Web: www.tobii.com
E-mail: support@tobii.com
Phone: +46 (0)8 663 6003

# User Manual

## Tobii Eye Tracker
## ClearView analysis software

February 2006

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# Setting up the Tobii hardware and ClearView software

## *Introduction*

This user manual is intented to give an in-depth understanding of how to use the Tobii Eye Tracker and ClearView software. It does not aim to provide basic information about the nature of eye movements or guidelines on how to perform eye tracking studies for research or commercial purposes or to create and design eye control applications. For such information, we instead recommend looking into some of the literature references found in the back of this document.

For details on how to create your own applications that communicate directly with the Tobii Eye Tracker, or with ClearView, please refer to the **Tobii Software Development Kit** manual.

For any uncertainties or questions, always feel welcome to contact Tobii support at support@tobii.com, or call us on number +46 8 663 60 03.

The user manual is valid for the following product versions:

- Tobii 1750, Tobii x50 and Tobii ET-17 eye tracking systems
- ClearView 2.6.0 analysis software

## *System requirements*

The Tobii Eye Tracker runs on a PC with the Windows Operating system (Windows 2000 service pack 3 or 4 or Windows XP service pack 1 or 2). The system can either be used in a single or double computer setup (see more under the chapter **Single or Double computer configuration**). If used in a double-computer configuration, one computer will host the eye tracker server and the other computer the application software (for example ClearView).

The eye tracker computer needs Firewire and USB connections. In order to work with a double monitor setup the ClearView computer needs a dual head graphics card.

A second keyboard and a second mouse may also be connected to the computer to facilitate simultaneous operator and subject control, for instance in web studies. At least one of the keyboards and one of the mice must in such cases be possible to connect through USB.

**Note :**
As the eye tracking software and ClearView develops these requirements may change without notice. Please contact Tobii for up to date recommendations.

## *Setting up the Tobii hardware*

The Tobii Eye Tracker unit may be operated in the same light conditions where one would normally use a conventional computer display. As the eye tracking mechanisms are somewhat sensitive to near-infrared (NIR) light, we recommend avoiding potentially disturbing sources high levels of NIR light. Such sources include direct sunlight or extreme levels of in-direct sunlight could cause problems, while ordinary office light conditions with limited amount of sun-light are not a problem.

## *Single or double computer configuration*

The Tobii Eye Tracker is designed to work well in both a single computer and a double computer configuration.

If the studies involve resource-intensive applications in parallel with the eye tracker, we recommend using a double computer configuration. Examples of such applications are when using high frame-rate video capturing, when conducting web studies or very high demands on timing accuracy. Use of the ClearView Live Viewer is also very resource demanding and double computer setups are advisable.

In double computer configuration, one computer is dedicated to running the eye tracking software (the eye tracking computer), and one machine is dedicated to the analysis or interaction application (the application computer). The two machines are connected via TCP/IP. For minimum latency in communication between the computers, we recommend connecting the computers on a dedicated network (i.e. not part of a larger office network). The easiest way to do this is to use a cross-over network cable to connect the two computers directly.

If the eye tracker is used for applications which are not very resource demanding, the system works equally well and is easier to maintain on a single computer. An example of such application is to use ClearView for basic slideshow studies. In this case, the eye tracking computer and the application computer are one and the same.

Once ClearView has been installed in **Global settings**, on the **Network** tab, **Remote computer** must be chosen ant the IP address to the eye tracker computer must be supplied.

If a crossover network cable is connecting the eye tracking computer and the application computer, these need to be assigned fixed IP addresses manually, using so-called black addresses. This is done by manually setting IP addresses beginning with 192.168. For example, give one computer the IP address 192.168.0.1 and the other 192.168.0.2.

To assign the IP address manually for a computer, go into the **Control Panel** and open up **Network Connections**, right click the proper connection (typically a Local area connection) and choose **Properties**. Scroll down to **Internet Protocol (TCP/IP)** in the list of items used by the connection and click the **Properties** button, click **Use the following IP address** and define a black address for that computer.

Firewalls will sometimes prevent ClearView from connecting to the eye tracker computer and the firewall needs to be instructed to allow the connection. This is made by making an exception and opening up the port 4455 for TCP and port 4457 for UDP traffic on the *eye tracker computer's* firewall. To do this for the built in firewall in Windows XP Service Pack 2 go into the **Control Panel** on the *eye tracker computer* an open the **Windows Firewall**. On the **Exceptions** tab, click **Add Port…** fill in "TET Server" as name and "4455" as Port number, choose TCP and click **OK** do the same for the name tTime" and port 4457 for UDP traffic.

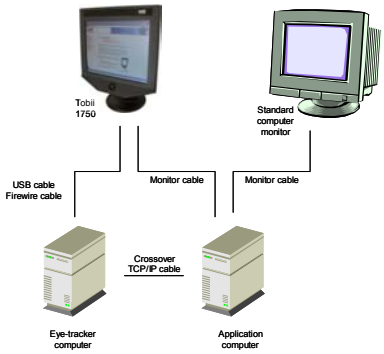
## Single or double screen configuration

The ClearView analysis software is designed to use single or double screens during testing. Double screens are recommended as the standard configuration since it allows the test subject to be presented with only the stimulus, while the test leader receives real time feedback of eye tracking quality during recording and set up.

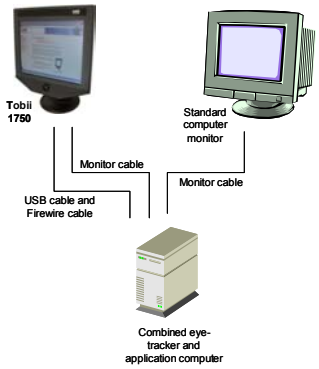
**Figure 1: Primary screen, (test leader display) left and secondary screen (eye tracker monitor) right**

## Different system setups

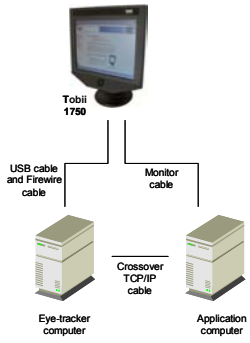
Below, schematics for four different system setups can be found. For most applications double monitors are used. For resource intensive applications like web studies, external video or using the Live viewer a double computer setup is recommended



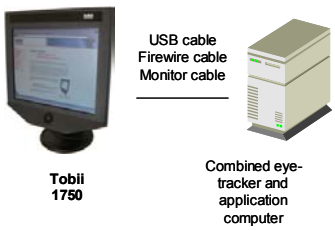

**Double computer, double screen configuration**




**Single computer, double screen configuration**




**Double computer, single screen**




**Single computer, single screen configuration**

## Setting up the Tobii 1750

Always power down your computer before connecting or disconnecting your Eye Tracker product.

Connect the Tobii 1750, your Tobii Eye Tracker server and application computer(s). Connect the four cables in the following order:

1. Monitor connector (15 pins) should be connected to graphics card of the application computer
2. USB connector should be connected to the USB port of the eye tracker computer.
3. Firewire connector should be connected to any Firewire port on the eye tracker computer
4. Power connector should be connected to the supplied 12V Powerbox power supply which should in turn be connect to a normal power socket (either 110 or 240V AC).

Make sure to connect the eye tracker to the same power socket as the computer which runs the TET Server. Connecting the eye tracker and computer to separate power sockets may result in permanent damage to the eye tracker. Turn on the computer last.


**Figure 2: On the backside of the Tobii 1750 four cables are connected, from left to right power, USB, Firewire and monitor cables**

## Setting up the Tobii x50

Always power down your computer before connecting or disconnecting your Eye Tracker product.

Connect the Tobii x50 and your PC. Connect the three cables in the following order:

1. USB connector should be connected to the USB port of the eye tracker computer.
2. Firewire connector should be connected to any Firewire port on the eye tracker computer
3. Power connector should be connected to the supplied 12V Powerbox power supply which should in turn be connect to a normal power socket (either 110 or 240V AC).

Make sure to connect the eye tracker to the same power socket as the computer which runs the TET Server. Connecting the eye tracker and computer to separate power sockets may result in permanent damage to the eye tracker. Turn on the computer last.

The Tobii x50 also requires careful setup of the eye tracker in relation to the monitor, projector screen or physical objects serving as stimulus. Read more about this procedure in the document *How to set up the Tobii x50*.

**Figure 3: The cable connections on the Tobii x50. From left to right, Firewire, USB and power.**

## *Setting up the Tobii ET-17*

Always power down your computer before connecting or disconnecting your Eye Tracker product.

