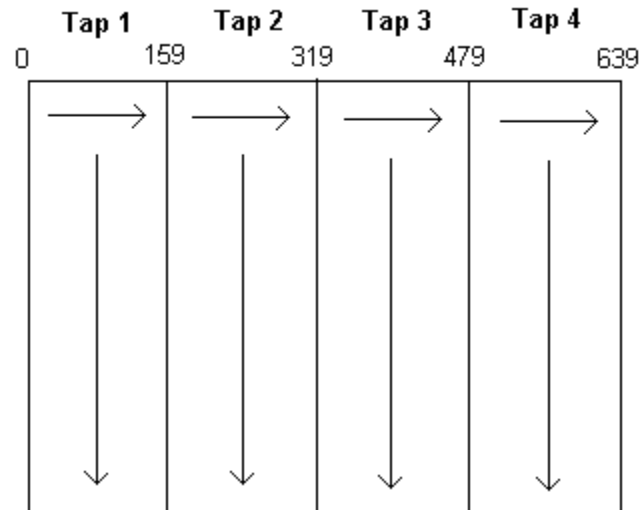


Figure 5.7: Multi-tap camera capturing image data.

The camera reads out each pixel, $p_{i,j}$, where i is the image row, and j is the image column, in the following order:

Row 0:

$p_{0,0}$, $p_{0,160}$, $p_{0,320}$, $p_{0,480}$, $p_{0,2}$, $p_{0,161}$, $p_{0,321}$, $p_{0,481}$, ..., $p_{0,159}$, $p_{0,319}$, $p_{0,379}$, $p_{0,639}$

Row 1:

$p_{1,0}$, $p_{1,160}$, $p_{1,320}$, $p_{1,480}$, $p_{1,2}$, $p_{1,161}$, $p_{1,321}$, $p_{1,481}$, ..., $p_{1,159}$, $p_{1,319}$, $p_{1,379}$, $p_{1,639}$

...

Row 479:

$p_{479,0}$, $p_{479,160}$, $p_{479,320}$, $p_{479,480}$, $p_{479,2}$, $p_{479,161}$, $p_{479,321}$, $p_{479,481}$, ..., $p_{479,159}$,
 $p_{479,319}$, $p_{479,379}$, $p_{479,639}$

The image pixels will be stored in consecutive computer memory addresses in this same order.

A conversion filter must be used to remap the pixels to the standard memory mapping shown below.

Row 0:

$p_{0,0}, p_{0,1}, p_{0,2}, p_{0,3}, p_{0,4}, p_{0,5}, \dots, p_{0,639}$

Row 1:

$p_{1,0}, p_{1,1}, p_{1,2}, p_{1,3}, p_{1,4}, p_{1,5}, \dots, p_{1,639}$

...

Row 479:

$p_{479,0}, p_{479,1}, p_{479,2}, p_{479,3}, p_{479,4}, p_{479,5}, \dots, p_{479,639}$

Color space conversion

A *Color Space Conversion* must be performed when image pixels are stored in a color image format which is not recognized by Video Savant. The color image formats recognized by Video Savant are listed above in the opening to this section.

A conversion filter will convert an unrecognized color image format to 24 bit RGB (8:8:8) color.

Consider a camera that captures 8-bit Bayer color images. In a Bayer color image, the image is represented by a two-dimensional lattice of 8-bit pixels in the same way as a grayscale images.

The difference between a Bayer color image and a grayscale image is that in a Bayer image each pixel is designated as either a red, green, or blue pixel value, not a grayscale pixel.

The arrangement of red, green and blue pixels is shown below.

$R_{0,0}$	$G_{0,1}$	$R_{0,2}$	$G_{0,3}$	$R_{0,4}$	$G_{0,5}$	$R_{0,6}$	$G_{0,7}$	...
$G_{1,0}$	$B_{1,1}$	$G_{1,2}$	$B_{1,3}$	$G_{1,4}$	$B_{1,5}$	$G_{1,6}$	$B_{1,7}$	...
$R_{2,0}$	$G_{2,1}$	$R_{2,2}$	$G_{2,3}$	$R_{2,4}$	$G_{2,5}$	$R_{2,6}$	$G_{2,7}$	...
$G_{3,0}$	$B_{3,1}$	$G_{3,2}$	$B_{3,3}$	$G_{3,4}$	$B_{3,5}$	$G_{3,6}$	$B_{3,7}$	...

Figure 5.8: Image with Bayer color mosaic

The Bayer color image can start with a red, green, or blue pixel in the top-left pixel. However, the same alternating pattern of green/red, and green/blue on each row is preserved.

The conversion filter must produce 24-bit RGB pixel consisting of a red, green, and blue value at each pixel location.

At each pixel location in the Bayer image, one of the colors is known, but the other two colors must be interpolated. The interpolation of pixel values is performed using the nearest neighbors containing the color that must be interpolated.

For example, in the above figure showing the Bayer color image, the interpolation of the red, green, and blue pixel components at pixel location, 2nd row, 4th column, can be calculated as follows:

$$\begin{aligned}R_{1,3} &= (R_{0,2} + R_{0,4} + R_{2,2} + R_{2,4}) / 4 \\G_{1,3} &= (G_{0,3} + G_{1,2} + G_{1,4} + G_{2,3}) / 4 \\B_{1,3} &= B_{1,3}\end{aligned}$$

There are a variety of techniques for interpolating color in a Bayer image, the preceding method is a common technique.

Geometric and color space conversion

Geometric and color space conversion must be performed when an unrecognized color image format is used, and image pixels are not organized in computer memory addresses using a standard memory mapping of image pixels.

The conversion filter must perform both a geometric conversion and a color space conversion. See the sections above to learn more about geometric and color space conversions.

Selecting a conversion filter

Before a conversion filter can be selected, the image color format, and image geometry (pixel readout order) must be known. This information can normally be found in the manual accompanying the camera.

Some camera interfaces have the ability to automatically convert images which would otherwise be stored in a non-standard memory map requiring a

geometric conversion, to a standard memory map. Consult the manual accompanying your camera interface to determine if this is the case for your camera.

A conversion filter is normally selected when a video file is first created. The procedure for creating a video file and selecting a conversion filter is described in Chapter 2, section Creating new video files.

❖ **To select a conversion filter after a video file has been created:**

1. Press the **Video file** button on the *Status* bar. A pop-up menu will appear.
2. Choose **Current video file properties** on the pop-up menu. The *Video file properties* window will appear.
3. Find the **Setup** button associated with **Conversion**, and press it. The *Select/configure Conversion filter* window will appear.
4. Press the **Select conversion...** button. The *Select Conversion Filter* window will appear.
5. In the list of conversion filters, select a conversion filter by clicking on it.
6. Press the **OK** button to select the filter or press **Cancel** to cancel the operation.
7. Press **OK** in each of the open windows to accept changes.

Configuring a conversion filter

❖ **To configure a conversion filter:**

1. Press the **Video file** button on the *Status* bar. A pop-up menu will appear.

2. Choose **Setup conversion filter...** on the pop-up menu. A window will appear from which settings can be made for the current conversion filter.
3. Make the appropriate settings in the conversion filter configuration window.
4. Press **OK** in each of the open windows to accept changes.

Adding a conversion filter

❖ To add a new conversion filter:

1. Press the **Video file** button on the *Status* bar. A pop-up menu will appear.
2. Choose **Current video file properties** on the pop-up menu. The *Video file properties* window will appear.
3. Find the **Setup** button associated with **Conversion**, and press it. The *Select/configure Conversion filter* window will appear.
4. Press the **Select conversion...** button. The *Select Conversion Filter* window will appear.
5. Press the **Add...** button. A window will appear from which the conversion filter DLL file can be selected.
6. Select the conversion filter DLL and press the **Open** button.
7. Press **OK** in each of the open windows to accept changes.

❖ Note: If you are unable to view files of type .dll:

1. Start the Windows file exploring application by right-clicking on the Windows **Start** button and choosing **Explore**;
2. Choosing **Tools** on the main menu;

3. Choosing **Folder Options** on the pop-up menu;
4. Clicking on the **View** tab in the *Options* window; and
5. Selecting **Show hidden files and folders** in the *Hidden files and folders* control group.

Removing a conversion filter

❖ To remove a conversion filter:

1. Press the **Video file** button on the *Status* bar. A pop-up menu will appear.
2. Choose **Current video file properties** on the pop-up menu. The *Video file properties* window will appear.
3. Find the **Setup** button associated with **Conversion**, and press it. The *Select/configure Conversion filter* window will appear.
4. Press the **Select conversion...** button. The *Select Conversion Filter* window appears.
5. In the list of conversion filters, select a conversion filter by clicking on it.
6. Press the **Remove** button. The selected conversion filter is removed.

Automating a set of video playback tasks using Python scripts

In cases where a set of video playback tasks must be repeatedly executed, for example, during a presentation, the tasks can be defined in a script, and the script can be invoked from the *DVR Control Panel* in Video Savant.

Scripts can be created and edited using the *DVR Control Panel*. The script language used is *Python*. For general information about the Python script language, refer to <http://www.python.org>. A basic knowledge of computer programming is sufficient to be able to develop Python scripts.

Video Savant extends the Python script language with a special set of functions that control much of the functionality of Video Savant. Functions are available for video recording, video playback, image file import/export, and image processing.

See the document *Video Savant Python Library* installed in the Video Savant folder for a complete list of Video Savant Python functions.

Script commands

Video Savant includes a comprehensive set of functions to control video recording, video playback, image file import/export and image processing from a Python script.

The following table summarizes the Video Savant Python functions for image display and video playback.

Video Savant Python Functions for Image Display / Video Playback	
iPlay	Display a single frame or sequence of frames. Playback timing can be controlled.
iPlayUntilElapsedTime	Play an image sequence at maximum frame (or line) rate for a specified amount of time.
iPlayUntilLastStorageBuffer	Play an image sequence at maximum frame (or line) rate until the last storage buffer has been reached.
iPlayUntilNumberOfFrames	Play an image sequence at maximum frame (or line) rate until the number of frames specified have been displayed.
iGrabContinuousStart	Start live video display.
iGrabContinuousStop	Stop live video display.

iDisplayFrame

Display a single frame (or set of lines).

Please refer to the document *Video Savant Python Library* installed in the Video Savant folder for a complete list of Video Savant Python functions.

Creating a new script

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Playback timing* control group, choose **Script**.
3. The *Playback timing* control group will have been replaced by the *Playback script* control group.
4. Press the **New** button.
5. Locate the edit box located on the far right of the control panel. Enter the script in this edit box.

Opening an existing script

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Playback timing* control group, choose **Script**.
3. The *Playback timing* control group will have been replaced by the *Playback script* control group. If the desired script has been opened before, it will be in the drop down list. If the desired script is in the drop down list, select it and skip to step 7 below.
4. Press the **Select script ...** button.
5. A window is shown allowing the user to browse for a saved python script. Python scripts always have the extension .py.

6. After the saved script is located, press **Open**.
7. The script appears in the edit box on the far right of the control panel. The script can be directly edited here.

Saving a script

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Playback timing* control group, choose **Script**.
3. Select **Playback script**. This control is located above the scripting edit box on the far right of the control panel.
4. Press the **Save...** button. If the script has been saved before, a message will appear asking the user if the script should be saved under the same name. Otherwise a *Browse* window will appear in which the filename and folder where script will be saved can be specified.

Running a script

1. Prepare the playback script. See the above sections to create a new script or to open an existing script.
2. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
3. Press the *Play*  button. The selected playback python script will begin to execute. The script will run until all lines of code have been executed. *Stopping conditions* are not used to determine when the script will end.
4. To view the python script output, select **Script output**. You can switch back to the playback script by selecting **Playback script**.

Viewing script output messages

1. Open the *DVR Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Choose the **Script output** setting. This control is located above the scripting edit box on the far right of the control panel.
3. To save the script output, press the **Save** button. A window will appear which will enable the user to select an appropriate file name for the script output.

Example script

The following python script demonstrates video playback.

```
import vspython
print "This example starts playback in buffer 5."
print "Playback will end after 1 minute and 45 seconds"
print "or when the last buffer has been reached"
iPlayUntilElapsedTime(5, "0:1:45")
print "Finished playback"
```

First, the script starts playback in buffer 5. The script continues playback for 1 minute and 45 seconds, or when the last storage buffer is reached, whichever occurs first.

For additional example scripts, refer to the document *Video Savant Python Library* installed in the Video Savant folder.

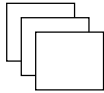


Image Processing and Analysis

A convenient framework exists within Video Savant for performing static image processing and analysis operations. These operations are referred to collectively as *processing operations*.

For information about processing images during image acquisition, see Chapter 4, section Recording additional data streams and real-time image processing.

For information about processing images during image playback, see Chapter 5, section Processing images during playback.

The *Pro*, *Basic*, and *RTL* Video Savant licenses include the same framework for performing processing operations, although only Video Savant Pro includes a library of processing operations. Video Savant Basic and RTL can only execute processing operations developed by a third party using Video Savant SDK.

Before describing the details of the processing operations offered in Video Savant Pro, the general procedures for accessing and preparing to use all processing operations is discussed.



Networking note: The *Processing Control Panel* supports configuration and execution of processing operations on *Slave* computers.

Choosing a processing operation

The image processing and analysis operations are accessed from the Video Savant *Processing Control Panel* shown below.

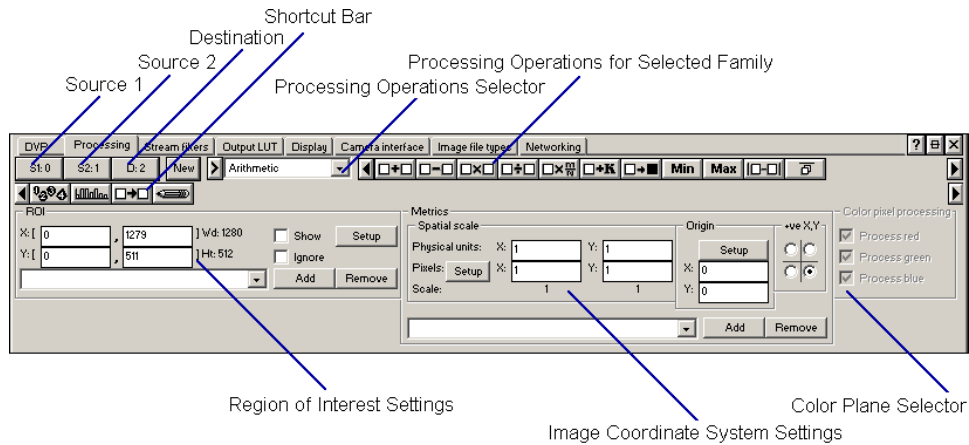


Figure 6.1: Processing Control Panel.

Processing operations are organized into families of related operations. The *Processing Operation Selector* control shown above is used to select a family of processing operations.

Unless configured otherwise, the *Processing Operation Selector* in Video Savant Pro will show several families of processing operations. For a list of the families, see the section Image processing operations later in this chapter.

In Video Savant Basic and RTL, the *Processing Operation Selector* will not list any families until one is added. See the section Adding processing operations later in this chapter. Please note that the processing operations included with Video Savant Pro will not work with Video Savant Basic or RTL.

Once a family is selected, the *Processing Operations* button bar associated with that family appears to the right of the *Processing Operation Selector*.

Each button is used to execute a specific processing operation. By moving the mouse over a processing operation button, the name of the operation can be seen, giving a clue as to its purpose.

Selecting images for processing

A processing operation normally requires images to be selected for processing. These images are referred to as *Source* image buffers. As well, many operations generate an image as a product of their processing, the storage location of which must be specified. These images are referred to as *Destination* image buffers.

The *Source* and *Destination* image buffers are the input parameters for an image processing operation. Each processing operation has specific requirements with respect to *Source* and *Destination* parameters. The input parameters for each of the processing operations included in Video Savant Pro are discussed in detail later in this chapter. The purpose of this section is to provide the basic procedure for specifying *Source* and *Destination* parameters.