Connect the Tobii ET-17 and the computer(s). Connect the four cables in the following order:

1. Monitor connector (15 pins) should be connected to graphics card of the application computer
2. Serial connector (9 pins) should be connected to the serial port of the eye tracker computer. It is vital that you use the serial port which is named COM1 for this cable (this is usually the "first" serial port of the computer).
3. Firewire connector should be connected to any Firewire port on the eye tracker computer
4. Power connector should be connected to the supplied 12V Powerbox power supply which should in turn be connect to a normal power socket (either 110 or 240V AC).

Make sure to connect the eye tracker to the same power socket as the computer which runs the TET Server. Connecting the eye tracker and computer to separate power sockets may result in permanent damage to the eye tracker. Turn on the computer last.

**Figure 4: On the back side of the Tobii ET 17 four cables are connected, from left to right, power, serial, Fire wire and monitor cables**

**Note :**
Always power down your computer before connecting or disconnecting your Eye Tracker product. Make sure to connect the eye tracker to the same power socket as the computer which runs the TET Server. Connecting the eye tracker and computer to separate power sockets may result in permanent damage to the eye tracker

## Installing the software

See the Installation Manual found on the Tobii CD.

Make sure to re-start your computer once installation is complete.

## Adjusting your computer settings

The first thing to do after installing the software and hardware is to ensure that the computer settings are appropriate for running eye tracking tests.

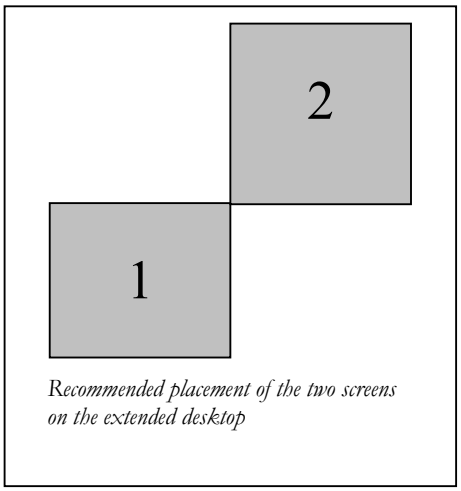
### Screen resolution and colours

In order to household computer resources it is important to optimize graphics settings. Tobii's recommendation is to always use the same resolution and colour depth on both the subject/eye tracker monitor and the operator monitor. Also since using high resolution and large colour depth is very resource intensive it is recommended to limit these to a resolution of 1024x768 and a 16-bit color depth). Changes to resolution and colour depth is done under control panel/display of your Windows operating system.

### Configure dual-monitor setup

This step is only required if you will use your system with double monitors.

In order to use double screens, your computer must be equipped with a dual-head graphics card (see chapter on **System Requirements**), and you must have two monitors connected to the dual-head graphics card.



*Recommended placement of the two screens on the extended desktop*

Once the graphics card is installed with the card-specific drivers, right-click on the desktop, select **Properties** -> **Settings** -> **Advanced**. If you are using the recommended ASUS graphics card, click on the tab named **Dual head**. Select the option to extend the desktop onto the secondary display. (In Windows XP right click on the desktop, choose **Properties** and go to the **Settings** tab. Click the representation of monitor 2 and check the box **Extend my Windows desktop onto this monitor**.)

Configure your displays so that the standard operator monitor is set as the primary display, and the monitor on your Tobii Eye Tracker is secondary display. Position the displays relative to each other on the "extended desktop". It is recommended to position the secondary display corner to corner with the primary display (see figure). This minimizes the risk that the mouse pointer accidentally moves between the screens.

Once you have installed ClearView, under **global settings** -> **monitor configuration**, the **monitor mode** must be changed to **Dual head**.

### Verify Internet explorer version

Your default Internet browser should be Internet Explorer version 6.0 or higher.

# Getting started

## *Start the ClearView software*

Make sure that the Tobii tracker and ClearView software are properly installed, and then start the application by double-clicking on the ClearView icon.

## *Prepare your first study*

Enter a name of your new study in the Start ClearView study window that appears at program startup. Click OK. Select New from the left-hand Stimuli area of the Prepare dialog box. Select the Image icon and write a name in the Save Stimulus as: text box. Click Next. A Stimuli Wizard – Image dialog box will open. Click the Browse button. Find an image file you wish to show and double-click on the file name. The image can be in BMP, JPG or GIF formats. Select the option Until Keypress. Click on the OK button. Select New from the right-hand Subjects window. Type your name in the Subject's name text box. Click OK.

## *Make your first calibration*

Ensure that you are sitting comfortably in-front of the Tobii at a distance of approximately 60 cm. Adjust your chair so that you can see the tip of your nose in the circular filter at the bottom of the eye tracker.

Select Record from the left-hand toolbar. Select your name from the central Subject area. Click on the Calibrate button. The Track status meter appears, including a representation of the camera's field of view with two white circles representing your eyes. Verify that the system automatically shows the position of your two eyes as white circles, and the text bar showing a green light with the text "both". If this does not occur, move until your eyes come into the view in the Track status meter. Click on the Start button and look focused at the point moving across the screen. It is not necessary to keep the head fixed during calibration.

When the process is complete a screen will be displayed showing the calibration result. If there are red squares around one or more blue circle click the Recalibrate button. If not, click Accept and assign a name to the calibration.

## *Record your first recording*

Select your stimulus in the left-hand Stimulus area. Select your name from the central Subject area. Click on the Record button below the right-hand Calibration area. Verify that the system finds you as in section 3 above. Click the Start button to start recording. Look at the image for a period of time. Press Space Bar to stop.

## *Analyze your study*

Select Analyze from the left-hand toolbar. Click on your stimulus name in the left-hand Stimuli area. Click on the small check box next to your recording name in the Recordings area. Click the Gaze Replay button in the right hand Analysis area. You should now be shown the gaze replay of your recording with your eye gaze replayed over your stimuli.

# The Tobii Eye Tracker

Tobii eye tracking systems are solutions for detecting and collecting eye gaze data. The key characteristics of Tobii Eye Trackers are:

- Plug and play eye tracking. All tasks relating to finding the eyes of the subject, and calculating gaze positions are done fully automatically by the system. To accomplish this the Tobii Eye Trackers use sophisticated hardware in combination with advanced software algorithms.
- Very high tracking quality. The Tobii Eye Tracker provides very robust, accurate and reliable data. It has excellent head-motion compensation and very low drift effects. All tracking is binocular..
- No restraints on the user. The system does not impose any restrictions on the user (such as helmets, head-rests or markers). This allows a natural user environment and therefore natural user behavior is captured. Calibration is also quick, automatic and long-lasting.

## *System overview*

The Tobii Eye Tracker consists of hardware and software for gaze point estimation and communication with various applications. The Tobii Eye Tracker requires application software to make use of the eye tracking data – either by using ClearView for eye gaze analysis, by using an application for eye based computer interaction or together with custom software created by yourself or someone else using the Tobii Software Development Kit.

The architecture is based on a client/server model, where one or several applications act as clients and the eye tracker engine as server.

See the below image for an overview of the system.

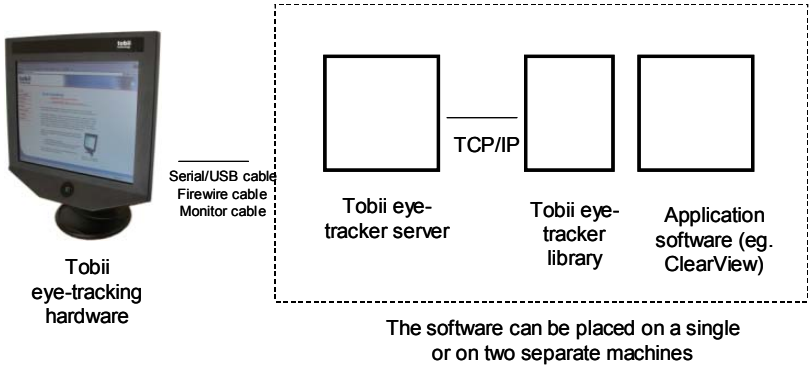



**Figure 5: Overview of the Tobii system**

### The Tobii eye tracking hardware

Different hardware platforms are available from Tobii, including the Tobii 1750, the Tobii x50 and the Tobii ET-17. The different hardware versions consist of similar components:

| | |
|---|---|
| TFT Display (not in the x50) | The TFT display is based on a high-quality TFT display unit. The display has excellent contrast and brightness and provides a maximum resolution of 1280x1024 pixels. It also provides very fast response time of 25 ms, which allows for good image quality with low smearing for moving images.<br><br>For studies that place high requirements on the smoothness of moving images on the screen, we recommend the Tobii x50 together with a standard CRT-monitor. |
| Camera | A high-resolution camera with a large field-of-view is used to capture images of the subject's eyes. |
| NIR-LEDs | Near infra-red light-emitting diodes (NIR-LEDs) are used to generate even lighting of the subject and reflection patterns in the eyes of the subject. |
| Optical filters | Optical filters are used to block sun-light and other sources of interfering light. |
| Control electronics | Control electronics are built-into the screen to control the monitor, the camera and the NIR-LEDs |

## Gaze data recording with the Tobii Eye Tracker

When an application commands the Tobii Eye Tracker Server (TET Server) to start recording (via the eye tracker library), collection of gaze data begins. TET Server controls the hardware, finds the relevant features of the user and calculates gaze position and other important variables. This is all done fully automatic by the TET Server.