There are three buttons on the *Processing Control Panel* that are used to specify *Source* and *Destination* parameters. These buttons are labeled **S1** (*Source 1*), **S2** (*Source 2*), and **D** (*Destination*). A processing operation may require some or all of these parameters to be specified.

❖ To specify the Source 1 parameter:

1. Select the sequence of image buffers (see Chapter 2, section Selecting an image buffer sequence).
2. Left-click on the **S1** button.

Source 2 and *Destination* are specified in the same way using the **S2** and **D** buttons respectively.

Organizing frequently used processing operations

Some processing operations must be used frequently. The *Shortcut bar* (see figure at start of this chapter) provides a convenient location from which shortcuts to processing operations from any of the families listed in the *Processing Operation Selector* can be placed.

Once a shortcut is set for a processing operation, it is no longer necessary to use the *Processing Operation Selector* to locate the processing operation.

❖ To add processing operations to the Shortcut bar:

1. Open the *Processing Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Select a family processing operations in the *Processing Operation Selector* control.
3. To the right of the *Processing Operation Selector* control, locate the button associated with the processing operation you wish to add to the *Shortcut bar*.
4. Press and hold the left mouse button down on the chosen processing operation button.
5. While continuing to hold the left mouse button down, drag the button so that the tip of the mouse pointer is positioned at the location on the *Shortcut bar* where the button is to be placed.
6. Release the left mouse button and the button will be copied to the *Shortcut bar*. If the operation button was not added, this is because the mouse pointer was not pointing at a valid position on the *Shortcut bar*.

❖ **To remove buttons from the Shortcut bar:**

1. On the *Shortcut bar*, locate the processing operation button you wish to remove.
2. Press and hold the left mouse button down on the processing operation button.
3. Drag the processing operation button so that the tip of the mouse pointer is not positioned on the *Shortcut bar*.
4. Release the left mouse button and the processing operation button will be removed from the *Shortcut bar*.

Adding processing operations

Processing operations can be added to the *Processing Operation Selector* control. The basic procedure is to select a library file, containing one or more processing operations. All of the processing operations in the library will be added to families in the *Processing Operation Selector*. The library automatically designates which families will receive its processing operations.

Normally all processing operations in a library will be added to a single family in the *Processing Operation Selector*. In some cases however, the processing operations of a library will be assigned to a collection of families.

A library of processing operations also known as a *Processing Library* can be created using the Video Savant SDK. See Chapter 8 for details.



Networking note: The *Master* cannot add or remove a *Processing Library* to a *Slave*.

❖ **To add a library of processing operations:**

1. Press the **New** button on the *Processing Control Panel*. The *Processing Library Details* window will appear.

2. Highlight an item in the **Active Processing Libraries** list. The new processing library will be added after the chosen item.
3. Press the **Add** button.
4. Locate the dynamic link library file (DLL) containing the processing library to be added.
5. Press the **OK** button.

❖ **Note: If you are unable to view files of type .dll:**

1. Start the Windows file exploring application by right-clicking on the Windows **Start** button and choosing **Explore**;
2. Choosing **Tools** on the main menu;
3. Choosing **Folder Options** on the pop-up menu;
4. Clicking on the **View** tab in the *Options* window; and
5. Selecting **Show hidden files and folders** in the *Hidden files and folders* control group.

Removing processing operations

In order to remove a specific processing operation, the library containing the processing operation must be removed. This means the other processing operations in the library will also be removed.

❖ **To remove a library of processing operations:**

1. Press the **New** button on the *Processing Control Panel*. The *Processing Library Details* window will appear.
2. Highlight the library item to remove in the **Active Processing Libraries** list.

3. Press the **Remove** button.
4. Press the **OK** button.

Setting a region of interest for image processing

A region of interest (ROI) in Video Savant is a rectangular region located within an image buffer. Most processing operations, and all image file import/export operations, perform their operations on pixels located on or within the current ROI, but not outside the current ROI.

❖ There are two methods for setting the region of interest:

- ☐ Using the *Quick menu*; or
- ☐ Using the *Processing Control Panel*.



Networking note: The ROI selection will be used on the selected *Slave* computers. ROI coordinates that are outside of image buffer boundaries for a *Slave* will be adjusted locally by the *Slave*. The only exception to this rule occurs when the *Default* ROI is selected from the *ROI* drop-down list. In this case, the *Slave* computers will use their own *Default* ROI settings.

Setting the region of interest using the Quick menu

❖ To set the ROI using the Quick menu:

1. Activate the *Quick menu* (see Chapter 2, section Exploring the work area...Quick menu).
2. Choose **Select ROI**.
3. Click the left mouse button. A cross-hair cursor will appear in the image buffer viewing area. If you don't see a cross-hair cursor, try clicking the left mouse button again until you see a cross-hair cursor.

4. Move the mouse (or use the arrow keys on the keyboard) to the position of one corner of the desired ROI. Click the left mouse button (or press the *Space-bar* key) to set this position.
5. Move the mouse (or use the arrow keys on the keyboard) to set positions of the 3 other corners of the desired ROI. Click the left mouse button (or press the *Space-bar* key) to set this position.
6. Move the mouse (or use the arrow keys on the keyboard) if you wish to translate the position of the selected ROI.
7. If you wish to reset the ROI position, return to step 3 above; *or* if you wish to cancel the ROI setting operation, press the *Escape* key; *or* if you wish to accept the selected ROI, click the right mouse button (or press the *Enter* key).

Setting the region of interest using the Processing Control Panel

❖ To set the region of interest using the Processing Control Panel:

1. Open the *Processing Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *ROI* control group of controls, enter the minimum and maximum X and Y coordinates directly into the controls provided; *or* select *Default* from ROI drop down list to set the ROI to the maximum allowable dimensions; *or* press the **Setup** button and follow the instructions in the above section Setting the region of interest using the Quick menu starting at step 3.
3. If you have already saved an ROI, use the drop down list to load a previously stored ROI.

Temporarily setting the region of interest to full size

In some situations, you may wish to temporarily set the ROI to full size, perform an operation such as importing an image file, and restore the ROI to its previous setting.

❖ To temporarily set the region of interest to full size using the Processing Control Panel:

1. Open the *Processing Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Enable the **Ignore ROI** control setting.

To restore the previous ROI, disable the **Ignore ROI** control setting.

❖ To temporarily set the region of interest to full size using the Quick Menu:

1. Activate the *Quick menu* (see Chapter 2, section Exploring the work area...Quick menu).
2. Choose **Ignore ROI**.

To restore the previous ROI, repeat this same procedure.

Displaying an outline of the current region of interest

When working the ROI, it is often helpful to see the location and size of the current ROI.

❖ To show the current ROI on the image using the Processing Control Panel:

1. Open the *Processing Control Panel* (see Chapter 2, section Exploring the work area...Control panels).

2. If you are in thumbnail image viewing mode, double click on any thumbnail to change to full size viewing mode.
3. Choose **Show ROI**.

To cancel showing of the ROI, repeat this same procedure.

❖ **To show the current ROI on the image using the Quick Menu:**

1. If you are in thumbnail image viewing mode, double click on any thumbnail to change to full size viewing mode.
2. Activate the *Quick menu* (see Chapter 2, section Exploring the work area...Quick menu).
3. Choose **Show ROI**.

To cancel showing of the ROI, repeat this same procedure.

Saving a region of interest

❖ **To save a region of interest:**

1. Open the *Processing Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. Press the **Add** button and the current ROI will be added to the end of the ROI drop down list.

To use a saved ROI, select it from the drop-down list.

To delete an entry from the ROI drop down list control, select the entry from the drop down list control and press the **Remove** button.



Networking note: The *Master* cannot add or remove an ROI to the drop-down list of a *Slave*.

Setting the image coordinate system

Distance measurements in an image can be calibrated to physical units in the real world. The image can be defined using a Cartesian coordinate system, with an origin, x -axis in the horizontal direction, and y -axis in the vertical direction.

The default coordinate system is defined in pixel units: the top-left corner of the image is the origin; the x -axis is positive increasing towards the right of the image; and the y -axis is positive increasing towards the bottom of the image.



Networking note: The coordinate system settings will be used on the selected *Slave* computers. Settings that are outside of image buffer boundaries for a *Slave* will be adjusted locally by the *Slave*. The only exception to this rule occurs when the *Default* metrics are selected from the *Metrics* drop-down list. In this case, the *Slave* computers will use their own *Default* metrics settings.

❖ To set the image coordinate system:

1. Open the *Processing Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. The spatial scale, origin, and orientation of the coordinate system must be defined. This can be done using *Spatial scale*, *Origin*, and *+ve X,Y* controls, and following the procedures below. Alternatively, a previously saved image coordinate system can be selected from the drop down list control in the *Metrics* group of controls.

Setting the origin

The location of the origin is always expressed in units of the default coordinate system.

❖ **To set the origin:**

1. Press the **Setup** button in the *Origin* control group. A cross-hair cursor will appear in the image.
2. Move the mouse to position the cross-hair cursor in the image to the desired location, and press the right mouse button. Alternatively, enter the position of the origin directly in the **X** and **Y** controls.

Setting the scale

The procedure of setting the scale requires that a distance be marked off in the *x* and *y* directions in the image. The corresponding physical units for that distance are then entered. The scale is calculated and expressed in *physical units per pixel unit*.

❖ **To set the scale:**

1. Start live video acquisition. See Chapter 2, section Capturing continuous (live) video frames.
2. Focus the camera.
3. Mark a horizontal line in the field of view. The start and end points should be located completely within the field of view.
4. Measure the physical distance between the start and end points of the horizontal line if this distance is not already known.
5. Enter the distance measurement in the *Physical units X* control located in the *Spatial scale* control group.
6. Mark a vertical line in the field of view with starting point at the start point or end point of the horizontal line marked in step 3 above.
7. Measure the physical distance between the start and end points of the

vertical line if this distance is not already known.

8. Enter the distance measurement in the *Physical units* **Y** control located in the *Spatial scale* control group.
9. Snap an image. See Chapter 2, section Capturing a single video frame.
10. Press the **Setup** button located in the *Spatial scale* control group. A cross-hair cursor will appear in the image.
11. Move the cross-hair cursor to location in the image marking the intersection of the horizontal and vertical calibration lines. Press the left mouse button when the cursor is located at the point of intersection.
12. Move the cursor to form a rectangle containing both horizontal and vertical calibration lines. Press the right mouse button to register the distance measurement or press the *Escape* key to cancel the procedure.

Alternatively, the x and y distances in pixel units may be entered directly in the **X** and **Y** controls located beside the **Setup** button.

Once the distances in pixel units are entered, interactively or directly, the spatial scale will be automatically calculated.

Setting the orientation

The orientation of the coordinate system indicates the positive increasing directions for the x and y axes of the Cartesian coordinate system.

❖ To set the orientation:

1. Locate the *+ve X,Y* control group.
2. Choose an orientation for the coordinate system as follows:
 - Upper-right button is x positive increasing to image right; y

positive increasing to image top;

- Lower-right button is x positive increasing to image right; y positive increasing to image bottom (default);
- Lower-left button is x positive increasing to image left; y positive increasing to image bottom; and
- Upper-left button is x positive increasing to image left; y positive increasing to image top.

Saving coordinate system settings

❖ To save a coordinate system setting:

1. Open the *Processing Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. If you want to save the current coordinate system settings, press the **Add** button in the *Metrics* control group. The settings will be added to the bottom of the *Metrics* drop down list control.

To use a saved coordinate system setting, select it from the drop-down list control.

To delete an entry in the *Metrics* drop-down list control, select the entry from the drop down list control and press the **Remove** button.



Networking note: The *Master* cannot add or remove an entry from the *Metrics* drop-down list of a *Slave*.

Setting the color planes for image processing

When working with color pixel types, image processing and analysis operations will use only the pixel color planes (i.e. red, green or blue pixel color components) that have been specified for use.

❖ **To set the color planes to be used for image processing and analysis:**

1. Open the *Processing Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
2. In the *Color pixel processing* control group, check the boxes corresponding to the pixel color planes to be used for image processing and analysis.

Image processing operations

Video Savant Pro includes the following families of processing operations:

Arithmetic operations	
Absolute difference	Calculate the absolute difference between two images forming a third image.
Add	Add two images to form a third image.
Add constant	Add a constant value to an image to form a second image.
Average	Average images in a sequence of image buffers and store the result in a destination image buffer.
Divide	Divide one image by another image to form a third image.
Maximum	Form a destination image by taking the greater (maximum) of the corresponding pixel values in two source images.
Minimum	Form a destination image by taking the lesser (minimum) of the corresponding pixel values in two source images.
Multiply	Multiply two images to produce a third image.

Multiply by fraction	Multiply two images by a fractional constant to produce a third image.
Negate	Perform a two's complement negation on an image to form a second image.
Subtract	Subtract one image from another to form a third image.

Boolean arithmetic, and bit-field operations

AND	Perform a bit-field Boolean AND operation between two images to form a third image.
AND, OR, XOR with constant	Perform a bit-field Boolean operation between an image and a constant value to form a third image.
Bit shift	Bit-shift image pixels left or right to form a second image.
NOT	Perform a bit-field Boolean NOT operation on an image to form a second image.
OR	Perform a bit-field Boolean OR operation between two images to form a third image.
XOR	Perform a bit-field Boolean XOR operation between two images to form a third image.

Geometric operations

Copy	Calculate the absolute difference between two images forming a third image.
Mirror about vertical, horizontal or diagonal plane	Add two images to form a third image.
Point to point measurements	Add a constant value to an image to form a second image.
Rotate $\pm 90^\circ$, 180°	Rotate image pixels ± 90 degrees, or 180 degrees, and copy to another location.

Analysis, statistics and measurement operations

Blob counting and measurement	Classify, count, and measure image blobs. A blob is a cluster of connected <i>on</i> pixels which are surrounded by background <i>off</i> pixels.
Contour plot with path extraction	Extract and plot image contours. An image contour marks the approximate path along which pixels have equal values. This is similar in concept to the elevation curves shown on topological maps.
Live pixel monitoring for points, lines, and areas	Perform continuous frame capture, and measure pixel values at a point, along a line (profile), or in an area (histogram).
Pixel value frequency histogram plot with data extraction	Measure the frequency distribution of pixel values in an image. The mean, standard deviation, and mode of the distribution are also calculated.
Pixel value viewing as numeric text	View an image as a matrix of text numbers. The possible numeric representations are decimal, binary, and hexadecimal.
Profile plot with data extraction	Extract the pixel values located along a line (profile) in an image and create a profile plot graphic.
Projection plot for rows or columns with data extraction	Calculate the image projection in the rows or columns direction and create a projection plot graphic and/or a data listing of the pixel values.
Surface plot with grid point data extraction	Create a surface plot of image data. In the surface plot, the 2-dimensional image data is visualized as a 3-dimensional surface, where the z-dimension at a point is proportional to the pixel value at that point in the image.

Transform operations	
Binarize	An image is <i>binarized</i> to form a second image.
Convolution with predefined and custom masks	An image is <i>convolved</i> with a mask to form a second image. The mask can be chosen from a list of predefined masks or directly specified.
Look up table	A look up table operation is performed on an image to form a second image.
Morphology with erosion, dilation, boundary, open and close	A morphology operation is performed on an image to form a second image. The possible operations are erosion, dilation, boundary, open and close.
Graphics drawing operations	
Ellipse	Draw a filled ellipse or an ellipse outline in an image.
Line	Draw a line in an image.
Rectangle	Draw a filled rectangle or a rectangle outline in an image.
Sketch	Draw in an image using a sketching tool.
Text	Draw text in an image. Auto-incrementing numeric suffixes can be appended to the text.