The TET Server starts automatically when the eye tracker computer is booted and can be found on the System Tray as a blue "t" with a green play symbol or a red stop symbol. Right clicking the icon reveals those few options the TET Server has; Starting, stopping and restarting, choice of hard ware (e.g. ET-17, 1750 or x50) and the choice of using an Infant AddOn illumination. This is an extra piece of hardware used for tracking infants. If using an x50 there are also tools for configuring the setup (read more in the document *How to set up the Tobii x50*).


**Figure 6: The TET Server icon on the System Tray includes those few settings the TET Server needs.**

As opposed to most other remote eye trackers on the market, the Tobii Eye Tracker uses binocular eye tracking. For each gaze data item, data is collected simultaneously for both eye. There are several advantages to this – binocular tracking can yield higher accuracy (through binocular averaging), less drift, better robustness (through redundancy of data) and also provides a value in itself (e.g. to measure vergence in vision studies).

Gaze data is sent in real-time to the application where it may be used in any way appropriate (saved to file for later analysis or used in real-time with a gaze-contingent or eye interaction applications).

The following data is provided to the application by the eye tracker through the TET Server:

| Data column | Description |
|---|---|
| Time | The timestamp in microseconds for when the gaze data was recorded. The time is based on the high-resolution Tobii timer. |
| Screen X (left eye) | The horizontal position of the gaze point on a normalized scale (0 is left side of screen, 1 is right side of screen). |
| Screen Y (left eye) | The vertical position of the gaze point (0 is top, 1 is bottom) |
| Cam X (left eye) | The horizontal location of the pupil in the camera image (0 is left edge, 1 is right edge). |
| Cam Y (left eye) | The vertical location of the pupil in the camera image (0 is top, 1 is bottom). |
| Distance (left eye) | The distance from the camera to the eye in mm (measured from surface of eye to centre of the filter in front of the camera)* |
| Pupil (left eye) | The size of the pupil in mm* |
| Code (left eye) | The validity of the gaze data (please refer to chapter on Tracking Ability for interpretation of this) |
| Screen X (right eye) | The horizontal position of the gaze point on a normalized scale (0 is left side of screen, 1 is right side of screen). |
| Screen Y (right eye) | The vertical position of the gaze point (0 is top, 1 is bottom) |

| | |
|---|---|
| Cam X (right eye) | The horizontal location of the pupil in the camera image (0 is left edge, 1 is right edge). |
| Cam Y (right eye) | The vertical location of the pupil in the camera image (0 is top, 1 is bottom). |
| Distance (right eye) | The distance from the camera to the eye in mm (measured from surface of eye to centre of the filter in front of the camera)* |
| Pupil (right eye) | The size of the pupil in mm* |
| Code (right eye) | The validity of the gaze data (please refer to chapter on Tracking Ability for interpretation of this) |

* The distance and pupil size measures are calculated to be as close to real values as possible. However individual differences in the eyes of subjects and the strength of glasses/contact lenses will cause errors in these values. However the measures still reflects *changes* in head position and pupil size accurately.

## Timing aspects of the system

There are several timing aspects which are important in an eye tracking system. In real-time applications (such as gaze-contingent applications and eye based interaction), latency is one of the key aspects. In post-recording analysis (for example slide show and web studies), frame-rate and precision in time-stamps are important.

### Frame rates

The frame rate denotes the number of gaze data points collected by the system per second. All new Tobii systems run at a constant frame-rate of 50 Hz. For older Tobii systems, such as the ET-17 and early versions of Tobii 1750 frame rates are about 35 Hz but vary over time. For these systems there are several situations in which the frame rate will drop, in extreme cases as low as 10 Hz.

- If the subject moves the head rapidly, so the system has difficulty finding the subjects eyes.
- If the subject turns away completely from the system so the eyes are lost.
- If the system has difficulties finding the subject's eyes for other reasons (i.e. under conditions when the track status meter is flickering or showing a red light).
- If other applications are running on the same computer as the eye tracker server and consume a lot of resources.

However, as soon as stable tracking is once again resumed, the frame rate goes up to full speed again.

For most analysis and interaction applications, the varying frame-rate will not be an issue (it occurs mostly in conditions where the subject is not looking properly at the screen anyways). However, if timing is absolutely critical, it is recommended to compare the timestamp of the recorded data to verify a constant frame rate. Since other applications running on the eye tracking computer may cause highly varying frame rates for older eye trackers, a double computer configuration is recommended for time critical studies, in particular if these are combined with other recource-demanding software.

### Latency

Latency is defined as the time taken from when the actual eye position is recorded until data reaches the application. Thus the latency of gaze data is the sum of the time taken for camera exposure, transfer, calculation and delays in the system.

For post-analysis applications (such as slide show studies and more), the measure of latency is irrelevant. However, for real-time applications (such as gaze-contingent applications and eye based interaction) latency can play an important role.

For the Tobii 1750, typical latency is between 25 and 35 ms, when used in normal conditions and limited head-motion on a 2.4 Ghz Pentium 4 PC.

For the Tobii ET-17, typical latency is between 30 and 50 ms.

As described in the **Frame rates** section, the frame-rate may drop under certain conditions, for example during rapid head-motion. Under such conditions, latency also increases up to a worst case of 120 ms.

### Precision in time-stamps

Each gaze data is marked with a time-stamp. The time-stamp is generated by a trigger signal sent from the eye tracker hardware, and collected on the eye tracker computer using a special Tobii high-resolution timer, based on the Windows multimedia timer.

Since the basis for estimating the eye position is an image taken from a camera, there is always a certain exposure time used to generate this image. The time-stamp is set to indicate the center of the exposure time, which is the best theoretical estimation of when the image was taken.

Under normal computer load (when the system is working at full speed), this time-stamp is accurate to +/- 3 ms for the Tobii 1750 and +/- 5 ms for the Tobii ET-17.

### Synchronization

If the TET Server and the application run on the same computer, no synchronization between them is required.

If they run on separate computers, the server needs to synchronize with the application. This is done automatically by the server and the application during the setup phase. Once a connection has been established, the application issues a "synchronize" command which starts an exchange of messages between the eye tracker server and the application. This measures delays and clock deviations between the two machines.

During operation, the TET Server knows how to re calculate time-stamps so that they match the internal system time of the application. This is accurate to less than 1 ms.

## Accuracy in gaze estimation

### Measured accuracy

If your experiment runs for more than five minutes, and if you don't want to use a bite bar, the Tobii Eye Tracker is probably the highest accuracy eye tracker available today. Over large head-movements and long periods of time, it boasts an "effective accuracy" of an amazing 1 degree (approx.) across the entire screen. The detailed measures of accuracy are described more below.

The accuracy of an eye tracker is measured in degrees. One degree of accuracy corresponds to an average error of about 1 cm between the measured and intended gaze point at 50 cm distance from the user to the screen. We define the term "accuracy", or "bias error", as all deviations between the measured and intended gaze point.

Accuracy of the Tobii Eye Tracker varies depending on conditions (such as lighting and quality of calibrations) and individuals. Average accuracy over a set of individuals has been tested to 0.5 degrees using standard accuracy measurement principles for eye trackers. This does not include drift effects or compensation errors from larger head-motions which are the main factors affecting effective accuracy or the eye tracker

Accuracy has been measured by having users perform a new 16-point calibration, and thereafter having them look at 64 evenly distributed points on a computer screen. The users have tried to keep their head decently still, but have not used a chin rest or a bite bar. For each of the 64 points, the average gaze data point was defined as the average of five gaze data points. Accuracy was then defined as the average of the deviation between the 64 averaged gaze points and the intended gaze points over this test. The average accuracy of the result from 10 different users was 0.5 degrees.

## *Drift effects*

The term "drift" indicates a deterioration of a calibration that occurs over time. This is mainly due to changes in characteristics of the eyes that are caused by change of pupil size (for example because of changes in surrounding light conditions) or if the eyes become dry.

For the Tobii Eye Tracker, drift over long time periods and great differences in light conditions range from 0 to 2 degrees for each eye individually. However, since the tracker allows binocular tracking, it is possible to use a feature called "binocular averaging". Most drift effects are inversely symmetrical between the eyes, and may therefore be averaged to remove a large portion of horizontal drift effects. By doing so, drift effects for most users are reduced to less than 0.5 degrees, but may vary from individual to individual.

A few important things to keep in mind in order to minimize drift effects:

- Make sure to calibrate using a background color with the same light intensity as your intended stimuli.
- If re-using an old calibration, verify calibration quality before the test session, and if this is not very good, perform a new calibration.
- Use binocular averaging, as this removes a large portion of the drift effects.
- Do not change light conditions too much during a study.

## *Head-movement compensation*

The term "head-motion compensation error" is the additional error that can occur if the subject moves or turns the head.

For the Tobii Eye Tracker, head-motion compensation is close to perfect, with an error that is less than 1 degree across the entire field of view of the camera. This includes not only head translations sideways and up or down, but also movement back and forth as well as large head rotations.

# Tracking ability

## General tracking ability

Tracking ability is the eye tracker's capability to track as large a of the population as possible. The Tobii Eye Tracker provides good tracking ability, and handles well also with varying light conditions and people wearing glasses or contact lenses.

The Tobii 1750 system performs very well across all ethnic groups and age groups. The Tobii ET-17 system has some difficulties tracking certain individuals, for instance people with dark brown eyes.

It is easy to verify tracking ability of a particular subject by using the track status meter (see description in the ClearView section of this manual).

In order to maximize tracking ability, follow the recommendations below

- Avoid very strong sources of near-infrared light e.g. direct outdoor sun-light or strong halogen lights which may disturb the tracking engine.
- Avoid test subjects with bifocal or progressive glasses, or narrow glasses with thick, reflective rims. One way to test if the glasses are too narrow, is to test if the subject can see the eye tracker camera below the monitor without the rims being in the way.
- Some people have features obstructing a very large portion of the eyes (for instance, very low eye lids or thick mascara). Such subjects should be avoided, since this can cause difficulties in tracking. One clear evidence of this is if you get a calibration only for the top or the bottom half of the screen.
- Ensure that subjects are sitting at the correct distance from the system when starting the study (60 cm), especially when calibrating.

## Tolerance to head-motion

The camera is fixed relative to the TFT screen, and uses a very wide field of view. This enables the system to tolerate fairly large head-motions and record the relevant information about the subject, even if he or she rotates or moves their head. As long as the system is able to detect at least one eye of the user, robust tracking of the gaze point is possible.

The field of view of the camera is about 20 x 15 x 20 cm (width x height x depth) at 60 cm from the screen. Since it is enough that one of the eyes is within the field of view, this gives an effective tolerance to head-motion of about 30 x 15 x 20 cm. This is enough to compensate for any head positions which are comfortable when sitting in a normal posture in front of a computer screen.

When using ClearView for most gaze analysis purposes, it is recommended to use a double-screen configuration. This allows the test leader to see the track status of the subject during a recording session. By doing this, the test leader obtains information as to where in the camera's field of view the subject's eyes currently are. If the subject has moved too far, the test leader can discretely instruct the subject to move into the field of view again.

To maximize the subject's comfort and ability to move during a test, follow these recommendations

- Use a steady chair with no wheels and a fixed back for the subject. This will allow the subject to relax, but automatically avoid large body movements. If the chair can be easily raised and lowered, this makes it easier to adjust for different subjects.

- Start each session with the subject's eyes somewhat above centre of the track status meter, and at a distance of 60 cm. This since subjects tend to sink down in their seat during testing.

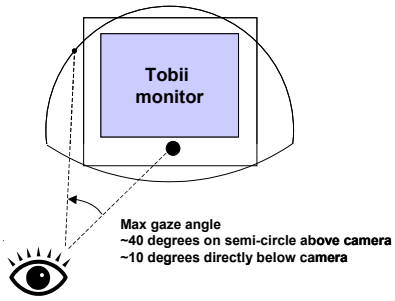
The tracker is unable to track eye movement if the head of the user moves too fast. This is mainly due to smearing effects in the camera image. Top head-motion speed is approximately 10 cm/s, which is enough for most head-movements taking place while looking at objects on a computer screen, especially since recovery time from total loss of tracking to full tracking quality is 100 ms once the subject stops moving.

## Gaze angles

A measure related to freedom of head-movement is the extent to which the system allows for large gaze angles, i.e. that the user looks far away from the camera, which is placed just below the display.

The Tobii Eye Tracker allows for gaze angles up to +/- 40 degrees in the semi-circle above the camera, measured from the camera mounted below the screen. Below the camera, the allowed gaze angles are up to +/- 10 degrees.

The eye tracker provides good accuracy throughout the entire range of tolerated gaze angles.




## The meaning of validity codes

The TET Server provides validity codes for each eye with every gaze data point. The validity code is a measure of the systems certainty that it has recorded the correct data.

The validity code ranges from 0 to 4, with the following interpretations for each value:

0 The system is certain that it has recorded all relevant data for the particular eye, and that the data recorded belongs to the particular eye (no risk of confusing left eye with right eye by the system).

1 The system has only recorded one eye, and has made some assumptions and estimations regarding if the recorded eye is left or right. However, it is still highly probable that the estimations done are correct. The validity code on the other eye is in this case always set to 3.

2 The system has only recorded one eye, and has no way of determining if this is the left or the right eye.

3 The system is fairly confident that the actual gaze data is actually incorrect or corrupted. The other eye will always have validity code 1.

4 The actual gaze data is missing or definitely incorrect. A couple of gaze data with validity code 4 on both eyes, followed by a number of gaze data with validity code 0 on both eyes, are usually a sure sign of a blink.

It is recommended that the validity codes are always used for data filtering, to remove data points which are obviously in-correct. For most studies, we recommend removing all data points with a validity code of 2 or higher.

# Using the ClearView analysis software

## *Introduction*

The ClearView analysis software is an application designed to provide easy-to-use yet flexible and powerful recording and analysis of eye tracking data.

The package facilitates efficient multi-person and multi-trial studies in the fields of experimental psychology, commercial usability, advertising, low-vision studies and more. To facilitate meaningful studies, the software combines the collection and analysis of eye gaze data with numerous other data sources, including key strokes, external devices, video recordings, web browser activity and more. ClearView also provides mechanisms to interface with other software.

## *Licenses*

The ClearView software may be installed on any number of computers, in order to prepare studies and analyze results. However, recording of data can only be done when connected to a Tobii Eye Tracker and with a valid license key installed.

Any time ClearView is launched without a valid license key a dialogue is launched where a license key can be added. License keys are distributed together with the hardware delivery.

To order a new license key contact sales@tobii.com. For technical assistance contact support@tobii.com. Providing the current serial number shown when an eye tracker is connected to the ClearView computer speeds up the process of making a new licens key

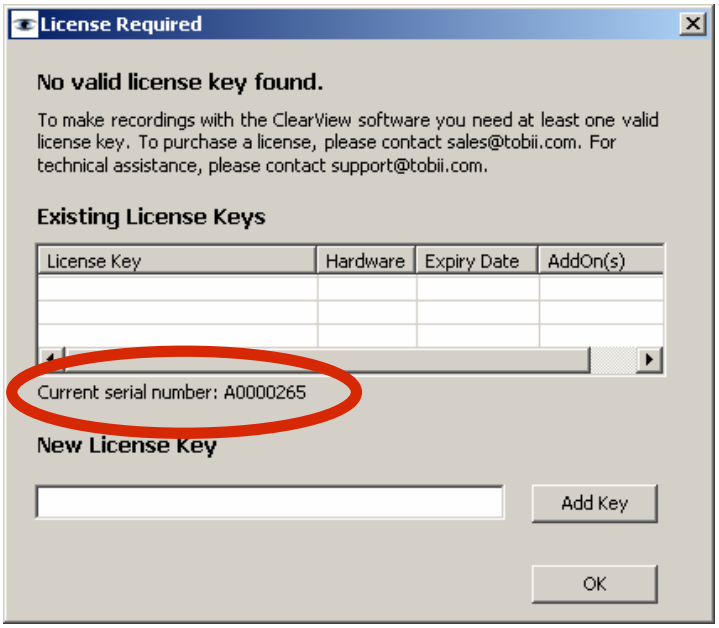



**Figure 7: The serial number is needed to create a new license key**

With the basic ClearView license, Image, Slide show stimuli are available. AVI, Screen, Web, Moving bitmap, Video capture and Scene camera stimuli as well as Live Viewer functionality require additional licenses.

## Basic workflow

When doing studies with ClearView, the basic workflow is divided into three main areas: **Prepare**, **Record** and **Analyze**.