Arithmetic operations

The *Arithmetic* operations are simple integer arithmetic processing operations performed on each pixel in an image buffer independent of neighboring pixels. The modified pixel values are written to the same (x, y) pixel location in a destination image buffer.

Some of these operations are *binary* meaning that they operate on two source images to produce a destination image. Pixels at corresponding (x, y) pixel locations in the two images are processed by the *binary* operator.

To display the Arithmetic operations, open the *Processing Control Panel* and select *Arithmetic* from the library selector drop down list.



Absolute difference

Calculate the absolute difference between two images forming a third image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
arith.dll	Source 1, Source 2, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, *Source 2*, and *Destination*.
2. Left click the *Absolute difference* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = |Source\ I_i - Source\ 2_i|$$

The positive difference is calculated.

This operation is applied repeatedly to each triplet generated by (*Source 1*, *Source 2*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1*, *Source 2*, and *Destination* can overlap for iterative processing.



Add

Add two images to form a third image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
arith.dll	Source 1, Source 2, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, *Source 2*, and *Destination*.
2. Left click the *Add* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = Source\ 1_i + Source\ 2_i$$

This operation is applied repeatedly to each triplet generated by (*Source 1*, *Source 2*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1*, *Source 2*, and *Destination* can overlap for iterative processing.

Overflow results are truncated to the maximum allowable values for the pixel type.



Add constant

Add a constant value to an image to form a second image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
arith.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, and *Destination*.
2. Right click the *Add constant* button found within the *Processing Control Panel*. A configuration window will appear.
3. Enter the constant value to add (positive or negative) in the **Constant** control.
4. Press the **Apply** button; or Press the **Close** button, and left click the *Add constant* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = Source\ I_i + Constant$$

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.

Overflow results are truncated to the maximum allowable values for the pixel type.



Average

Average images in a sequence of image buffers and store the result in a destination image buffer.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
arith.dll	Source 1, Destination	All	No	Independent	Yes

Procedures

1. Set the image buffer(s) to be averaged in *Source 1*.
2. Set the destination image buffer to contain the averaged result in *Destination*.
3. Left click the *Average* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination = (Source\ I_0 + Source\ I_1 + Source\ I_2 + \dots + Source\ I_n) \div n,$$

where n is the number of image buffers in the sequence.

The value for n is restricted to less than or equal to 2 147 483 647, the maximum value for a signed 32-bit integer.

Pixel summations are performed in a signed 32-bit integer accumulator. If the sum of corresponding pixels in the image sequence exceeds 2 147 483 647 (the maximum value for a signed 32-bit integer), an erroneous result will be obtained.

The image buffer(s) in *Source 1* can overlap the *Destination* image buffer.

ROIs are ignored by this operation.



Divide

Divide one image by another image to form a third image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
arith.dll	Source 1, Source 2, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, *Source 2*, and *Destination*.
2. Left click the *Divide* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$\text{Destination}_i = \text{Source } 1_i \div \text{Source } 2_i$$

This operation is applied repeatedly to each triplet generated by (*Source 1*, *Source 2*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1*, *Source 2*, and *Destination* can overlap for iterative processing.

Overflow results caused by division by zero are truncated to the maximum allowable values for the pixel type.



Maximum

Form a destination image by taking the greater (maximum) of the corresponding pixel values in two source images.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
arith.dll	Source 1, Source 2, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, *Source 2*, and *Destination*.
2. Left click the *Maximum* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = \text{maximum}(Source\ 1_i, Source\ 2_i)$$

This operation is applied repeatedly to each triplet generated by (*Source 1*, *Source 2*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1*, *Source 2*, and *Destination* can overlap for iterative processing.



Minimum

Form a destination image by taking the lesser (minimum) of the corresponding pixel values in two source images.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
arith.dll	Source 1, Source 2, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, *Source 2*, and *Destination*.
2. Left click the *Minimum* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = \text{minimum}(Source\ 1_i, Source\ 2_i)$$

This operation is applied repeatedly to each triplet generated by (*Source 1*, *Source 2*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1*, *Source 2*, and *Destination* can overlap for iterative processing.



Multiply

Multiply two images to produce a third image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
arith.dll	Source 1, Source 2, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, *Source 2*, and *Destination*.
2. Left click the *Multiply* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = Source\ 1_i \times Source\ 2_i$$

This operation is applied repeatedly to each triplet generated by (*Source 1*, *Source 2*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1*, *Source 2*, and *Destination* can overlap for iterative processing.

Overflow results are truncated to the maximum allowable values for the pixel type.



Multiply by fraction

Multiply two images by a fractional constant to produce a third image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
arith.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, and *Destination*.
2. Right click the *Multiply by fraction* button found within the *Processing Control Panel*. A configuration window will appear.
3. Enter the multiplier part of the fractional constant value in the **Constant multiplier** control.
4. Enter the divisor part of the fractional constant value in the **Constant divisor** control.
5. Press the **Apply** button; or Press the **Close** button, and left click the *Multiply by fraction* found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = (Source\ I_i \times Constant\ multiplier) \div Constant\ divisor$$

The multiplication is performed first, then the division. The interim multiplication result can overflow without truncation before the division is performed. The result calculated after the division is performed, is truncated if an overflow has occurred.

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.



Negate

Perform a two's complement negation on an image to form a second image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
arith.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. In *Source 1*, select the image buffer(s) to negate.
2. Left click the *Negate* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = \text{Two's complement}(Source\ I_i)$$

The two's complement operation is equivalent to flipping the pixel bits and adding 1.

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.



Subtract

Subtract one image from another to form a third image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
arith.dll	Source 1, Source 2, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, *Source 2*, and *Destination*.
2. Left click the *Subtract* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = Source\ 1_i - Source\ 2_i$$

This operation is applied repeatedly to each triplet generated by (*Source 1*, *Source 2*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1*, *Source 2*, and *Destination* can overlap for iterative processing.

Negative results are set to zero.

Boolean arithmetic, and bit-field operations

The *Boolean arithmetic*, and *bit-field arithmetic* operations are simple processing operations performed on each pixel in an image buffer, independent of neighboring pixels. The modified pixel values are written to the same (x, y) pixel location in a destination image buffer.

Some of these operations are *binary* meaning that they operate on two source images to produce a destination image. Pixels at corresponding (x, y) pixel locations in the two images are processed by the *binary* operator.

To display the Boolean arithmetic, and bit-field operations, open the *Processing Control Panel* and select *Boolean Arithmetic* from the library selector drop down list.



AND

Perform a bit-field Boolean AND operation between two images to form a third image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
bitarith.dll	Source 1, Source 2, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, *Source 2*, and *Destination*.
2. Left click the *AND* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = Source\ 1_i \text{ AND } Source\ 2_i$$

The AND operation examines the pixel values in the sources bit-by-bit, and sets the bits in the destination value according to this table:

Pixel bit from Source 1	Pixel bit from Source 2	AND result
0	0	0
0	1	0
1	0	0
1	1	1

This operation is applied repeatedly to each triplet generated by (*Source 1*, *Source 2*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1*, *Source 2*, and *Destination* can overlap for iterative processing.



AND, OR, XOR with constant

Perform a bit-field Boolean operation between an image and a constant value to form a third image. The possible Boolean operations are AND, OR, and XOR.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
bitarith.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, and *Destination*.
2. Right click the *Boolean with constant* button found within the *Processing Control Panel*. A configuration window will appear.
3. In the **Operation** control, select the operation to perform: **AND**; **OR**; or **XOR**.
4. Enter the constant value for the operation in the **Constant** control.
5. Press the **Apply** button; or Press the **Close** button, and left click the *Boolean with constant* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$Destination_i = Source\ I_i \text{ AND Constant value};$

$Destination_i = Source\ I_i \text{ OR Constant value};$ or

$Destination_i = Source\ I_i \text{ XOR Constant value}.$

The AND, OR, and XOR operations examine the pixel values in the sources bit-by-bit, and sets the bits in the destination value according to this table:

Pixel bit from	Pixel bit from	AND result	OR	XOR
----------------	----------------	------------	----	-----

Source 1	Constant value		result	result
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	1	0

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.



Bit shift

Bit-shift image pixels left or right to form a second image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
bitarith.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, and *Destination*.
2. Right click the *Bit shift* button found within the *Processing Control Panel*. A configuration window will appear.
3. In the **Bits to shift** control, enter the number of bit positions to shift.
4. In the **Direction** control, enter the shifting direction: **Left** or **Right**.
5. Press the **Apply** button; or Press the **Close** button, and left click the *Bit shift* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

Right bit shift: $Destination_i = Source\ I_i \gg Constant\ value$; or
 Left bit shift: $Destination_i = Source\ I_i \ll Constant\ value$.

Bits are not shifted circularly.

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing



NOT

Perform a bit-field Boolean NOT operation on an image to form a second image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
bitarith.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, and *Destination*.
2. Left click the *NOT* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:
 $Destination_i = NOT\ Source\ I_i$

The NOT operation examines the pixel values in the source bit-by-bit, and sets the bits in the destination value according to this table:

Pixel bit from Source 1	NOT result
0	1
1	0

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.



OR

Perform a bit-field Boolean OR operation between two images to form a third image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
bitarith.dll	Source 1, Source 2, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, *Source 2*, and *Destination*.
2. Left click the *OR* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = Source\ 1_i \text{ OR } Source\ 2_i$$

The OR operation examines the pixel values in the sources bit-by-bit, and sets the bits in the destination value according to this table:

Pixel bit from Source 1	Pixel bit from Source 2	OR result
0	0	0
0	1	1
1	0	1
1	1	1

This operation is applied repeatedly to each pair generated by (*Source 1*,

Destination) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.



XOR

Perform a bit-field Boolean XOR operation between two images to form a third image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
bitarith.dll	Source 1, Source 2, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1*, *Source 2*, and *Destination*.
2. Left click the *XOR* button found within the *Processing Control Panel*.

Comments

The calculation is as follows:

$$Destination_i = Source\ 1_i \text{ XOR } Source\ 2_i$$

The XOR operation examines the pixel values in the sources bit-by-bit, and sets the bits in the destination value according to this table:

Pixel bit from Source 1	Pixel bit from Source 2	XOR result
0	0	0
0	1	1
1	0	1
1	1	0

This operation is applied repeatedly to each triplet generated by (*Source 1*, *Source 2*, *Destination*) until the end of the longest sequence is reached.

Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1*, *Source 2*, and *Destination* can overlap for iterative processing.

Geometric operations

The *Geometric* operations include: operations that move pixels from one point location in an image to another point location; and operations that perform spatial measurements with regards to a set of pixel locations in an image.

To display the geometric operations, open the *Processing Control Panel* and select *Geometric* from the library selector drop down list.



Copy

Copy an image from one image buffer to another.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
geometry.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1* and *Destination*.
2. Left click the *Copy* button found within the *Processing Control Panel*.

Comments

This operation copies the source image ROI to the same ROI location in the destination image buffer.

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.



Mirror about vertical, horizontal or diagonal plane

Swap pixels in an image about vertical, horizontal or diagonal reflection plane and copy to another location.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
geometry.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1* and *Destination*.
2. Right click the *Mirror* button found within the *Processing Control Panel*. A configuration window will appear.
3. Select the reflection plane to be applied to the source image(s) in the **Reflection Plane** control. The options are: horizontal, vertical, diagonal (/), and diagonal (\).
4. Enable the **Replace source** control if you wish to set the source pixels to a constant pixel value after the operation is complete. Otherwise, disable this control setting.
5. If you have enabled the **Replace source** control, the source pixels will be set to the value you enter in the **Constant** control.
6. Press the **Apply** button; or Press the **Close** button, and left click the *Mirror* button found within the *Processing Control Panel*.

Comments

If the processed source image ROI exceeds image buffer boundaries in the

destination, it is clipped.

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.



Point to point measurements

This operation contains an assortment of measurements, plotting, and pixel copy operations that can be performed on a set of (x, y) point locations in an image.

❖ The measurements which can be performed include:

- ☐ *Coordinate extraction.* The image coordinates of point locations are extracted using a cursor in the image.
- ☐ *Line segment length.* The line segment lengths between pairs of point locations are measured.
- ☐ *Path length.* The total of all segment lengths measured between a series of points is calculated.
- ☐ *Segment angle.* The angle between a line segment (formed between a pair of points) and the horizontal is measured.
- ☐ *Polygon area.* The area enclosed within the polygon described by a series of points (at least 3) is measured.
- ☐ *Pixel value extraction.* The pixel values at point locations are extracted from an image.

The plotting operations include scatter and line plots generated from a set of points. The plots are superimposed on top of an image.

The pixel copy operations allow pixels in an ROI to be copied to another location within the same image buffer or a different image buffer.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
geometry.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

All point operations begin by activating the *Point measurements* window. The next step is to select a set of points. The desired measurement, plot, or pixel copy operation is then invoked.

Step 1. Activating the Point measurements window

To activate the *Point measurements* window, left click the *Point measurements* button found within the *Processing Control Panel*. The *Point measurements* window will appear.

Step 2. Selecting a set of points (coordinate extraction)

❖ There are two ways to select a set of points:

1. Direct selection of points using an image cursor; and
2. Importing points from another application.

❖ To directly enter points in the point list using an image cursor:

1. Select the image buffer for *Source 1*. This will be the image buffer where points are set up.
2. In the *Point measurements* window, press the **Setup** button. A cursor will appear in the image viewing window.
3. Position the cursor cross-hairs directly on top of the point you wish to select, and left-click the mouse; the coordinates of the point will be added to the **Points list** in the *Point measurements* window. The

coordinates of the point are displayed in units as defined by the current coordinate system (see *Setting the image coordinate system* in this chapter). The keyboard arrow keys can be used to position the cursor; and the *Space bar* is equivalent to left-clicking the mouse.

4. Repeat the above step for as many points as desired.
5. After all points have been selected, right-click the mouse or press the *Enter key* to exit point selection.

❖ **To import points from another application:**

1. From the other application, copy the x, y point pairs to the Windows clipboard. Applications with this capability usually have an **Edit** menu option with a **Copy** sub-menu option.
2. In the *Point measurements* window, press the **Edit** button located above the **Points** list. A pop-up menu will appear.
3. Choose **Paste** on the pop-up menu.

Step 3. Performing measurement, plot, or pixel copy operations

Before measurement, plot, or pixel copy operations are performed, the points to be used must be selected (highlighted) in the **Points** list control in the *Point measurements* window. Left-click on a point to enable the selection highlight; or press the **Edit** button above the **Points** list control, and choose **Select all** on the pop-up menu to select all points.

The following measurements are calculated using units as defined by the current coordinate system (see *Setting the image coordinate system* in this chapter).

Measuring line segment length

❖ **To measure the line segment length between consecutive points in the Points list:**

1. Select the points to use as described at the beginning of step 3.
2. Press the **Calculate** button in the *Point measurements* window. A pop-up menu will appear.
3. Choose **Segment lengths** on the pop-up menu. The results will be listed in the **Results** list in the *Point measurements* window.

Measuring path length

❖ **To measure the combined length of all segment lengths measured between a series of points:**

1. Select the points to use as described at the beginning of step 3.
2. Press the **Calculate** button in the *Point measurements* window. A pop-up menu will appear.
3. Choose **Total length** on the pop-up menu. The result will be listed in the **Results** list in the *Point measurements* window.

Measuring line segment angle

❖ **To measure the angle between a line segment (formed between a pair of points) and the horizontal:**

1. Select the points to use as described at the beginning of step 3.
2. Press the **Calculate** button in the *Point measurements* window. A pop-up menu will appear.
3. Choose **Angles** on the pop-up menu. The results will be listed in the **Results** list in the *Point measurements* window.

Measuring polygon area

❖ To measure the area enclosed within the polygon described by a series of points:

1. Select the points to use as described at the beginning of step 3. At least three points must be selected.
2. Press the **Calculate** button in the *Point measurements* window. A pop-up menu will appear.
3. Choose **Area** on the pop-up menu. The result will be listed in the **Results** list in the *Point measurements* window.