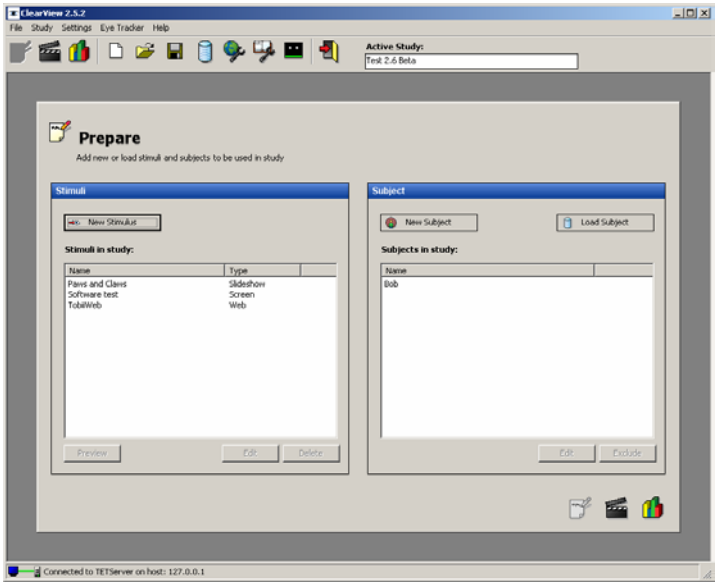



**Figure 8: The ClearView main view**

Of these three general groups of actions the only time a Tobii Eye Tracker is required for the **Record** actions where actual eye tracking data is being collected. You are free to **Prepare** or **Analyze** studies in your office or at home and thus leave your Tobii free in your lab for others to run studies.

## Prepare


During the prepare phase, two main actions are completed

- Creating stimuli
- Selecting and/or creating test subjects.

To start preparation click on the **Prepare** button on the toolbar or in the lower right hand corner of the ClearView main window.

Create a new stimulus by clicking on **New stimulus** and select the type of stimuli you wish to use. For each type of stimulus, a separate stimulus preparation wizard appears.

To select test subjects, use the right-hand window. If these subjects have been used in previous studies then click the **Load Subject** button. If they are a new subject use the **New Subject** button.

For detailed information on each stimulus type, how to set it up and what is recorded, see the chapter *The different stimuli types* below

### Record

 When the stimuli and subjects have been prepared recordings can be made. In most cases a recording procedure will consist of four steps:

- Verifying tracking ability and the subject's position in front of the screen using the track status meter.
- Performing (or selecting) a calibration.
- Verifying calibration quality using the real-time gaze display.
- Performing the stimulus presentation and doing the actual recording.

To access the recording tools click on the **Record** button on the toolbar or in the lower right corner of the ClearView main window.

For more details, see the chapter **Recording Tools** below.

### Analyze

 Once recording is finished the data collected can be analyzed in the analysis section of ClearView. There are several different tools available in ClearView for data visualization and analysis. Depending on the type of study, the work-flow during analysis may vary quite a bit. For many studies though the following steps would be performed

- Using the different visualization tools (gaze replay, gaze plot and hotspot plot) to get a qualitative view of the data and identify behavior of interest.
- Defining areas-of-interest to facilitate meaningful data quantification.
- Making raw text exports or use DirectExcel templates for quantitative analysis and conclusions.

To access the analysis tools click on the **Analyze** button on the toolbar or in the lower right corner of the ClearView main window.

For more details, see the chapter on **Analysis and export tools** below.

## The ClearView Sample package

On the ClearView installation CD there is a folder with Sample files including a Sample package. These folders contain a number of useful files including pictures, movies, analysis tools and templates for easy creation of different stimuli. Place the Sample package in the ClearView Stimuli folder defined in **Global Settings**. The default location of this folder is C:\Program Files\Tobii\ClearView\Stimuli.

The Sample package includes the following folders:

- **AVI Samples** – AVI movies that can be used to test the AVI stimuli
- **Direct Excel Templates** – Analysis templates used with the Direct Excel export from ClearView. See also the section DirectExcel export in this manual.
- **Generators** – Excel templates that can be used to create script files for Moving Bitmap and Slide show stimuli
- **Image Samples** – A collection of pictures in different formats that can be used to test the Image and Slide show stimuli. In this folder there are also specially designed accuracy test images to test calibration quality with the Real time gaze view tool (See the section Recording tools below).

- **Infant Calibration AVIs** – A set of AVIs that have been developed by Scott Johnson at New York University for calibration of infants. ***Place these AVIs directly in the ClearView Stimuli folder***. (Read more about calibrating infants in the section Study Settings below.)
- **Moving bitmap examples** – Examples of scripts for Moving Bitmap stimuli.
- **Slideshow examples** – Examples of scripts for creating Slideshow stimuli.

## *The different stimuli types*

When first opening a study in ClearView the Prepare view is presented. This view contains all necessary tools to prepare a study including what stimuli to show and what subjects to show them to.

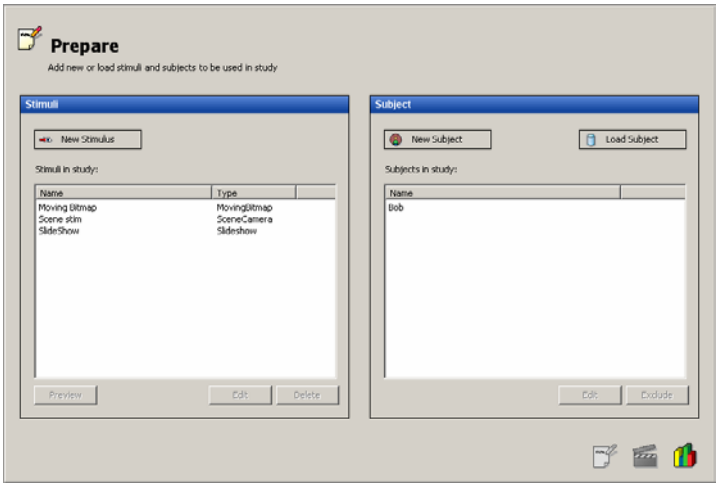



**Figure 9: The prepare view includes controls for creating eye tracking tests**

In the left part of the Prepare view a list of all studies in the study is shown. These can be viewed by clicking **Preview** button to see how they will be presented to subjects, they can be edited by clicking the **Edit** button as long as no recordings have been made on them and they can be deleted from the study by clicking the **Delete** button.

To create a new Stimulus, click the **New Stimulus** button which will bring out the Stimulus wizard where the stimulus type and name is selected. The different stimuli types are discussed below.

**Note:**
When creating a new stimulus ClearView copies the AVIs or images used to define the stimulus to its data base. The original files do not need to be available after this.

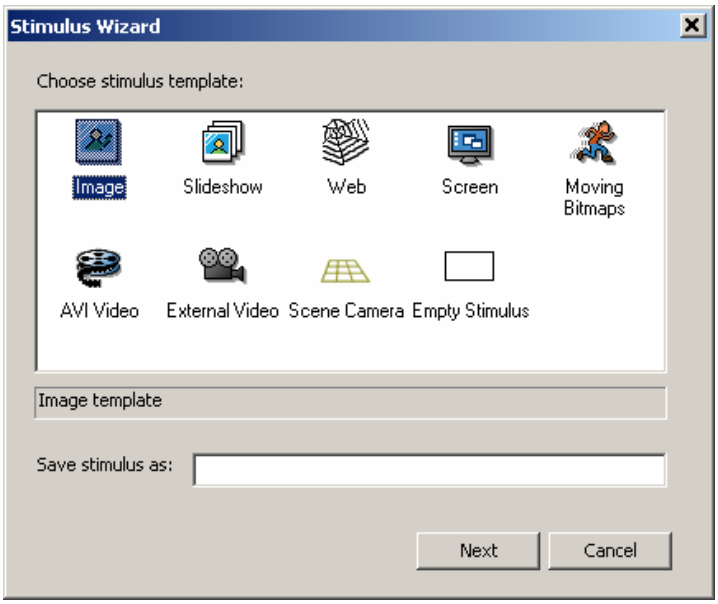



**Figure 10: The Stimulus Wizard displays the different types of stimuli available**

## *Image stimulus*

Image stimuli are used to present a single image to the test subject. This can be used for very quick and simple studies of gaze behavior, for example in simple advertising studies or vision testing.

### Preparing the image

The following parameters are available for the stimuli:

- **Show mouse pointer.** Specifies whether the test person will see the mouse pointer on the eye tracker screen during presentation of the stimulus.
- **Back color.** Sets the color used for the background if your image is smaller than the screen. This is set by clicking on the colored box immediately to the right of the **Browse** button.
- **Image file.** Sets the image file to be used as your stimulus. Use the **Browse** button to find your file. Any GIF, BMP, or JPG file may be used.
- **View time.** Sets the time the image will be displayed. This feature is disabled when **Until key press** is selected.
- **Until key press.** Displays the image unit the user presses a key. This feature is disabled when **View time** is selected.

### Data recorded

During the presentation of the image, eye gaze data is recorded. Also key strokes, mouse clicks and external trigger signals are recorded to the event file.

## *Slide show stimulus*

Slide show stimuli are used to present a sequence of images to the test subject and record information about eye gaze, slide transitions and subject responses (key strokes, mouse clicks etc). Typically, slide shows are used in experimental psychology, advertising studies and low vision studies to measure gaze behavior, response times, search patterns and more.

### Preparing the slide show manually

To create the slide show in ClearView, the following parameters are defined:

- **Show mouse pointer**. If selected, the mouse pointer will be shown during stimulus presentation.
- **Image file**. Sets the image file to be used as your stimulus. Any BMP, JPG, WMF or GIF file may be used. Use the **Browse** button to find your file. This feature is disabled when **Blank slide** is selected.
- **Blank Slide**. Used to display a blank slide. This feature is disabled when **Image file** is selected.
- **Color of background**. Sets the color used for the background if your image is smaller than the screen, or if you use a blank slide. This is set by clicking on the colored box immediately to the right of the **Browse** button or next to the **Blank slide** button.
- **View time**. Sets the time the image will be displayed. This is disabled when **Until key press** is selected.
- **Until key press**. Displays the image until the subject presses a key. This is disabled when **View time** is selected.

When the configuration of the slide is finished, click the **Add** button to add the slide to the slideshow. You can **Edit**, **Remove** or change the **Slide position** using the arrow buttons and the buttons below the list of slides in slideshow window.

To import an entire slide show from text file, click the **Import** button, use the browse button to find a slide show script (e.g. one of the example scripts in the Sample package). Using scripts to simplifies creation of large slide shows, for example with pre randomized slide orders. The import file must contain tab-delimited text where each row contains columns with the following information in the following order:

- **Image file name** (eg. *C:\temp\image1.jpg*). If the file name is blank or the file cannot be found, it is set to be a blank slide. Using the word *blank* as image file name also sets the slide to blank.
- **Color of background** (eg. red or 110,55,255). The color may even be set using standard Windows names for colors or using the RGB color code with a comma as delimiter.
- **Time/Keypress** (eg. 0.34). The unit is seconds. If the time field is blank or has the text *key press*, the slide will advance on a key press instead.
- **Label** (eg. FirstSlide). This is a label associated with each slide.

### Data recorded

During the presentation of the slide show, eye gaze data is recorded. For each slide transition a "showslide" event is saved to the event file. This data contains a precise time stamp for when the event occurs, the slide order number, name and label. Key strokes, mouse clicks and responses from external game-pads are also recorded into the event file, allowing reaction times and subject responses to be measured.

### Advanced issues

Precision in slide timing

One common use of slide shows in eye tracking is reaction time studies. Because of this, the timing issues involved in stimulus presentation and data collection are very important. Tobii have taken great care to provide timing precision for image presentation, and use DirectX and pre-loaded images to RAM to improve the speed of image presentation. The time-stamps of image presentations are accurate to approximately +/- 2 ms.

However, it should also be noted that the accuracy of the timing is only relevant to a certain point as the eye tracker itself has certain delays and the screen refresh rates may delay the showing of the images. For a CRT monitor, typical refresh times are in the order of 15 ms. Since the slide presentation is not synchronized with the refresh rate, there is thus a 15 ms uncertainty window. For TFT monitors (such as the one built into the Tobii ET-17) there is not a fixed refresh time, but instead a "fading in" of each image which takes up to 25 ms to complete if going from black to white. The timing characteristics of the Tobii eye tracking hardware itself are described in detail the chapter **The Tobii Eye Tracker.**

The time when each slide is presented is not always precisely the times specified in the definition of the slide show. This is due to the fact that the command to the graphics board may be delayed based on computer load and the time-slicing mechanisms of Windows. The timestamp of "showslide" can differ up to 20 ms from the specified times in the slide show definition. For highly accurate analysis, we therefore recommend always looking carefully at the time-stamps.

Fast subject responses

To ensure maximum precision in timing for subject responses, we recommend using a game-pad such as the Microsoft Sidewinder instead of relying on the standard computer keyboard. The reason for this is that the standard keyboard usually has a delay of up to 20 ms, whereas a game pad has considerably less delay.

## *Web stimulus*

The Web stimulus uses the contents of a web browser as stimuli. The subject is presented with a standard Internet browser at a predefined start page, and is free to browse the Internet in any way. Web stimuli is typically used as a comprehensive tool for web usability and web advertising studies, for example to measure task completion, attention to different elements and to study fixation patterns.

### Preparing the web stimuli

You can setup the following parameters for web stimuli:

- **Start URL.** Sets the address of the web page your recording will start from. There is no need to specify *http://*
- **Use screen recording.** Controls if the subject's screen will be recorded to create movies of the web pages visited. These screen recordings are the same as in the separate screen stimuli as described previously, and is recommended for most web studies. Without screen recording hotspots and gaze plots can still be made but gaze replay and AVI export are disabled analysis tools.

- **Block File download.** This blocks the browser to start downloading files to the hard disk if the user clicks a link which does that.
- **Block Pop ups.** Since ClearView does not track the content of popup windows there is a built in pop up stopper in the ClearView browser
- **Show content during page download.** In some cases it might be important to know exactly when all the different parts of a web page were presented to the subject. ClearView can download a requested web page in the background of the last page viewed and present it when it has been completely downloaded. However this functionality is not compatible with certain types of Java menus.
- **Browser location.** Coordinates for top left corner of the browser window (x going left to right and y top down from the upper left corner of the screen)
- **Browser size.** Defines the height and width of the browser window. Note: This is the origin and size of the whole browser window not the origin and size of the internal window showing the web page.

### Design tip

When performing usability studies, a study is usually set up of a number of tasks that the subject should solve, for example "Find the contact information for the European sales office". Splitting tasks into different stimuli will greatly improve the ease of managing and analyzing the data after the tests. It is suitable to prepare one stimuli each for each of these tasks, to enable later analysis to separate between them. It is also possible to use different start pages for the different tasks.

### Data recorded

While the subject is browsing web pages, eye tracking data is recorded. If screen recording is enabled, a video of the information presented on the subject's screen is also created, based on the same principles as the Screen recording stimuli. In addition to this, a bitmap of each HTML frame on each web page is recorded each time any new frame is shown in the browser. This bitmap can later be used for area-of-interest definitions, gaze plots and hotspot plots. Also information relating to web page transitions, browser window positions, HTML frame positions and scrolling is constantly recorded, so that the gaze information in the analysis phase can be accurately correlated with the contents on each web page. Key strokes and mouse clicks are also recorded and saved to the event file.

### Important notes

The Internet is a pretty "messy place" with a lot of different types of data being presented and a lot of dynamic behavior. The recording mechanisms provided by the ClearView web recording tool have been designed to facilitate recording of a number of different events and information. However, there are exceptions where the tool does not record information correctly. The below table shows details on which types of web content are correctly recorded in ClearView

| Type of content | Handled today | Comment |
|---|---|---|
| Standard HTML pages | Yes | All basic HTML content, including text, tables, bitmaps etc |
| HTML frames | Yes | Infinite sub-frames, with or without scrolling for each frame |
| I-Frames | No | Will be handled in future versions of ClearView. |

| | | |
|---|---|---|
| Pop-up windows | No | If your study allows it, we recommend disabling pop-up windows. This can be done by downloading and installing a so-called "pop-up stopper". |
| ASP-generated pages | Yes | If web pages are created using ASP, and if they generete clean HTML they can be properly handled with ClearView. |
| Javascript and other script tools | No | If the Javascript somehow affects the visual layout (for example by presenting dynamic menues), these are simply ignored by the recording tool. Therefore, you can still make good recordings on pages with limited amount of Javascript effects. |
| Flash animations | No | Flash animations are simply ignored by the web recording tool. |

Browser window size

The web recording tool automatically disables the ability to change size of the browser window. This is done to ensure that the bitmap that is saved of each web page is consistent throughout the entire recording session.

Page identifier

ClearView identifies web fames based on the URL, the width and the height. This means that frames with the same content but different URLs will be treated as different frames in analysis. Also, frames with the same URL but different sizes will also be treated as separate pages in analysis.

Hardware acceleration

During web stimulus presentation, ClearView tries to disable hardware graphics acceleration automatically. This is necessary in order to capture a video of the screen effectively.