No area is calculated for polygons which contain crossing line segments. Unclosed polygons are closed automatically.

Pixel value extraction

❖ To extract the pixel values at point locations in an image:

1. Select the points to use as described at the beginning of step 3.
2. Select the image buffer to extract pixel values from using *Source 1* found within the *Processing Control Panel*.
3. Press the **Calculate** button in the *Point measurements* window. A pop-up menu will appear.
4. Choose **Pixel values** on the pop-up menu. The results will be listed in the **Results** list in the *Point measurements* window.

Drawing scatter and line plots

A scatter plot displays a mark or *symbol* at each point location in the plot. The symbol can be a dot, a circle, or a cross. The points can be optionally

labeled with a number; the label font can be chosen. The x and y axes of the current coordinate system can be drawn.

A line plot draws a line segment between consecutive points, but is otherwise the same as a scatter plot.

❖ **To draw a scatter or line plot:**

1. Select the image buffer where the plot will be drawn using the *Destination* control found within the *Processing Control Panel*.
2. Select the points to use as described at the beginning of step 3.
3. Press the **Plot** button in the *Point measurements* window. A pop-up menu will appear.
4. Choose **Select symbol**, and then choose **Point**, **Circle**, or **Cross**.
5. If you wish to label each point with a number, choose **Labels** on the pop-up menu. The label font can be selected by choosing **Choose label font** on the pop-up menu.
6. If you wish draw the coordinate system axes, choose **Draw axes** on the pop-up menu.
7. To draw a scatter plot, choose **Scatter plot** on the pop-up menu. To draw a line plot choose **Line plot** on the pop-up menu.

Copying a sub-image to point target(s)

❖ **To copy pixels in an ROI to one or more target locations:**

1. Select the source image buffer(s) where the pixels will be copied from, by setting the *Source* control found within the *Processing Control Panel*. Pixels will be copied from the current ROI in the source image buffer(s) (see Setting a region of interest for image processing in this chapter).

2. Select the destination image buffer(s) where the pixels will be copied to, by setting the *Destination* control found within the *Processing Control Panel*.
3. Select the target points to use as described at the beginning of step 3. The pixels in the source image buffer ROI will be copied to a rectangle of the same size (clipped to fit in bounds) with the top-left corner of the destination rectangle set to the target point location.
4. Press the **Copy** button in the *Point measurements* window. A pop-up menu will appear.
5. If you wish to copy the source ROI pixels to multiple targets in a single destination image buffer, choose **All points per buffer** on the pop-up menu. If you wish to copy to many image buffers using one target point per destination image buffer, choose **One point per buffer** on the pop-up menu.
6. The source pixels in the copy operation can be erased (set to a constant pixel value) after the copy is performed. Press the **Copy** button, and select **Configure** to enable or disable this option.

Comments

If a pixel copy operation will result in the copied pixels exceeding the boundaries of the destination image buffer, the source pixel rectangle will be automatically clipped to fit the destination image buffer.

Data can be exported to another application from the **Results** list in the *Point measurements* window by: highlighting the data in the list to be exported; pressing the **Edit** button located above the **Results** list; and choosing **Copy**. The data will be copied to the Windows clipboard where it can be pasted into another application.

Data can be deleted from either list in the *Point measurements* window by: highlighting the data in the list to be deleted; pressing the **Edit** button located above either list; and choosing **Delete** (or choose the **Clear all** option).

Networking

The **Results** list in the *Point measurements* window displays the calculation results from the selected computers.



Rotate $\pm 90^\circ$, 180°

Rotate image pixels ± 90 degrees, or 180 degrees, and copy to another location.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
geometry.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1* and *Destination*.
2. Right click the *Rotate* button found within the *Processing Control Panel*. A configuration window will appear.
3. Select the angle of rotation to be applied to the source image(s) using the **Angle** control. The options are: +90 degrees (counter-clockwise); -90 degrees (clockwise); and 180 degrees.
4. Enable the **Replace source** control if you wish to set the source pixels to a constant pixel value after the operation is complete. Otherwise, disable this control setting.
5. If you have enabled the **Replace source** control, the source pixels will be set to the value you enter in the **Constant** control.
6. Press the **Apply** button; or Press the **Close** button, and left click the *Rotate* button found within the *Processing Control Panel*.

Comments

If the processed source image ROI exceeds image buffer boundaries in the

destination, it is clipped.

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.

Analysis, statistics and measurement operations

The *Analysis, statistics and measurement* operations include sophisticated techniques for analyzing the structure of images. These operations generate results in the form of reports and graphs.

To display the analysis, statistics and measurement operations, open the *Processing Control Panel* and select *Analysis* from the library selector drop down list.



Blob counting and measurement

Classify, count, and measure image blobs. A blob is a cluster of connected *on* pixels which are surrounded by background *off* pixels.

❖ The key features of this operation are:

- ❑ *Blob counting and measurement.* Before blobs are counted, the image is binarized to mark pixels as either part of an object or part of the background. Blobs can be excluded from the count if the blob area does not fall in a specified range, or if the blob intersects the boundaries of the ROI. Blob centroids and axes of rotation are also calculated.
- ❑ *Blob frequency distribution calculation.* Blobs can be classed by area into a frequency distribution. The distribution can be shown as a histogram plot and saved to a bitmap graphic file.

- ❑ *Export results to text and graphic files.* Data describing each blob and the frequency distribution of blob areas, can be exported to an ASCII data file. Plot graphics can be exported to bitmap graphic files.
- ❑ *Graphic overlays on images.* Graphics can be overlaid on the image to: paint the counted objects; draw bounding rectangles around the objects; number the objects or show the axes of rotation of the object.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
blob.dll	Source 1, Destination	All	Yes	Average	No

Procedures

1. Set the image buffer to analyze in *Source 1*.
2. Set the image buffer to draw blob graphics in *Destination*. The drawing of blob graphics in an image buffer is optional.
3. Select the ROI marking the image area to analyze (see Setting a region of interest for image processing in this chapter).
4. Left click the *Blob* button found within the *Processing Control Panel*. A configuration window will appear.
5. In the **Blob definition** control group, set the “**On**” **pixel range** control. Pixels falling within these inclusive limits will be considered foreground pixels (part of a blob).
6. Enable the **Exclude edge blobs** to exclude blobs which intersect with the edges of the ROI from being counted.
7. Set the **Minimum area** and **Maximum area** controls. Blobs with areas outside of the specified area range will not be counted. The units for this setting are the *physical units* specified in the *Metrics* control group of the *Processing* control panel.

8. Set the **Number of classes** and **Class size** controls. The area range between *Minimum area* and *Maximum area* is sub-divided into smaller, equally sized sub-groups known as classes. The *Class size* refers to the area range covered by a class. The number of blobs falling into each class is counted to form the frequency distribution of blob areas.

Changing *Minimum area*, *Maximum area* or *Class size* settings automatically causes a recalculation of the *Number of classes*. Changing *Minimum area* or *Maximum area* will not change *Class size*, and therefore the last class (largest areas) will be smaller than the other classes. If *Number of classes* is explicitly specified, the *Class size* will be adjusted so that all classes are of equal size.

Changing *Class size* changes *Number of classes*. If the *Class size* does not evenly divide the area range between *Minimum area* and *Maximum area*, the last class (largest area) will be smaller than the other classes. When setting *Number of classes* directly the *Class size* will be adjusted so that all classes are of equal size.

9. To enable the creation of a bitmap graphic showing a histogram plot of blob area frequency distribution, enable the **Generate graph** option. The dimensions of the bitmap containing the plot are specified in the **Size** control boxes.
10. To enable the output of blob analysis data to the *Data Viewer* window, enable the **Generate data listing** control.
11. To enable blob graphics to be drawn in an image buffer, enable the **Draw blob graphics** option.
12. Press the **Apply** button to create the frequency distribution histogram plot; to list blob analysis data; or both.

For information on interacting with graphics in the *Graphic Viewer* window, and data in the *Data Viewer* window, see the sub-section *Interacting with Data and Graphic Viewers* at the end of this section (Analysis, statistics and measurement operations).

Comments

The blob analysis data output to the *Data Viewer* window lists some introductory statistics followed by data in the following format:

Frequency Distribution of Blob Areas

Class Number, Center Area of Class, Number of Blobs

<Class Number> *tab* <Center Area of Class> *tab* <Number of Blobs>

Individual Blob Measurements

Blob Number, Centroid X position, Centroid Y position, Blob Area

<Blob Number> *tab* <Centroid X position> *tab*
<Centroid Y position> *tab* <Blob Area>

Blob Number, Blob Axes: Axes A: (x1, y1), (x2, y2); Axes B: (x1, y1), (x2, y2)

<Blob Number> *tab* <A_{x1}> *tab* <A_{y1}> *tab* <A_{x2}> *tab* <A_{y2}> *tab*
<B_{x1}> *tab* <B_{y1}> *tab* <B_{x2}> *tab* <B_{y2}>

When working with color pixel types, the average of the color planes selected for processing is used as the pixel value (see the section *Setting the color planes* for image processing in this chapter).

Networking

For meaningful results, this operation should only be applied to *Slaves* with the same pixel type as the *Master*.



Contour plot with path extraction

Extract and plot image contours. An image contour marks the approximate path along which pixels have equal values. This is similar in concept to the elevation curves shown on topological maps.

❖ **The key features of this tool are:**

- ☐ Contours for a specified set of pixel values may be extracted.
- ☐ Contour plot graphics can be created and saved to a bitmap graphic file.
- ☐ The contours can be drawn on an image.
- ☐ The set of image coordinates describing the path of each contour can be exported to an ASCII data file.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
contour.dll	Source 1	All	Yes	Average	No

Procedures

1. Set the image buffer to analyze in *Source 1*.
2. Set the image buffer to plot contours in *Destination*. Plotting of contours in an image buffer is optional.
3. Select the ROI marking the image area to plot (see Setting a region of interest for image processing in this chapter).
4. Left click the *Contour* button found within the *Processing Control Panel*. A configuration window will appear.
5. In the **Contour Levels** control, enter the pixel values for the contours that are to be extracted. Alternatively, the pixel values may be loaded from a text file by pressing the **Load** button. The format of the text file is one pixel value on each line. Pixel values in the **Contour Levels** control can be saved to a text file for later use by pressing the **Save** button.
6. The image can be pre-processed with a smoothing operation before contours are extracted. Enter the number of smoothing passes in the **Smoothing passes** control.
7. To enable the drawing of contours on an image, enable the **Display contours in image** option in the **Plotting options** control group.

8. To enable the set of coordinates denoting the path of each contour to be added to the *Data Viewer* window located at the bottom of the *Contour Options* window, enable the **Record contour coordinate data** option in the **Plotting options** control group. The coordinate data is reported in terms of the *physical units* specified in the *Metrics* control group of the *Processing* control panel.
9. To enable the creation of a bitmap graphic showing the contour plot, enable the **Generate graph** option in the **Plotting options** control group. Additional options related to the generation of this plot include: setting the size of the bitmap graphic (**Size** controls); labeling the axes of the plot (**Label the axes** option); labeling the contours with numbers (**Label the contours** option); and drawing the contours (**Draw contours** option).
10. Press the **Apply** button to create the contour plot; to list the contour data; or both.

For information on interacting with graphics in the *Graphic Viewer* window, and data in the *Data Viewer* window, see the sub-section *Interacting with Data and Graphic Viewers* at the end of this section (Analysis, statistics and measurement operations).

Comments

The smoothing operation is a 3×3 convolution kernel with all mask elements set to 1 and a divisor equal to 9. The format of contour coordinate data stored in the *Data Viewer* window is a series of (x, y) pairs, 1 pair per line as follows:

<x location> <space character> <y location>

When working with color pixel types, the average of the color planes selected for processing is used as the pixel value (see the section *Setting the color planes for image processing* in this chapter).

Networking

For meaningful results, this operation should only be applied to *Slaves* with the same pixel type as the *Master*.



Live pixel monitoring for points, lines, and areas

Perform continuous frame capture, and measure pixel values at a point, along a line (profile), or in an area (histogram).

❖ The key features of this tool are:

- ☐ The point monitoring operation displays a scrolling plot of the *Pixel Value* at a fixed point in the image for each incoming frame.
- ☐ The line monitoring operation displays a profile plot of *Pixel Value* vs. *Pixel Position on a Line*, and is updated for each incoming frame.
- ☐ The area monitoring operation displays a histogram plot of *Pixel Value Frequency* vs. *Pixel Value*, and is updated for each incoming frame.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
analysis.dll	Source 1	All	No	Average	No

Procedures

1. Set the image buffer to analyze in *Source 1*.
2. Left click the *Pixel monitor* button found within the *Processing Control Panel*. A configuration window will appear.

3. Enter the tool name in the **Tool name** control. A tool is described by its *type* and the settings pertaining to its *type*.
4. Select the tool type in the **Tool type** controls. The possible selections are **Point**, **Line**, and **Area**.
5. Enter the coordinate settings for the tool in the **Tool settings** control group. The interpretation of the controls depends on the *Tool type* as follows:
 - *Point tool.* **x1**, **y1** specify the point coordinates.
 - *Line tool.* **x1**, **y1** specify the coordinates of the start point of the line; **x2**, **y2** specify the coordinates of the end point of the line.
 - *Area tool.* **x1**, **y1** specify the coordinates of one corner of the enclosing rectangle; **x2**, **y2** specify the coordinates of the diagonally opposite corner.
6. If you are using the *Area* tool, select the pixel classification criteria in the frequency distribution by pressing the **Pixel class** button. The settings for each case are listed below.
 - *All bits identical (common case).* Two pixels are classed the same if corresponding bits in each pixel value are identical.

 If you are working with an 8-bit camera (color or monochrome), set the **Index bits** control to 8.

 If you are working with a 9...16-bit monochrome camera: set the **Index bits** control to the camera pixel size; set the **Shift bits** control to 0; set the **Class bits** controls that are enabled to 0's by pressing the enabled toggle buttons.
 - *Most-significant bits identical.* Two pixels are classed the same if corresponding bits in a range of most-significant bits are identical.

If you are working with an 8-bit camera (color or monochrome): set the **Index bits** control to the desired number of most-significant bits; set the **Shift bits** to $8 - \text{index bits}$).

If you are working with a 9...16-bit monochrome camera: set the **Index bits** control to the desired number of most-significant bits; set the **Shift bits** to $(\text{camera pixel size} - \text{index bits})$; set the **Class bits** controls that are enabled to 0's by pressing the enabled toggle buttons. For instance if you are working with a 12-bit camera, and wish to classify pixels based on the 8 most significant bits: set **Index bits** to 8; set **Shift bits** to 4; set the 4 enabled buttons of the **Class bits** to 0's.

- Exclude pixels using a bit mask. A bit mask, *class bits*, is compared to a range of most-significant bits in a pixel. If the most-significant pixel bit range does not match the *class bits*, the pixel is discarded from the calculation; if the bits do match, the pixel is included in the calculation, and two pixels are classed the same if corresponding *index bits* are identical.

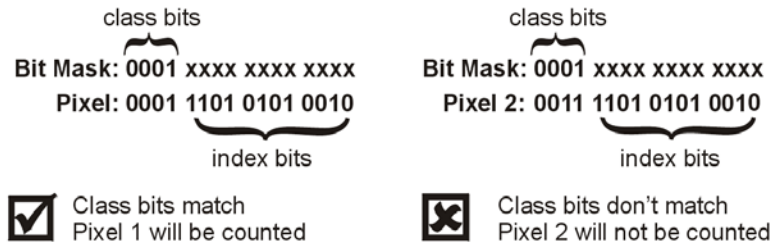


Figure 6.2: Calculations using class bits

Setting of the controls is best illustrated by an example. Assume you are working with a 12-bit camera, and wish to obtain a frequency distribution of pixel values with values greater than or equal to 2048 ($1000\ 0000\ 0000_{\text{binary}}$). Set **Shift bits** to 0; set **Index bits** to 11; set the first 4 **Class bits** starting from the left to 0; set the fifth **Class bit** from the left to 1.

7. To interactively choose the coordinate settings, press the **Interactive setup** button. A cursor will appear in the image buffer. Set the coordinates as follows:
 - *Point tool.* Move the cursor to the desired point location using the mouse or keyboard *Arrow* keys; Right click or press the *Enter* key.
 - *Line tool.* Move the cursor to the location of the line start point using the mouse or keyboard *Arrow* keys and left click (or press the *Space bar* key); Move the cursor to the location of the line end point and right click (or press the *Enter* key).
 - *Area tool.* Move the cursor to the location of the one corner of the area rectangle using the mouse or keyboard *Arrow* keys, and left click (or press the *Space bar* key); Move the cursor to the location of the opposite rectangle corner and right click (or press the *Enter* key).

Press the *Escape* key to cancel and exit the image cursor mode at any time.

8. Enter the frequency range for the graph in the **Frequency range** control group. These settings are used only for area tools. **Minimum** specifies the minimum pixel frequency which will register on the profile plot; **Maximum** specifies the maximum pixel frequency.
9. Enter the maximum pixel value for the graph in the **Max pixel value** control. This value is used as the maximum value on the y (pixel value) axis of the graphs for point and line tools only. The setting is separate for each line a point tool.
10. Press the **Add/Update** button to add the tool to the **Tool list**.
11. Highlight the tool(s) in the **Tool list** which will be used for measurement.
12. Press the **Measure current** button to perform a single measurement on the image already stored in *Source 1*. Only highlighted items in the **Tool list** will be used.
13. Press the **Measure live** button to repeatedly capture images, and perform measurements. Only highlighted items in the **Tool list** will be used.

14. Press the **Close** button when you are finished.

Comments

Points, lines, and areas can be measured at the same time; more than one point, line, or area can be monitored at a time.

A common application of the *Area* tool is to maximize the contrast between light and dark in an image, and avoid image saturation. The user manually adjusts the camera aperture in response to feedback from the *Area* tool. The *Area* tool frequency distribution plot will reach maximum breadth when maximum image contrast has been maximized. If a large proportion of pixels are found at the highest gray level, image saturation is occurring, and the aperture setting should be reduced.

An alternative method for adjusting image contrast may be possible: Some camera interface devices can precondition the signal from an analog camera to improve image contrast for the light conditions present using a *Programmable ADC*.

A common application of the *Line* tool is to aid in focusing the camera lens on the field of view. The user manually adjusts the camera focus in response to feedback from the *Line* tool. The *Line* tool profile plot will reach peak amplitude when the foreground of the field of view reaches focus.

Networking

Calculations for each of the selected tools will be performed on the computers selected in the *Networking Control Panel*. All windows showing the analysis of each tool will be shown on the *Master*. The title bar of the analysis window will indicate the computer on which the analysis is performed.



Pixel value frequency histogram plot with data extraction

Measure the frequency distribution of pixel values in an image. The mean, standard deviation, and mode of the distribution are also calculated.

❖ **The key features of this tool are:**

- ☐ The frequency distribution data can be shown as a histogram plot and saved to a bitmap graphic file.
- ☐ The frequency distribution data can be exported to an ASCII data file.
- ☐ The pixels can be classed based on the full range of bits in the pixel values or a sub-range of bits.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
pixelfrq.dll	Source 1	All	Yes	Average	No

Procedures

1. Set the image buffer to analyze in *Source 1*.
2. Select the ROI marking the image area to analyze (see Setting a region of interest for image processing in this chapter).
3. Left click the *Pixel frequency* button found within the *Processing Control Panel*. A configuration window will appear.
4. Select the pixel classification criteria in the frequency distribution. The settings for each case are listed below.
 - *All bits identical (common case)*. Two pixels are classed the same if corresponding bits in each pixel value are identical.

If you are working with an 8-bit camera (color or monochrome), set the **Index bits** control to 8.

If you are working with a 9...16-bit monochrome camera: set the **Index bits** control to the camera pixel size; set the **Shift bits** control to 0; set the **Class bits** controls that are enabled to 0's by pressing the enabled toggle buttons.

- *Most-significant bits identical.* Two pixels are classed the same if corresponding bits in a range of most-significant bits are identical.

If you are working with an 8-bit camera (color or monochrome): set the **Index bits** control to the desired number of most-significant bits; set the **Shift bits** to (8–*index bits*).

If you are working with a 9...16-bit monochrome camera: set the **Index bits** control to the desired number of most-significant bits; set the **Shift bits** to (*camera pixel size* – *index bits*); set the **Class bits** controls that are enabled to 0's by pressing the enabled toggle buttons. For instance if you are working with a 12-bit camera, and wish to classify pixels based on the 8 most significant bits: set **Index bits** to 8; set **Shift bits** to 4; set the 4 enabled buttons of the **Class bits** to 0's.

- *Exclude pixels using a bit mask.* A bit mask, *class bits*, is compared to a range of most-significant bits in a pixel. If the most-significant pixel bit range does not match the *class bits*, the pixel is discarded from the calculation; if the bits do match, the pixel is included in the calculation, and two pixels are classed the same if corresponding *index bits* are identical.

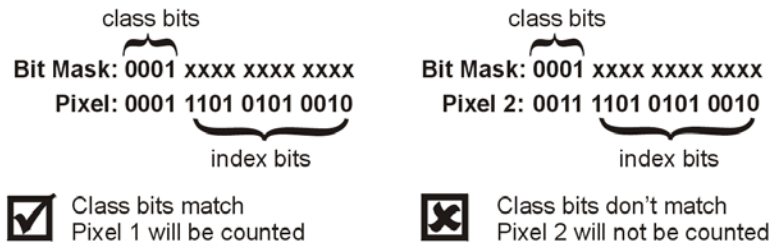


Figure 6.3: Calculations using class bits.

Setting of the controls is best illustrated by an example. Assume you are working with a 12-bit camera, and wish to obtain a frequency distribution of pixels values with values greater than or equal to 2048 (1000 0000 0000_{binary}). Set **Shift bits** to 0; set **Index bits** to 11; set the first 4 **Class bits** starting from the left to 0; set the fifth **Class bit** from the left to 1.

5. To enable the creation of a bitmap graphic showing a histogram plot of pixel frequency distribution, enable the **Generate graph** option. The dimensions of the bitmap containing the plot are specified in the **Size** control boxes. The range of histogram bars shown on the histogram can be restricted by setting the **Graph minimum** and **Graph maximum** controls.
6. To enable the output of results to the *Data Viewer* window, enable the **Generate data listing** control.
7. Press the **Apply** button to draw the pixel frequency histogram plot; to list the pixel frequency distribution data; or both.

For information on interacting with graphics in the *Graphic Viewer* window, and data in the *Data Viewer* window, see the sub-section *Interacting with Data and Graphic Viewers* at the end of this section (Analysis, statistics and measurement operations).

Comments

The format of the distribution data output to the *Data Viewer* window is one index and frequency value per line as follows:

```
<distribution index (i.e. pixel value in some cases)> tab  
<frequency at index>
```

When working with color pixel types, the average of the color planes selected for processing is used as the pixel value (see the section *Setting the color planes for image processing* in this chapter).

Networking

For best results, this operation should only be applied to *Slaves* with the same pixel type as the *Master*.



Pixel value viewing as numeric text

View an image as a matrix of text numbers. The possible numeric representations are decimal, binary, and hexadecimal.

The pixel value numbers can be exported as ASCII text to a file or to the Windows clipboard.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
analysis.dll	Source 1	All	Yes	Independent	No

Procedures

1. Set the image buffer to analyze in *Source 1*.
2. Left click the *Pixel Values* button found within the *Processing Control Panel*. The *Pixel Values* window will appear. The gray-shaded numbers in the top row are the column numbers in the source image buffer. The gray-shaded numbers in the left column are the row numbers.
3. Set the numeric representation style. Press the **Configure** button. In the **Viewing format** control group, select **Decimal**, **Binary**, or **Hexadecimal**. The numeric representation style can also be changed using the appropriate drop down list on the bottom right of the viewer.
4. Change the system. In the **System** drop down list, there will be an entry for the *Master* system (**This Computer**) and each of the connected *Slave* computers. Select the desired computer from the drop down list.
5. Change the source image buffer. In the **Image Number** edit box, enter the buffer number of the buffer that you want to use as the source for the *Pixel Value Viewer*. Press **Go** to accept the switch to the new buffer.
6. View pixel values from different areas of the image using one of these methods:

- Size the *Pixel Values* window by dragging the window edges;
 - Move the scroll-bar thumbs located on the right and bottom of the number grid; or
 - Press the **Interactive** button. A small rectangular-shaped cursor will appear in the image. Position the cursor near the image area of interest using the mouse (or the keyboard *Arrow* keys); left-click the mouse (or press the *Space bar* key) and the number grid will be updated to the position of the cursor. Right-click or press the *Escape* key to exit cursor mode.
7. To save pixel value data to an ASCII text file:
- Press the **Configure** button.
 - Select the **Area for clip and save** to one of the **Pixel value view area**, **Whole image** or current **Region of Interest**.
 - Select the delimiter between numbers under the **Data format** group. The choices are **Tab separated**, **Comma separated** and **Space separated**.
 - Press the **OK** button to accept the settings.
 - Press the **Save** button and choose a file name for the output ASCII text file.
8. To copy pixel value data to the Windows clipboard, follow the above procedure except for the last step: Press the **Clip** button instead of the **Save** button.
9. Press the **Close** button when you are finished.

Comments

Color pixel types are viewed as three comma separated numbers in the order (*red, green, blue*) in each grid cell of the *Pixel Values* window.

Viewing pixel values in binary or hexadecimal numeric representations is often useful when working with digital cameras. Problems with a digital camera, or digital camera interface, can often be identified using this technique.

Networking

A *Master* or *Slave* computer can be interactively selected within the *Pixel Values* window using the **System** selector control.



Profile plot with data extraction

Extract the pixel values located along a line (profile) in an image and create a profile plot graphic.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
profile.dll	Source 1	All	No	Average	No

Procedures

1. Set the image buffer for analysis in *Source 1*.
2. Left click the *Profile* button found within the *Processing Control Panel*. A configuration window will appear.
3. To enable the creation of a bitmap graphic showing a profile plot of pixel values, enable the **Generate graph** option. The dimensions of the bitmap containing the plot are specified in the **Size** control boxes.
4. To enable the output of profile data to the *Data Viewer* window, enable the **Generate data listing** control.
5. Select the profile line in the image buffer. To select the profile line:
 - Press the **Apply** button. A cross-hair image cursor will appear in the image buffer.

- Position the mouse cursor to the first end-point at the line and left-click.
- Position the mouse cursor at the second end-point of the line and right-click to complete profile line selection and exit image cursor mode. Alternatively, left-click, move the mouse to translate the line position, and right-click to complete profile line selection and exit image cursor mode. Left-clicking a second time will return you to step (ii) above.

After the profile line is selected: the profile data will be extracted; the data list (if requested) will be generated; and the profile plot (if requested) will be created.

The *Escape* key can be used to terminate and cancel the profile line selection procedure and analysis.

For information on interacting with graphics in the *Graphic Viewer* window, and data in the *Data Viewer* window, see the sub-section Interacting with Data and Graphic Viewers at the end of this section (Analysis, statistics and measurement operations).

Comments

The format of the profile data output to the *Data Viewer* window is one pixel (x,y) location and the corresponding pixel value on each line as follows:

```
<pixel x location> tab <pixel y location> tab <pixel value>
```

When working with color pixel types, the average of the color planes selected for processing is used as the pixel value (see the section Setting the color planes for image processing in this chapter).

Networking

The graph ranges will not be applied correctly for *Slaves* with pixel bit depths that differ from the *Master*.



Projection plot for rows or columns with data extraction

Calculate the image projection in the rows or columns direction and create a projection plot graphic and/or a data listing of the pixel values.

An image projection in the rows (or columns) direction is a summation of pixel values in a row (or column). The result is a set of summation values for each row (or column).

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
project.dll	Source 1	All	Yes	Average	No

Procedures

1. Set the image buffer for analysis in *Source 1*.
2. Select the ROI marking the image area to analyze (see *Setting a region of interest for image processing* in this chapter).
3. Left click the *Projection* button found within the *Processing Control Panel*. A configuration window will appear.
4. In the **Projection type** control group, select **Rows** or **Columns**.
5. To enable the creation of a bitmap graphic showing a projection plot, enable the **Generate graph** option. The dimensions of the bitmap containing the plot are specified in the **Size** control boxes.
6. To enable the output of projection data to the *Data Viewer* window, enable the **Generate data listing** control.
7. Press the **Apply** button to create the projection plot; to list the projection data; or both.

For information on interacting with graphics in the *Graphic Viewer* window, and data in the *Data Viewer* window, see the sub-section Interacting with Data and Graphic Viewers at the end of this section (Analysis, statistics and measurement operations).

Comments

The format of the projection data output to the *Data Viewer* window is a row (or column) number and the sum for that row (or column) on each line as follows:

<row (or column) number> *tab* <sum for row (or column)>

When working with color pixel types, the average of the color planes selected for processing is used as the pixel value (see the section Setting the color planes for image processing in this chapter).

Networking

The graph ranges will not be applied correctly for *Slaves* with pixel bit depths that differ from the *Master*.



Surface plot with grid point data extraction

Create a surface plot of image data. In the surface plot, the 2-dimensional image data is visualized as a 3-dimensional surface, where the *z*-dimension at a point is proportional to the pixel value at that point in the image.

After a surface plot is created, it can be saved to a bitmap graphic file.

The matrix of pixel values, from which the grid points of the plot are formed, can be exported to an ASCII data file.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
surface.dll	Source 1	All	Yes	Average	No

Procedures

1. Select the image buffer for *Source 1*.
2. Select the ROI marking the image area to plot (see Setting a region of interest for image processing in this chapter).
3. Left click the *Surface* button found within the *Processing Control Panel*. A configuration window will appear.
4. Set the pixel value range using the **Minimum** and **Maximum** controls. Pixel values below the *minimum* value will be set to *minimum* value. Pixels above the *maximum* value will be set to the *maximum* value. The *x* and *y* axes will intercept the *z* axis at the *minimum* value.
5. Set the grid point sampling interval using the **Skip** control. A *skip* value of 1 will cause every pixel in every image row to be used as grid points in the plot; a *skip* value of 2 will cause every 2nd pixel in every 2nd row to be used as grid points in the plot; and so on. The top left corner of the ROI is always the first grid point.
6. Set the rotation of *azimuth* of the viewing perspective of the plot by using the **Azimuth** control. With an *azimuth* of 0 degrees the plot will be viewed with line of sight parallel to the *y* axis, and perpendicular to the *x* axis. As the *azimuth* increases, the plot rotates; at 90 degrees the plot will be viewed with line of sight parallel to the *x* axis, and perpendicular to the *y* axis.
7. Set the inclination or *altitude* of the viewing perspective of the plot by using the **Altitude** control. With an *altitude* of 0 degrees the plot will be viewed with line of sight parallel to the *z=minimum* plane (*minimum* is set by **Minimum** control). As the *altitude* is increased, the inclination of the viewing is increased; at 90 degrees the plot will be viewed with the line of sight perpendicular to the *z=minimum* plane.

8. To enable the listing of the pixel values used at each grid point, enable the **Generate data listing** control. The plot parameters, and grid point data will be stored in the *Data Viewer* window attached to the *Surface Plot Options* window.
9. To enable the actual drawing of the surface plot, enable the **Generate graph** control. The dimensions of the bitmap containing the plot are specified in the **Size** control boxes.
10. Press the **Apply** button to create the surface plot; to list the grid point data values; or both.
11. If the **Generate data listing** checkbox was checked, the output of the **Surface** operation will be displayed in the **Graphic Viewer** window. To best manipulate this data, cut and paste the data into an application without wordwrap such as Notepad.