On some computers (mostly certain laptop models) hardware acceleration can not be disabled by ClearView. In these cases it may be necessary to turn off the hardware acceleration manually. To do this in Windows XP right click on the Desktop and choose **Properties**. Go to the **Settings** tab and click **Advanced** in the next window use the slider on the **Troubleshoot** tab to turn the hardware acceleration to none.

Disabling hardware acceleration greatly reduces the processor load when doing the screen recording, but may also cause smooth graphics and animations to become slightly jittery.

| | |
|---|---|
| Screen resolution trade-offs | When using screen recordings as the Web stimulus does, there is a trade off between screen resolution and resource requirements.<br><br>For standard screen recordings, we recommend using a 16-bit color depth and a 1024x768 resolution on the computer settings, and a 10 fps frame-rate for the screen recording. This will put a reasonably low load on the computer and the video files produced become fairly small (about 2MB/minute). If more colors, higher resolution or faster frame-rates are used, this will require more computational resources during recording and more storage space. If accurate timing in the eye tracking is required, we recommend using a double-computer configuration in such cases (see chapter on **Setting up the Tobii hardware**) |

## *Screen stimulus*

The Screen stimulus is not really a stimulus, but rather a type of recording. This stimulus is used to record a video of what happens on the user's screen during gaze recording. This may be used to achieve a good qualitative understanding of gaze behavior while using different types of software on a computer.

The Screen Stimulus may also be used in combination with the web recording tool described in following chapters.

The screen recording is intended for recording low-intensity graphics such as when the subject is browsing a web site or using a word processor. For highly graphics intensive applications such as replaying a full quality movie or playing a computer game, the AVI stimulus or the External video stimulus are recommended instead.

### Preparing the screen recording

There are no editable options when creating the Screen stimulus but the frame rate of the screen recording can be altered under the **Recording** tab in **Global Settings**.

### Data recorded

At the start of recording, the ClearView screen is hidden, and whatever is present on the computer desktop is shown. The subject is free to use any type of application on the computer. Eye gaze data is recorded, as well as a movie of the screen contents. Key strokes and mouse clicks are also recorded and saved in the event data file.

The screen recording video is recorded at full screen resolution.

### Advanced issues

| | |
|---|---|
| Hardware acceleration and Screen resolution trade offs | The Screen Stimulus puts the same restrictions on hardware acceleration and screen resolution as the Web stimulus |

## *Moving bitmaps stimulus*

Moving bitmap stimuli is used to present one or several small pictures that move around the screen in various patterns, defined in a script. Typically, moving bitmap stimuli can be used for smooth pursuit studies, preferential looking paradigms, reaction type studies and more. The stimulus wizard imports one or more scripts and renders an AVI based on these.

For each moving bitmap stimuli, the following parameters are editable

- **Background color**. Defines the color of the background screen.
- **Background image**. Allows you to define an image to use as background for the stimuli.
- **Quality**. The frame rate of the AVI rendered by ClearView. Low (20 fps), Medium (35 fps) or High (50 fps)

### Preparing the moving bitmap stimuli

To import a Moving Bitmap script, click the **Add script** button in the Moving bitmap Stimuli wizard window, and click **Import** to find your particular script file.

The scripts are imported from tab-delimited text files according to a specific format. A Microsoft Excel template provided in the ClearView sample package can be used to create such script files. To do this, create a new Excel document using the Moving Bitmap Generator template provided in the ClearView Sample pack, enter your script information, and save as a text file.

Each row in the script contains a particular action. The actions are carried out in sequence. The script file must be a tab delimited text file where each row except the header row in the text file contains the following information from left to right.

- **Bitmap file.** Defines the picture to use for this particular action in the script. Any .BMP, JPG or GIF file will work. The color of the top left pixel of the bitmap is used as transparent color.
- **Start x, Start y, Stop x and Stop y coordinates (four columns).** Defines the picture's start and stop positions on the screen, measured in pixels from the top left corner of the screen (x left to right, y top down). The coordinates define the centre position of the bitmap.
- **View time**. The view time (or period) for the particular action.
- **Type of movement**. The type of movement that should take place. This can be any of the following types:
- Static: The picture is simply shown at the start coordinate for the view time defined.
- Linear: The picture moves with a linear motion from start to stop position in the view time defined.
- Sinus: The picture moves in a sinusoidal motion from start to stop position in the view time defined.
- Jump: The picture jumps in a single step from start to stop position and then stays there for the view time defined.
- **Number of repetitions**. The number of times that the particular motion takes place. E.g. having two repetitions for a static movement simply doubles the view time while for linear, sinusoidal and jump movements it makes the picture move/jump from the start position to the stop position and back again.

- **Label**. A text label for each action in the script. This can later be found in exported data files for reference.

To create stimuli with multiple bitmaps that move around according to individual patterns, any number of scripts can be added to a single stimulus. The script to appear "on top" of other scripts can be changed by using the arrow buttons in the Moving Bitmaps stimuli wizard.

### Data recorded

During the presentation of the moving bitmap stimuli, eye gaze data is constantly recorded. For each gaze data point, the position on the screen of each bitmap is also recorded. This will allow easy and powerful analysis of eye gaze position relative to the stimuli. Also keystrokes, mouse clicks and responses from external game-pads are recorded into the event file, which can be used to measure reaction times and subject responses.

### Advanced issues

| | |
|---|---|
| Smearing effects on TFT monitors | For certain types of moving bitmap studies, such as smooth pursuit studies, the "smoothness" of movement of the stimuli can be very important.<br>When using the Tobii 1750 or the Tobii ET-17 eye tracker, the tests are always confined to a TFT monitor. This has certain limitations in screen refresh rates. In particular, TFT monitors "fade in" and "fade out" the screen, which cause a certain smearing of fast-moving images. When such issues are crucial, we instead recommend using the Tobii x50 hardware, which allows stimuli presentation on a CRT monitor instead. |
| Avoiding jittery motions | Another issue related to screen behavior is "jitteryness" of motions of the bitmap. Tobii generates precision animated movie files from the scripts to provide smooth animations. However, jitteryness still occurs if the stimuli presentation process in the computer does not get enough time-slots to generate smooth graphics motion. This can be the case if the TET Server itself is running on the same machine as ClearView which does the stimuli presentation. Therefore, when smoothly animated moving bitmap stimuli shall be used, we strongly recommend a two-computer configuration (see chapter on **Setting up the Tobii hardware**). |
| Screen resolution | Since CPU-load needs to be minimized in moving bitmap stimuli, the stimulus AVI is rendered in 600x800 and will be displayed in this resolution regardless of screen resolution. |

## *AVI stimulus*

The AVI stimulus can show one or a sequence of AVIs as stimulus. This is useful for a variety of studies ranging from psychology studies and infant studies to advertising studies.

### Preparing the AVI stimuli

The following parameters can be edited for the stimulus.

- **Background color**. Sets the color used for the background if your AVI-movie is smaller than the entire screen.
- **AVI path**. Sets the AVI file to play be used as your stimuli.
- **Show AVI until**. Defines what event will stop the playing of one AVI and progress to the next in the list. The alternatives are to play the AVI until it is finished, to loop it until a key is pressed or to progress either when the AVI is finished or a key is pressed.

### Data recorded

During the presentation of the AVI movie, eye gaze data is recorded. Times for the changes of played AVIs, key strokes and mouse clicks are also recorded and saved in the event data file.

### Important notes

The AVI format is a standard format for movies including video and audio. AVI files can contain compressed or raw data (uncompressed) but normally the files are compressed in order to get a reasonable size on the AVI file. Compressed AVI files typically have sizes of 10-50 Mb per minute while uncompressed files normally have sizes of some 600 Mb per minute.

The AVI stimulus in ClearView is not intended for showing uncompressed AVI files. Also the AVI stimulus only shows movie files in the AVI format and other types of movies have to be converted to AVI files. There are several good video editing programs available that can be used to convert movies to the AVI format and to compress AVIs to a proper size. Many of these can be downloaded for free from the Internet. If you would like specific recommendations, please contact Tobii support.

## *External video capture stimulus*

External video capture stimulus is intended to use when video data from a different source than ClearView is used as stimuli. ClearView records a video input from most video sources as a movie, which can later be used for gaze analysis. Examples of common video sources are

- Web cameras
- Video capture cards for e.g VCRs input
- VGA capture cards

This stimulus type is recommended when presenting stimuli with another software than ClearView (e.g. E-Prime) or when doing eye tracking on other dynamical stimuli generated outside ClearView such as console games, interactive television or resource intensive computer games played on another computer.