For more information on interacting with graphics in the *Graphic Viewer* window, and data in the *Data Viewer* window, see the sub-section Interacting with Data and Graphic Viewers at the end of this section (Analysis, statistics and measurement operations).

Comments

The format of the grid point data when stored in the *Data Viewer* window is:

```
<samples on top grid row>
...
<samples on (top+n×skip-1) grid row>
...
n=1, 2, ... until last row within ROI is reached.
```

The sample values on each row are separated by *tab* characters. The format of each row is:

```
<pixel value of left grid column>
...
< pixel value of (left+m×skip−1) grid column>
...
m=1, 2, ... until last column within ROI is
reached.
```

When working with color pixel types, the average of the color planes selected for processing is used as the pixel value (see the section *Setting the color planes* for image processing in this chapter).

Networking

The graph ranges will not be applied correctly for *Slaves* with pixel bit depths that differ from the *Master*.

Interacting with Data and Graphic Viewers

Several operations in the Analysis, statistics and measurement operations section share common interface components for interacting with the graphics and data generated from analysis. This sub-section details the operation of these components.

Graphic Viewer operations

❖ The following operations can be performed using the Graphic Viewer window:

- ☐ Saving the graphic to a bitmap graphic file (.BMP). Choose **File...Save** on the *Graphic Viewer* window menu.
- ☐ Printing the graphic. Choose **File...Print** on the *Graphic Viewer* window menu.

- ☐ Clearing the contents of the *Graphic Viewer* window. Choose **File...New** on the *Graphic Viewer* window menu.
- ☐ Opening a bitmap graphic file for viewing in the *Graphic Viewer* window. Choose **File...Open** on the *Graphic Viewer* window menu.
- ☐ Performing data exchange between the Clipboard and the *Graphic Viewer* window. Choose **Edit** on the *Graphic Viewer* window menu.



Networking note: Graphics generated by operations performed on *Slaves* will be displayed in the *Graphic Viewer* window on the *Master*.

Data Viewer operations

❖ The following operations can be performed using the Data Viewer window:

- ☐ Saving the data stored in the *Data Viewer* window to an ASCII data file. Choose **File...Save As** on the *Data Viewer* window menu.
- ☐ Print the data stored in the *Data Viewer* window. Choose **File...Print** on the *Data Viewer* window menu.
- ☐ Clearing the contents of the *Data Viewer* window. Choose **File...New** on the *Data Viewer* window menu.
- ☐ Opening an ASCII data file for viewing in the *Data Viewer* window. Choose **File...Open** on the *Data Viewer* window menu.
- ☐ Performing data exchange between the Clipboard and the *Data Viewer* window. Choose **Edit** on the *Data Viewer* window menu. Select an item on the menu.



Networking note: Data generated by operations performed on *Slaves* will be displayed in the *Data Viewer* window on the *Master*.

Transform operations

The *Transform* operations are performed on a source image to produce a destination image.

Some of these operations involve neighborhood pixel processing. With neighborhood pixel processing, a pixel and its neighbors are used to calculate the pixel to be written to the same (x, y) pixel location in a destination image buffer.

To display the transform operations, open the *Processing Control Panel* and select *Transform* from the library selector drop down list.



Binarize

An image is *binarized* to form a second image. The calculation is as follows: Pixels with values in a specified range are set to a constant value; Pixels with values outside of the range are set to 0.

Library filename	Parameters	types	ROI processing	processing	Sequence
transfrm.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1* and *Destination*.
2. Select the ROI for image processing (see Setting a region of interest for image processing in this chapter).
3. Right click the *Binarize* button found within the *Processing Control Panel*. A configuration window will appear.
4. Set the **Binarization value** control to the pixel value to which pixels falling in the binarization range will be set.

5. Set the pixel range for binarization using the **Start of range** and **End of range** controls.

If *End of range* is greater than *Start of range* then pixel values greater than or equal to *Start of range* and less than or equal to *End of range* will be set to the *Binarization value*.

If *End of range* is less than *Start of range* then pixel values greater than or equal to *Start of range* or pixel values less than or equal to *End of range* will be set to the *Binarization value*.

6. Press the **Apply** button; or Press the **Close** button, and left click the *Binarize* button found within the *Processing Control Panel*.

Comments

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.



Convolution with predefined and custom masks

An image is *convolved* with a mask to form a second image. The mask can be chosen from a list of predefined masks or directly specified.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
transfrm.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1* and *Destination*.

2. Select the ROI for image processing (see Setting a region of interest for image processing in this chapter).
3. Right click the *Convolution* button found within the *Processing Control Panel*. A configuration window will appear.
4. *Predefined* masks and *Custom* masks can be used in the convolution.

To specify a predefined mask, choose the predefined mask in the **Mask Library** group.

❖ **To specify a custom mask:**

- Enter the *Mask width* in the **Mask width** control of the **Custom mask** group.
- Enter the *Mask height* in the **Mask height** control.
- Enter the *Divisor* in the **Divisor** control.
- Enter the *Mask values* in the matrix of **Mask value** controls.
- Enable the **Copy edge value** control to copy the edge results from the nearest computed result.
- Enable the **Negate negative results** to take the absolute value of any negative results. Otherwise, negative results will be set to 0.
- To add the mask to the list of predefined masks, press the **Save** button.

The *Mask values* can all be set to 0 by pressing the **Zero values** button.

The *Mask values* can be set to a constant value by entering the value in the control beside the **Fill with** button, and then pressing the **Fill with** button.

5. Press the **Apply** button; or Press the **Close** button, and left click the **Convolution** button found within the *Processing Control Panel*.

Comments

An image is convolved with a 3×3 mask (matrix of positive, negative or zero-valued integers) as follows:

$$\text{Mask} = \begin{matrix} m_{11} & m_{12} & m_{13} \\ m_{21} & m_{22} & m_{23} \\ m_{31} & m_{32} & m_{33} \end{matrix} \quad \text{Image} = \begin{matrix} p_{11} & p_{12} & p_{13} & \dots \\ p_{21} & p_{22} & p_{23} & \\ p_{31} & p_{32} & p_{33} & \\ \dots & & & \end{matrix}$$

The convolution computation of this 3×3 mask with the pixels in the top left image corner yields:

$$p_{22}' = (m_{11} \bullet p_{11} + m_{12} \bullet p_{12} + m_{13} \bullet p_{13} + m_{21} \bullet p_{21} + m_{22} \bullet p_{22} + m_{23} \bullet p_{23} + m_{31} \bullet p_{31} + m_{32} \bullet p_{32} + m_{33} \bullet p_{33}) \div n\text{Divisor}$$

with negative results made positive.

The mask is convolved with the image starting at the top left, replacing the image pixel under the center of the mask. The mask is then translated one pixel to the right, and another convolution is performed. This is repeated until the right side of the image is reached, after which the mask is placed on the left side of the image, one pixel row down, and another "line" of calculations is done.

The mask width must be less than or equal to the image buffer width. The mask height must be less than or equal to the image buffer height. The mask width and height values are always odd numbers.

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.



Look up table

A look up table operation is performed on an image to form a second image.

Library filename		Pixel types	processing	Color plane processing	Sequence processing
transfrm.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

❖ To access this operation:

1. Select the image buffer(s) for *Source 1* and *Destination*.
2. Select the ROI for image processing (see Setting a region of interest for image processing in this chapter).
3. Right click the *Look up table* button found within the *Processing Control Panel*. A configuration window will appear.
4. Specify the look up table entries. The look up tables can be interactively assigned or read from a file. Both procedures are described below.
5. Set the pixel classification criteria. This procedure is described below.
6. Press the **Apply** button; or Press the **Close** button, and left click the *Look up table* button found within the *Processing Control Panel*.

❖ To interactively assign look up table entries:

1. Locate the control labeled **Channel**. The options for this control depend on the image pixel type you are working with:
 - *8-bit grayscale images*. The options are **Channel 1**, **Channel 2** or **Channel 3**. These are three 8-bit grayscale look up tables which can be independently set, and activated. The selected channel contains the active look up table.

- *Color images.* The options are **Red**, **Green**, or **Blue**. Select the pixel color plane to modify the look up table associated with that color plane.
 - *9 ... 16-bit grayscale images.* The options are **Channel 1**, **Channel 2** or **Channel 3**. These are three 16-bit grayscale look up tables which can be independently set, and activated. The selected channel contains the active look up table.
2. Locate the **Transform** control, and select a transformation function. You may select **Linear**, **Logarithmic**, or **Exponential**. Do not select **Load custom**.
 - Linear transform:
 $y(x) = mx + b$;
 where m , b are constants
 - Logarithmic transform:
 $y(x) = \log_e(x) + b$;
 where e is the natural base of logarithms; and
 b is a constant
 - Exponential transform:
 $y(x) = e^x + b$;
 where e is the natural base of logarithms; and
 b is a constant
 3. The curve generated by the transformation function can be adjusted using the **Window** and **Level** controls. The *window* and *level* values determine the constants in the transformation functions.

❖ To read look up table entries from a file:

1. This step depends upon the current image pixel type:
 - *8-bit grayscale images.* The **Channel** control specifies three options: **Channel 1**, **Channel 2** or **Channel 3**. These are three 8-bit grayscale look up tables which can be independently set, and activated. The selected channel will receive the look up

table when read from a file. If the **Tie** control is checked, all channels will receive the look up table.

- *Color images.* The **Channel** control specifies the options: **Red**, **Green**, or **Blue**. The selected pixel color plane will receive the look up table when read from a file. If the **Tie** control is checked, all color planes will receive the look up table.
 - *9 ... 16-bit grayscale images.* There is only one look up table, and it is always active. This look up table will receive the look up table read from a file.
2. Locate the **Transform** control, and select **Load custom**. The *Select Custom Look up Table* window will appear. There are two look up table file types: *look up table values (.luv)*; and *look up table index (.lui)* (see Chapter 5, section Setting output look up tables...Setting a look up table from a file).
 3. The look up table entries are displayed as an analytical plot of $y(x)$; where x is the incoming pixel value (look up table index); and y is the transformed pixel value (table entry at table index).
 4. The **Window** and **Level** controls cannot be used to alter the look up table entries when a look up table is read from a file.

Setting the pixel classification criteria

The pixel classification specifies how the pixel bit field indexes the look up table. The settings for each pixel classification case are listed below.

- *All bits identical (common case).* Two pixels are classed the same if corresponding bits in each pixel value are identical.

If you are working with an 8-bit camera (color or monochrome), set the **Index bits** control to 8.

If you are working with a 9...16-bit monochrome camera: set the **Index bits** control to the camera pixel size; set the **Shift bits** control to 0; set the

Class bits controls that are enabled to 0's by pressing the enabled toggle buttons.

- *Most-significant bits identical.* Two pixels are classed the same if corresponding bits in a range of most-significant bits are identical.

If you are working with an 8-bit camera (color or monochrome): set the **Index bits** control to the desired number of most-significant bits; set the **Shift bits** to $(8 - \text{index bits})$.

If you are working with a 9...16-bit monochrome camera: set the **Index bits** control to the desired number of most-significant bits; set the **Shift bits** to $(\text{camera pixel size} - \text{index bits})$; set the **Class bits** controls that are enabled to 0's by pressing the enabled toggle buttons. For instance if you are working with a 12-bit camera, and wish to classify pixels based on the 8 most significant bits: set **Index bits** to 8; set **Shift bits** to 4; set the 4 enabled buttons of the **Class bits** to 0's.

- *Exclude pixels using a bit mask.* A bit mask, *class bits*, is compared to a range of most-significant bits in a pixel. If the most-significant pixel bit range does not match the *class bits*, the pixel is discarded from the operation; if the bits do match, the pixel is included in the operation, and two pixels are classed the same if corresponding *index bits* are identical.

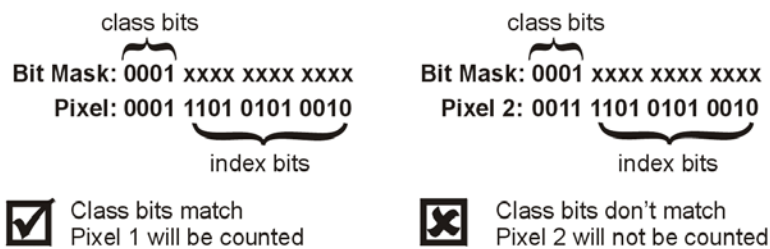


Figure 6.4: Calculations using class bits

Setting of the controls is best illustrated by an example. Assume you are working with a 12-bit camera, and wish to apply a look up table to pixels values with values greater than or equal to 2048 ($1000\ 0000\ 0000_{\text{binary}}$). Set **Shift bits** to 0; set **Index bits** to 11; set the first 4 **Class bits** starting from the left to 0; set the fifth **Class bit** from the left to 1.

Comments

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.



Morphology with erosion, dilation, boundary, open and close

A morphology operation is performed on an image to form a second image. The possible operations are erosion, dilation, boundary, open and close.

Library filename	Parameters	types	ROI processing	Color plane processing	Sequence processing
transfrm.dll	Source 1, Destination	All	Yes	Independent	Yes

Procedures

1. Select the image buffer(s) for *Source 1* and *Destination*.
2. Select the ROI for image processing (see Setting a region of interest for image processing in this chapter).
3. Right click the *Morphology* button found within the *Processing Control Panel*. A configuration window will appear.
4. In the **Operation** control select the morphology operation to be performed. The choices are erosion, dilation, boundary, open and close.
5. Press the **Apply** button; or Press the **Close** button, and left click the *Morphology* button found within the *Processing Control Panel*.

Comments

The *Erosion* operation is calculated by positioning a 3×3 mask over all 3×3 pixel groups in an image and replacing the center pixel in the group with the minimum of all pixel values in the group.

More formally,

$$\text{Image} = \begin{pmatrix} p_{11} & p_{12} & p_{13} & \dots \\ p_{21} & p_{22} & p_{23} & \\ p_{31} & p_{32} & p_{33} & \\ \dots & & & \end{pmatrix}$$

An erosion operation with the pixels in the top left image corner yields:

$$p_{22}' = \text{Minimum} (p_{11}, p_{12}, p_{13}, p_{21}, p_{22}, p_{23}, p_{31}, p_{32}, p_{33})$$

The *Dilation* operation is similar except the maximum value is used.

The *Boundary* operation is the calculated by subtracting the eroded image from the original image.

The *Open* operation is a dilation followed by an erosion.

The *Close* operation is an erosion followed by a dilation.

This operation is applied repeatedly to each pair generated by (*Source 1*, *Destination*) until the end of the longest sequence is reached. Shorter sequences rewind after the last buffer.

The image buffer(s) for *Source 1* and *Destination* can overlap for iterative processing.

Graphics drawing operations

The *Graphics drawing* operations allow simple graphics and text to be drawn in images.

To display the graphics drawing operations, open the *Processing Control Panel* and select *Graphics* from the library selector drop down list.



Ellipse

Draw a filled ellipse or an ellipse outline in an image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
graphics.dll	Destination	All	No	Independent	Yes

Procedures

1. Select the image buffer(s) for *Destination*.
2. Right click the *Ellipse frame* or *Ellipse fill* button found within the *Processing Control Panel*. A configuration window will appear.
3. Specify the ellipse color (or gray level) in the *Pen options* control group. If the **Reverse (XOR)** control is enabled, the color of each pixel of the ellipse will be calculated by performing an XOR operation between the original pixel values and the values set in the *Pen options* control group.
4. Specify the outline width of the ellipse using the **Line width** control.
5. Press the **Close** button.
6. To draw an ellipse frame, left click the *Ellipse frame* button found within the *Processing Control Panel*; to draw a filled ellipse, left click the *Ellipse fill* button. A cross-hair cursor will appear in the first image buffer of *Destination*.
7. Using the mouse or *Arrow* keys, move the cursor to the position marking the first corner of the bounding rectangle. Press the left mouse button or push the *Space bar* key to mark the position.
8. Move the cursor to the position marking of the opposite corner of the bounding rectangle. Press the left mouse button or push the *Space bar* key to mark the position.

9. Move the cursor to translate the position of the bounding rectangle if desired. To re-select the rectangle coordinates, left click the mouse and return to step 7 above.
10. To draw the ellipse in the image at the position of the rectangle cursor, right click or press the *Enter* key. When the ellipse is drawn, the image cursor procedure will be exited. Note that by holding the *Shift* key at the same time as the ellipse is drawn, the image cursor will not be exited, and you can draw additional ellipses. Pressing the *Escape* key at any time will exit the image cursor.

Comments

Image pixels are modified when the ellipse is drawn.

This operation is applied once to each image buffer of *Destination*.

Networking

The settings made in the *Graphics Configuration* window on the *Master* are used when drawing this graphic on the *Slaves*.



Line

Draw a line in an image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
graphics.dll	Destination	All	No	Independent	Yes

Procedures

1. Select the image buffer(s) for *Destination*.
2. Right click the *Line* button found within the *Processing Control Panel*. A configuration window will appear.

3. Specify the line color (or gray level) using the **Pen options** control. If the **Reverse (XOR)** control is enabled, the color of each pixel on the line will be calculated by performing an XOR operation between the original pixel value and the value in the **Pen options** control.
4. Specify the line width using the **Line width** control.
5. Press the **Close** button.
6. Left click the *Line* button found within the *Processing Control Panel*. A cross-hair cursor will appear in the first image buffer of *Destination*.
7. Using the mouse or *Arrow* keys, move the cursor to the position marking the start of the line. Press the left mouse button or push the *Space bar* key to mark the position.
8. Move the cursor to the position marking of the other end of the line. Press the left mouse button or push the *Space bar* key to mark the position.
9. Move the cursor to translate the position of the line if desired. To re-select the line coordinates, left click the mouse and return to step 7 above.
10. To draw the line in the image at the position of the line cursor, right click or press the *Enter* key. When the line is drawn, the image cursor procedure will be exited. Note that by pressing the *Shift* key at the same time as the line is drawn, the image cursor will not be exited, and you can draw additional lines. Pressing the *Escape* key at any time will exit the image cursor.

Comments

Image pixels are modified when the line is drawn.

This operation is applied once to each image buffer of *Destination*.

Networking

The settings made in the *Graphics Configuration* window on the *Master* are

used when drawing this graphic on the *Slaves*.



Rectangle

Draw a filled rectangle or a rectangle outline in an image.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence
graphics.dll	Destination	All	No	Independent	Yes

Procedures

1. Select the image buffer(s) for *Destination*.
2. Right click the *Rectangle frame* or *Rectangle fill* button found within the *Processing Control Panel*. A configuration window will appear.
3. Specify the rectangle color (or gray level) using the **Pen options** control. If the **Reverse (XOR)** control is enabled, the color of each pixel of the rectangle will be calculated by performing an XOR operation between the original pixel values and the value in the **Pen options** control.
4. Specify the frame width of the rectangle using the **Line width** control.
5. Press the **Close** button.
6. To draw a rectangle frame, left click the *Rectangle frame* button found within the *Processing Control Panel*; to draw a filled rectangle, left click the *Rectangle fill* button. A cross-hair cursor will appear in the first image buffer of *Destination*.
7. Using the mouse or *Arrow* keys, move the cursor to the position marking the first corner of the rectangle. Press the left mouse button or push the *Space bar* key to mark the position.
8. Move the cursor to the position marking of the opposite corner of the rectangle. Press the left mouse button or push the *Space bar* key to mark the position.

9. Move the cursor to translate the position of the rectangle if desired. To re-select the rectangle coordinates, left click the mouse and return to step 7 above.
10. To draw the rectangle in the image at the position of the rectangle cursor, right click or press the *Enter* key. When the rectangle is drawn, the image cursor procedure will be exited. Note that by pressing the *Shift* key at the same time as the rectangle is drawn, the image cursor will not be exited, and you can draw additional rectangles. Pressing the *Escape* key at any time will exit the image cursor.

Comments

Image pixels are modified when the rectangle is drawn.

This operation is applied once to each image buffer of *Destination*.

Networking

The settings made in the *Graphics Configuration* window on the *Master* are used when drawing this graphic on the *Slaves*.



Sketch

Draw in an image using a sketching tool.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	Sequence processing
graphics.dll	Destination	All	No	Independent	No

Procedures

1. Select the image buffer for *Destination*.
2. Right click the *Sketch* button found within the *Processing Control Panel*. A configuration window will appear.

3. Specify the sketch color (gray level) using the **Gray level** control. If the **Reverse (XOR)** control is enabled, the color of each pixel of the sketch will be calculated by performing an XOR operation between the original pixel values and the value in the **Gray level** control.
4. Press the **Close** button.
5. Left click the *Sketch* button found within the *Processing Control Panel*. A cross-hair cursor will appear in the *Destination* image buffer.
6. To sketch in the image, hold the left mouse button down (or press the *Space bar* key) and move the mouse (or use the *Arrow* keys).
7. To exit the sketch procedure: right click; press the *Enter* key or press the *Escape* key.

Comments

Image pixels are modified when the sketch is drawn.

This operation is applied only to the first image buffer of *Destination*.

Networking

This operation will only be applied to the *Master* computer. It does not affect the *Slave* computers.



Text

Draw text in an image. Auto-incrementing numeric suffixes can be appended to the text.

Library filename	Parameters	Pixel types	ROI processing	Color plane processing	processing
graphics.dll	Destination	All	No	Independent	Yes

Procedures

1. Select the image buffer for *Destination*.
2. Right click the *Text* button found within the *Processing Control Panel*. A configuration window will appear.
3. Specify the text color (gray level) using the **Pen options** control. If the **Reverse (XOR)** control is enabled, the color of each pixel of the text will be calculated by performing an XOR operation between the original pixel values and the value in the **Pen options** control.
4. Enter the text label in the **Text label** control.
5. Press the **Select font** to select the font for the text to be drawn.
6. To append an auto-incrementing numeric suffix to each label, enable the **Append numeric suffix** control. The **Current suffix number** control indicates the next number to be appended, and can be edited. This number will be automatically incremented after each label is drawn.
7. Press the **Close** button.
8. Left click the *Text* button found within the *Processing Control Panel*. A rectangle cursor representing the text's bounding rectangle will appear in the *Destination* image buffer.
9. Using the mouse or the *Arrow* keys, move the cursor to the position where the text is to be placed.
10. Right click or press the *Enter* key to draw the text. After the text is drawn, the image cursor will be exited. Note that by pressing the *Shift* key at the same time as the text is drawn, the image cursor will not be exited, and you can draw additional text labels. Pressing the *Escape* key at any time will exit the image cursor.

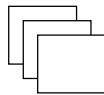
Comments

Image pixels are modified when the text is drawn.

This operation is applied once to each image buffer of *Destination*.

Networking

The settings made in the *Graphics Configuration* window on the *Master* are used when drawing this graphic on the *Slaves*.



Controlling Video Savant over a Computer Network

In some situations it is desirable to control Video Savant running on one or more computers on a local area network from a *Master* computer on the same computer network. If Video Savant Pro is installed on the computer designated as the *Master* computer, that computer can be used to control the other *Slave* computers.

The *Networking Control Panel* in Video Savant Pro, shown below, allows the user to control other computers, each running Video Savant RTL, Basic, or Pro. The number of computers that can be controlled is limited by the resources of the *Master* computer.

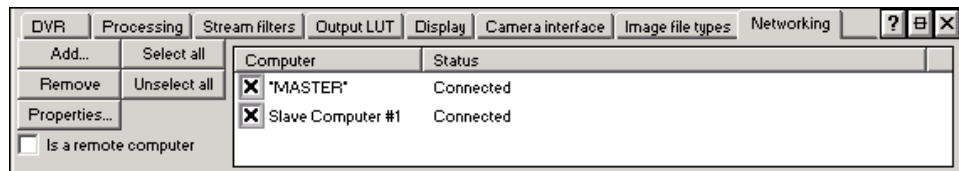


Figure 7.1: Networking Control Panel.

The sections of this chapter describe how to configure Video Savant on the *Master* and *Slave* computers to enable network control. After making the necessary configurations, the *Master* computer will be ready to control the *Slave* computers from the control panels in Video Savant.

There are specific considerations that must be understood when executing operations over a network from the Video Savant control panels of the *Master* computer. Throughout this manual, the following symbol has been used to denote key information relating to the execution of an operation over a network:



Figure 7.2: The symbol used to denote information relating to execution of an operation over a network.

Before first executing an operation over a computer network, please review the sections in this manual that discuss the operation you wish to perform, and look for the *Networking* symbol to determine if there are any special considerations when executing the operation over a network.

Configuring the computer network

Video Savant uses the TCP/IP networking protocol for execution of operations over a local area network (LAN). Most LANs use TCP/IP, so Video Savant's networking features should be immediately accessible. However, if problems are encountered please verify that TCP/IP is properly installed across your LAN.

Choosing a computer as the Master

❖ To choose a computer as the Master:

1. Decide which computer will be used as the *Master* computer. A computer can only be designated as the *Master* if Video Savant Pro is installed. It is not necessary to configure the *Master* for image acquisition.
2. Start Video Savant Pro on the *Master* computer.
3. Open the *Networking Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
4. Uncheck the **Is a remote computer** checkbox control.

Selecting a computer for participation as a Slave

If you are running Video Savant Basic or RTL, you must use the Quick menu to select a computer for participation as a slave (See the instructions *To select a computer for participation as a Slave using the Quick menu* below).

❖ To select a computer for participation as a Slave using the Networking control panel:

1. Install Video Savant Pro, Basic, or RTL on the computer to be controlled as a *Slave* computer.
2. If Video Savant Basic or RTL is installed on the selected *Slave* computer, you must follow the instructions for *To select a computer for participation as a Slave using the Quick menu* below since a Networking control panel is not available for Video Savant Basic or RTL machines.
3. If Video Savant Pro is installed on the *Slave* computer, start Video Savant on the *Slave* computer.
4. Open the *Networking Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
5. Check the **Is a remote computer** checkbox control. Video Savant may need to restart.
6. Start Video Savant on the *Master* computer.
7. On the computer designated as the *Master* computer, open the *Networking Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
8. Press the **Add...** button. The *Find Slave Computer* window will be shown.

9. Either the network name or TCP/IP address of the *Slave* computer must be known. If neither are known, the network IP address of any computer can be quickly determined by executing the command `IPCONFIG` in a command console window on that computer.
10. If the network name of the *Slave* computer is known, enter the computer name and press the **Find TCP/IP address** button to automatically determine the network IP Address of the computer. Alternatively, if the IP Address of the *Slave* computer is known, enter the IP address, and press the **Find name** button to automatically determine the computer name.
11. Enter a name that you wish to associate with the *Slave* computer in the **User selected name** control.
12. Press the **OK** button to accept the settings.

If the *Slave* computer has been successfully configured, a confirmation message will appear. The name that was specified in the **User selected name** control will appear in the column labeled **Computer** in the Video Savant *Networking Control Panel* on the *Master*. The status of the *Slave* will be indicated in the **Status** column as *Connected*.

If the *Slave* computer could not be accessed by the *Master*, an error message will appear after which the *Find Slave Computer* window will be shown. Verify that the *Slave* IP address is correct. If the IP address was correctly entered, verify the network settings on the *Master* and *Slave* computers.

❖ **To select a computer for participation as a Slave using the Quick menu:**

1. Install Video Savant Pro, Basic, or RTL on the computer to be controlled as a *Slave* computer.
2. Right click on the image area to access the *Quick menu*.
3. Choose *Set as master / slave*.

4. The *Set computer as master or slave on network* settings are displayed. Choose *Set computer as Slave (remote)*.
5. Press OK.
6. A message appears confirming that you want to make this computer a slave machine. Press *Yes*. Video Savant may need to restart.
7. Start Video Savant on the *Master* computer.
8. On the computer designated as the *Master* computer, open the *Networking Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
9. Press the **Add...** button. The *Find Slave Computer* window will be shown.
10. Either the network name or TCP/IP address of the *Slave* computer must be known. If neither are known, the network IP address of any computer can be quickly determined by executing the command `IPCONFIG` in a command console window on that computer.
11. If the network name of the *Slave* computer is known, enter the computer name and press the **Find TCP/IP address** button to automatically determine the network IP Address of the computer. Alternatively, if the IP Address of the *Slave* computer is known, enter the IP address, and press the **Find name** button to automatically determine the computer name.
12. Enter a name that you wish to associate with the *Slave* computer in the **User selected name** control.
13. Press the **OK** button to accept the settings.

If the *Slave* computer has been successfully configured, a confirmation message will appear. The name that was specified in the **User selected name** control will appear in the column labeled **Computer** in the Video Savant *Networking Control Panel* on the *Master*. The status of the *Slave* will be indicated in the **Status** column as *Connected*.

If the *Slave* computer could not be accessed by the *Master*, an error message will appear after which the *Find Slave Computer* window will be shown. Verify that the *Slave* IP address is correct. If the IP address was correctly entered, verify the network settings on the *Master* and *Slave* computers.

Changing configuration settings for a Slave

At times it may be desirable to change the user-selected name of a *Slave* computer. For example, an experimental setup may change, and the name may no longer be meaningful.

If a *Slave* computer is reconfigured on the network and the network name or TCP/IP address are changed, the computer will no longer be recognized as a *Slave* by the *Master*. The *Not connected* message will appear in the **Status** column on the Video Savant *Networking Control Panel* on the *Master* computer.

For these reasons, a *Slave* computer's user-selected name, network name, and TCP/IP address can be changed at any time.

❖ To change the user-selected name, network name, or TCP/IP address of a Slave:

1. Start Video Savant on the *Slave* computer.
2. Start Video Savant on the *Master* computer.
3. Open the Video Savant *Networking Control Panel* on the *Master* (see Chapter 2, section Exploring the work area...Control panels).
4. Press the **Properties...** button. The *Find Slave Computer* window will be shown.
5. To change the computer's network name, enter the new computer name in the **Computer name** control.

6. To change the computer's IP Address, enter the new IP Address in the **TCP/IP Address** control.
7. To change the user-selected name for the *Slave*, enter the new name in the **User selected name** control.
8. Press the **OK** button to accept these settings.

If the *Slave* computer has been successfully configured, a confirmation message will appear. The name that was specified in the **User selected name** control will appear in the column labeled **Computer** in the Video Savant *Networking Control Panel* on the *Master*. The status of the *Slave* will be indicated in the **Status** column as *Connected*.

If the *Slave* computer could not be accessed by the *Master*, an error message will appear after which the *Find Slave Computer* window will be shown. Verify that the *Slave* IP address is correct. If the IP address was correctly entered, verify the network settings on the *Master* and *Slave* computers.

Removing a Slave from participation

❖ To remove a Slave from participation:

1. Start Video Savant on the *Master* computer.
2. Open the *Networking Control Panel* (see Chapter 2, section Exploring the work area...Control panels).
3. In the list of computers on the *Networking Control Panel*, select the *Slave* computer that you wish to remove by left-clicking on the name.
4. Press the **Remove** button. The selected computer will be removed from the list.

Selecting computers for an operation

❖ To select computers for an operation:

1. Start Video Savant on the *Master* and the required *Slaves*.
2. Open the Video Savant *Networking Control Panel* on the *Master* (see Chapter 2, section Exploring the work area...Control panels).
3. In the list of computers on the *Networking Control Panel*, the computers that are currently being controlled are marked with an "X" beside them. Double click on a computer to mark/unmark it as being controlled.
4. To mark all of the computers as controlled, press the **Select all** button.
5. To unmark all of the computers, press the **Unselect all** button.

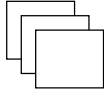
Restrictions on operations that can be disabled on the Master

When the *Master* computer is *not* selected on the *Networking Control Panel*, many operations will still be performed on the *Master* regardless.

❖ The following operations can be disabled on the Master:

- ☐ Video recording;
- ☐ Video playback;
- ☐ Exporting LUT settings to LUT files;
- ☐ Exporting images to image files; and
- ☐ Execution of processing operations on the *Processing Control Panel*.

All other operations will be performed on the *Master* regardless of whether or not the *Master* is selected on the *Networking Control Panel*.



Developing Custom Solutions with Video Savant SDK

In some instances, Video Savant may not include all of the features needed to satisfy the requirements of a vision system. For this reason, Video Savant can be customized to meet the specific needs of an application.

Customization of Video Savant requires use of the Video Savant SDK (Software Development Kit) and knowledge of the *C/C++* or Visual Basic programming languages.

Approaches to customizing a solution

❖ **There are two approaches to customizing a solution:**

- ☐ Create a *Video Savant plug-in module*; or
- ☐ Create a *Video Savant standalone application*.

It is recommended that custom solutions be developed as Video Savant plug-in modules whenever possible. This is because Video Savant users know how to interact with plug-in modules. As well, plug-in modules can be shared and re-used.

Video Savant standalone applications are typically developed when the primary user-interface will not be the Video Savant user-interface. In this case, it is still beneficial to isolate the parts of an application which can be implemented as Video Savant plug-in modules.

Types of Video Savant plug-in modules

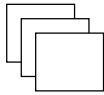
❖ The types of Video Savant plug-in modules are:

- ❑ *Processing libraries.* These modules provide high-level control of image capture, image display and image processing.
- ❑ *File filters.* These modules allow exchange of image data between Video Savant's internal storage and external image file types.
- ❑ *Stream filters.* These modules allow real-time processing of an incoming video stream, and recording of additional data streams. These modules are active during video recording and/or playback.
- ❑ *Compression filters.* These modules allow for real-time compression of the acquired video stream.
- ❑ *Conversion filters.* These modules allow conversion of images captured in a foreign image format into a native image format recognized by Video Savant.

Video Savant SDK features

❖ The Video Savant SDK includes the following:

- ❑ A detailed description of each function in the Video Savant SDK function library with example code fragments illustrating the use of most functions.
- ❑ A programming guide for each type of Video Savant plug-in module together with a complete source code example for each.
- ❑ A complete source code example of a Video Savant standalone application.



Troubleshooting

IO Industries designed Video Savant to be used in vision systems for a wide variety of digital video recording applications. The complexity of these vision systems can lead to difficulties when trying to find the cause of a problem. This chapter provides guidance for isolating and resolving problems.

Problem solving process

❖ **Resolving problems will be much easier if you observe the following guidelines:**

- ❑ *Observe what is happening.* Write down what the vision system is doing and what actions you performed immediately before the problem occurred.
- ❑ *Isolate the problem.* Using the tools available to you, such as the troubleshooting tips in this chapter, try to discover the specific actions that caused the problem.

The questions and procedures offered in this chapter are meant as a guide, they are not definitive problem solving techniques. Many problems can be solved simply, but a few may require help from your dealer. If you find you need to consult your dealer or others, be prepared to describe the problem in as much detail as possible.

Preliminary checklist

Consider the simplest solution first. The items in this checklist are easy to fix and yet cause what appears to be a serious problem.

- ❑ Make sure you turn on all peripheral devices before you turn on the computer. This includes the video camera and any other external device you are using.
- ❑ Check all cables. Are they correctly and firmly attached? Loose cables can cause signal errors.
- ❑ Inspect all connecting cables for loose wires and all connectors for loose pins.

Make notes of your observations and keep them in a permanent error log. This will help you describe your problems to your dealer. If a problem recurs, the log will help you identify the problem faster.

Analyzing the problem

The source of the problem must be isolated. A problem may be caused by the Video Savant software or some other software or hardware component in the vision system.

Examine the following sections to find the problem description which most closely matches what you have observed. Follow the recommendations provided to attempt to isolate and resolve the problem.

Errors or warnings occur during startup

Symptom

You receive the warning message “No software protection key has been detected. Video Savant is starting in Demo Mode. Some software features have been disabled”

Recommendations

- ❑ Verify that the Video Savant software protection key is plugged firmly into the computer's parallel port or USB port (depending on your key).
- ❑ Verify that the driver software for the software protection key is installed (see Chapter 2, section *Installing Video Savant*).
- ❑ If you are using a parallel port software protection key, try a different parallel port configuration setting using the computer BIOS setup utility.
- ❑ If you are using a USB port software protection key, make sure that you have installed the driver for the USB key itself (see Chapter 2, section *Attaching a USB Software Protection Key to your computer*).
- ❑ Verify that the driver software for the software protection key is configured for the parallel port or USB port you are using. To verify:
 - Launch the Video Savant setup program (This program usually launches automatically after inserting the Video Savant CD-ROM in the CD-ROM drive). Choose **Install Software Key Driver** to run the driver software install program.
 - Select **Function... Configure Sentinel Driver** from the application's menu. Ensure that the parallel port or USB port that the software protection key is attached to is shown in the list provided
- ❑ Unplug any devices that are plugged into the port extension of the Video Savant software protection key.
- ❑ Examine the Windows Event Viewer log to see if the software key driver (Sentinel) is conflicting with other drivers.

Symptom

You receive the error message “Unable to open camera interface device. *Device Name* is not an installed camera interface driver.”

Recommendations

- ☐ Verify that the default camera interface is correctly selected (see Chapter 2, section Working with Device Selector...Selecting the default camera interface).
- ☐ Re-install Video Savant (see Chapter 2, section Installing Video Savant).
- ☐ Delete the file VSAVANT4.INI located in the Windows install sub-directory (default is C:\WINNT for Windows NT/2000 or C:\windows for Windows XP). Re-install Video Savant.

Symptom

You receive any other error message starting with “Unable to open camera interface device...”, or the computer stops responding to mouse or keyboard input.

Recommendations

- ☐ Verify that the default camera interface is correctly selected (see Chapter 2, section Working with Device Selector...Selecting the default camera interface).
- ☐ Verify that your camera interface manufacturer’s demonstration software works correctly (Some manufacturers may not supply demonstration software).
- ☐ View the camera interface driver release notes (see Chapter 2, section Working with Device Selector... Viewing camera interface driver release notes). The driver release notes specify the required version of the camera interface manufacturer’s software. Verify that the

version number of the manufacturer's software installed on the computer matches this version number.

If the required version is newer than the installed version, contact a representative of the camera interface device manufacturer to obtain the required version.

If the installed version is newer than the required version, a newer version of the driver might be available on the IO Industries website. Visit our website and download the latest driver for your camera interface device. The website indicates which version of the manufacturer's software is required for the posted camera interface driver. To install the updated driver, see Chapter 2, section *Working with Device Selector...* Installing an unlisted or updated camera interface driver.

- ❑ In the camera interface driver release notes, additional camera interface configuration instructions may be included. Follow these instructions if provided.

If you are still unable to start Video Savant, and have determined that the camera interface device *does not* function with the manufacturer's demonstration software, contact a technical support representative of the camera interface device manufacturer.

Single frame capture (Snap) fails

Symptom

You receive the error message "Timeout waiting for acquisition to complete.", or the computer stops functioning correctly when you attempt to capture an image using the **Snap** button on the *DVR Control Panel*.

Recommendations

- ❑ Verify that the camera power is turned on, and the power cord is securely attached.

- ❑ Verify that the camera data cable is securely attached to the camera and the computer.
- ❑ Restart the system from a power off state. Before powering the computer, power the camera.
- ❑ Disable all Video Savant stream filters (see Chapter 4, section Recording additional data streams and real time image processing... Removing a stream filter). Restart Video Savant and try capturing images again. If image capture is successful, isolate which stream filter is causing the problem, and view the stream filter release notes for special configuration information (see Chapter 4, section Recording additional data streams and real time image processing... Viewing stream filter release notes).
- ❑ Verify that your camera interface manufacturer's demonstration software works correctly (Some manufacturer's may not supply demonstration software).

If the demonstration software successfully captures images from the camera, the camera interface video format may be improperly configured in Video Savant. More information is available for configuring the video format (see Chapter 2, section Setting the camera interface video format). If the demonstration software fails to capture images from the camera, contact your camera interface dealer. See the section Receiving technical support below.

- ❑ Verify that the specialized features associated with the camera interface are set correctly (see Chapter 4, section Setting special camera interface configuration options).
- ❑ Verify that the PCI bus configuration settings of the computer are set as recommended by the camera interface manufacturer. The computer BIOS configuration software usually provides a PCI latency timer setting which can affect performance. Typically the PCI latency timer should be set to the maximum value.

Some camera interface manufacturers provide a separate software utility for setting the PCI latency timer. You should run this utility if it exists, and set values according to the manufacturer's specification.

Symptom

The captured frame is a dark or black image.

Recommendations

- ☐ Verify that the camera power is turned on, and the power cord is securely attached.
- ☐ Verify that the camera data cable is securely attached to the camera and the computer.
- ☐ Open the camera aperture wider.
- ☐ Increase the light intensity.
- ☐ Decrease the camera shutter speed if the camera has a shutter control.
- ☐ If you are working with a monochrome camera which outputs pixel sizes in the range of 9 to 16 bits, the output look up table should be adjusted to match the pixel size and maximize brightness and contrast in the image (see Chapter 5, section Setting output look up tables). Note that adjusting the output look up tables does not change the pixel values stored in memory; only the display of the pixels is affected. It is sometimes helpful to examine the pixel value range before adjusting output look up tables (see Chapter 6, section Analysis, statistics and measurement operations... Pixel value viewing as numeric text).
- ☐ If you are working with an analog output camera, your camera interface (frame grabber) may be able to condition the video signal before it is digitized, by using a programmable Analog to Digital Converter to improve brightness and contrast in the image. More information is available about the configurability of your camera (see Chapter 4, section Setting special camera interface configuration options).

Continuous frame capture (Live) fails

Symptom

You receive the error message “Timeout waiting for acquisition to complete.”, or the computer stops functioning correctly when you attempt a continuous frame capture operation using the **Live** button on the *DVR Control Panel*.

Recommendations

- ☐ Verify that single frame capture works. If single frame capture fails, see the above section Single frame capture (Snap) fails, and attempt to resolve this problem first.
- ☐ Verify that the PCI bus configuration settings of the computer are set as recommended by the camera interface manufacturer. The computer BIOS configuration software usually provides a PCI latency timer setting which can affect performance. Typically the PCI latency timer should be set to the maximum value.

Some camera interface manufacturers provide a separate software utility for setting the PCI latency timer. You should run this utility if it exists, and set values according to the manufacturer’s specification.

Sequential frame capture (Video recording) fails

Symptom

You attempt a sequential frame capture (video record) using the *Record*  button on the *DVR Control Panel* and one of the following problems occur:

- ☐ You receive the error message “Timeout waiting for acquisition to complete.”.
- ☐ The computer stops functioning correctly.

- ❑ Video frames are recorded at a slower rate than expected.
- ❑ Video frames contain corrupt image data.

Recommendations

- ❑ Verify that single frame capture works. If single frame capture fails, see the above section *Single frame capture (Snap) fails*, and attempt to resolve this problem first.
- ❑ The camera interface may require a special configuration option to be set for the camera being used (see Chapter 4, section *Setting special camera interface configuration options*).
- ❑ If you are using an external trigger to initiate video recording, verify that Video Savant is configured for operation with an external trigger (see Chapter 4, section *Video recording control using an external trigger*). Video Savant may require a special configuration option to be set for externally triggered frame capture (see Chapter 4, section *Setting special camera interface configuration options*).

The trigger device itself may not be functioning correctly. Verify that the trigger is outputting the proper signal, and that it is correctly attached to the camera or camera interface as required.

- ❑ Verify that the PCI bus configuration settings of the computer are set as recommended by the camera interface manufacturer. The computer BIOS configuration software usually provides a PCI latency timer setting which can affect performance. Typically the PCI latency timer should be set to the maximum value.

Some camera interface manufacturers provide a separate software utility for setting the PCI latency timer. You should run this utility if it exists, and set values according to the manufacturer's specification.

- ❑ If the video storage mode of Video Savant is set to *Disk* mode, there may be problems in the disk configuration. To determine if this is the problem, set the Video Savant video storage mode to *Memory* mode, and try capturing a frame sequence.

If sequence capture works in *Memory* mode, then it is likely that there is a disk configuration problem. If this is the case, the write speed of the video file should be measured (see Chapter 2, section Measuring video drive write-speed).

For single PCI bus computers, the disk write-speed should exceed the video rate by at least 25 per cent for most camera interfaces, and by an even greater margin for some camera interfaces using older on-board memory buffering technology. For dual PCI bus computers which are configured with the camera interface on one PCI bus and the video drive on the other PCI bus, the disk write-speed should exceed the video rate by at least 5 per cent. If stream filters are active, the disk write-speed may need an even greater margin.

- ❑ Disable all Video Savant stream filters (see Chapter 4, section Recording additional data streams and real time image processing... Removing a stream filter). Restart Video Savant and try capturing a frame sequence again. If image capture is successful, isolate which stream filter is causing the problem, and view the stream release notes for special configuration information (see Chapter 4, section Recording additional data streams and real time image processing... Viewing stream filter release notes).

Video Savant takes a long time to start

Symptom

Video Savant seems to be taking a long time to start after it is launched when in disk mode.

Recommendations

- ❑ Verify that your memory usage settings are correct. (Follow the steps below)
1. On the bottom left of the screen, press the **Video file** button.

2. Select **Administrator**
3. In the *Maximum Memory Usage* control box, select **Specify**.
4. If you are running in disk mode, specify a size at least 2 MB more than the **Request memory usage** value.
5. If you are running in memory mode, specify a size at least 2 MB more than the size of the video file. (To figure out the size of the video file press the **Video file** button and select **Current video file properties** The size of the video file will be displayed in the window)
6. Press **OK**.
7. Restart Video Savant. If Video Savant continues to run slowly, try setting *Maximum Memory Usage* to a higher value or setting **Request memory usage** to a lower value.

My Video Savant 3.0 SDK application fails

Symptom

My Video Savant 3.0 SDK application fails to run correctly using Video Savant 4.0.

Recommendations

- ☐ Verify that you have purchased a Video Savant 4.0 SDK edition. Video Savant 4.0 requires the Video Savant 4.0 SDK in order to create SDK applications. You cannot build Video Savant 4.0 applications with the Video Savant 3.0 SDK.
- ☐ Verify that you are using the correct function name. Many SDK functions that existed in Video Savant 3.0 are available in Video Savant 4.0 under another name. See the **Video Savant 4.0 SDK Manual** for more details

Receiving technical support

If you require any additional help using Video Savant, you may need to contact your dealer.

❖ **The following steps should be taken before contacting technical support:**

- ☐ Review the above sections of this chapter.
- ☐ If you have determined that the problem is internal to Video Savant and not the hardware in the vision system, visit IO Industries on the Internet at <http://ioindustries.com>. See the Support area to download updates of drivers and other modules.

If the problem is not resolved by following the above steps:

- ☐ Carefully document the steps leading to the problem.
- ☐ Document the hardware used in the vision system including:
 - Video camera model;
 - Camera interface model; and
 - Computer model and configuration.
- ☐ If you have determined that the problem is internal to Video Savant:
 - Open the *Versions* application in the Video Savant folder.
 - The version information will be saved to a file VSVER.TXT in the Video Savant installation directory.
- ☐ Contact the dealer from which Video Savant (or the problematic hardware) was purchased and be prepared to email the information from the above steps to the dealer

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