### Preparing the external video capture

To prepare the external video capture, you first need to ensure that you have the proper hardware setup. Your video source needs to be connected to a video capture card of the computer where ClearView is running. Please refer to the **System Requirements** chapter or contact Tobii support for information on recommended video capture cards.

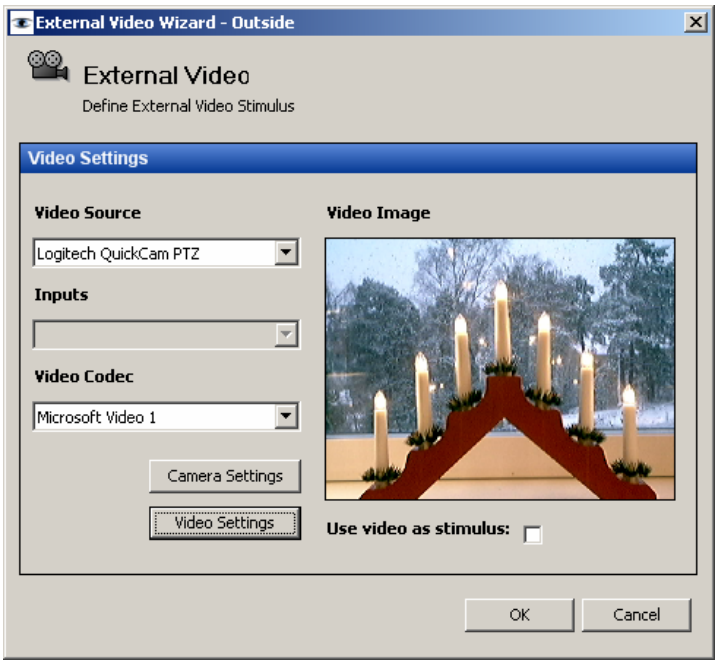



**Figure 11: The Stimulus wizard for External Video includes settings for Video source and quality**

In the prepare view for External video capture, a number of settings defining the video to be captures can be defined:

- **Video Source**. This needs to match the type of video source used. Most video capture cards have the option of capturing at least S-Video and Composite.
- **Video Input Device**. This will define the input device of your video capture card. Usually, there will only be one choice available, which refers to the Video capture card installed on your machine.
- **Video Compressor**. This defines the compressor to use to create the video recording. The choice of compressor will impact the video quality, the video file size, the CPU load during recording, portability etc. For most purposes the Microsoft Video 1 compressor is recommended
- **Camera Settings**. These are the settings of the currently installed camera and typically includes settings for brightness, contrast etc.
- **Video Settings**. These are also hardware specific settings which typically include size and frame rate for the video captured.
- **Use video as stimulus.** When this option is checked ClearView will display the video input on the subject screen during recording.

Once the settings above have been defined the above settings, a preview of the video capture quality will be shown by clicking the **Start Preview** button. This will display the video from your video source. Note that in some cases the quality of the preview will be lower than that of the video captured to file.

### Data recorded

During recording, Clearview will record a complete video of the input from the video capture card. Gaze data, as well as key strokes, mouse clicks and external trigger signals will also be recorded.

### Important notes

| | |
|---|---|
| CPU load and timing of the captured video | When performing video capture, the video signal needs to be converted from an analog to a digital signal. Thereafter, it needs to be captured and compressed into a movie. Because of this, delays are induced that affect the precision in timing of the video. Also at high CPU loads some video capture devices loose video frames occasionally. This means that although, gaze data and trigger data is timed with the same precision as for all other ClearView stimuli, she synchronization of gaze data in relation to the captured video can be degraded.<br><br>This issue is partly related to CPU load. Video capture consumes a lot of CPU resources, as does the eye tracking itself. Therefore, the use of a two-computer setup for the video capture stimulus is recommended. |

## *Scene Camera stimulus*

The scene camera stimulus is intended to be used in combination with the x50 hardware when video data is collected from a physical scene using a stand-alone camera. This stimulus is very similar to the external video stimulus, with the addition that it also performs a point-of-view compensation to compensate for the fact that the scene camera is placed at a certain angle relative to the stimuli and the user.

A typical scene camera setup will typically contain the following key items:

- Some sort of stimulus, presented in the physical world. This can for example be a collection of objects that are moved around on a table. For proper gaze recording, the stimuli should to the greatest extent possible be positioned in a 2-dimensional plane. Any deviations from the plane (for example caused by the height of objects placed in the plane) will cause parallax errors in the gaze estimation.
- A "calibration grid" which is placed on the surface that is being tracked is used for individual calibrations and to align the point-of-view calibration.
- A scene camera, which is used to generate a video of the scene presented to the test subject. The camera needs to be connected to a functioning video source on the computer where ClearView is running. Please refer to the **System Requirements** chapter for information on recommended video capture cards.
- A Tobii x50 eye tracker.
- One or two computers with TET Server and ClearView software.

## Preparing the external video capture

In the prepare view for Scene Camera, there are a number of settings describing video source and intended capture results. These settings are identical to those used for External Video Capture. Please refer to the chapter on **External Video Capture** for a description of these settings.

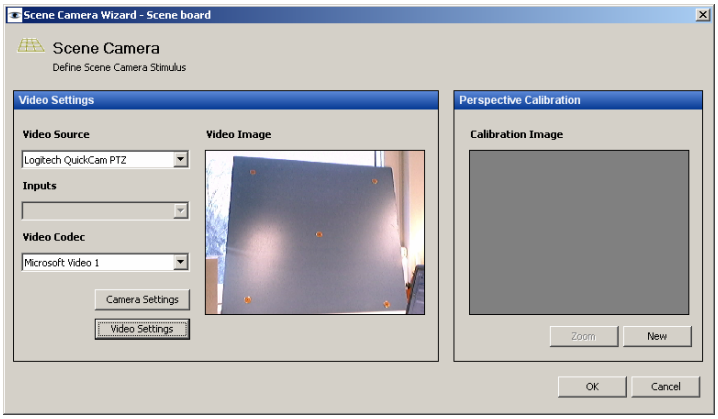



**Figure 12: The Scene stimulus is very similar to that of External Video**

After specifying the video capture settings, a perspective calibration has to be made in order to correlate the captured vide to the physical world. In order to define how this grid is positioned relative to the scene camera, a perspective calibration is required. This allows ClearView to re-calculate all gaze data to accurately indicate where on the presented scene the subject has been looking.

To perform the perspective calibration, first place the calibration grid on the surface to be tracked. Then adjust the settings for your video characteristics as described above. Use the preview pane to adjust the scene camera so that it captures the area on which eye tracking is to be conducted. Fix the camera so that it cannot be accidentally moved and click the **New** button in the **Calibration image** section of the Stimulus wizard.

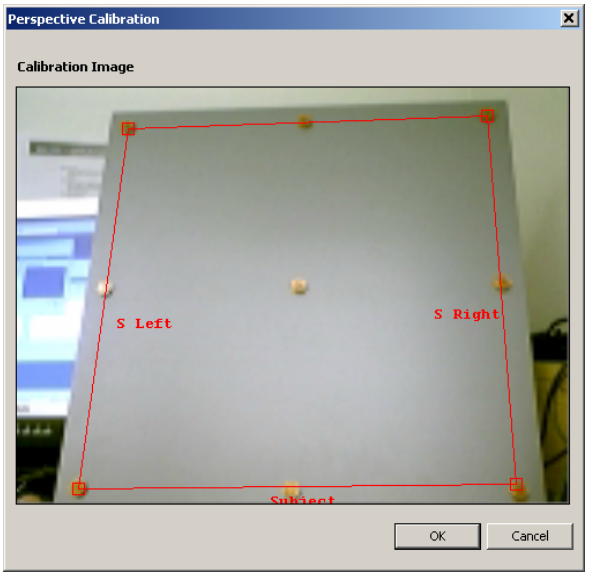



**Figure 13: Perspective calibration is a crucial part of the Scene stimulus setup**

The scene camera now shows an image of the scene, with a polygon drawn on top. Adjust the polygon by dragging its corners so that these are precisely on the corner calibration points (see more about this in the document *How to set up the Tobii x50*).

### Calibrating a Scene Stimulus setup

When calibrating a test subject for a real world setting with physical objects it is advisable to use the low vision calibration type (see also the section **Study Settings**)

### Data recorded

During recording, ClearView will record a complete video of the input from the scene camera. Gaze data, as well as key strokes, mouse clicks and external trigger signals will also be recorded. Gaze coordinates are in the calibration grid and range from (0,0) to the resolution of the scene camera movie.

### Important notes

| | |
|---|---|
| Minimizing parallax errors | The perspective calibration is intended to compensate for the difference in angle from the calibration grid and the scene camera.<br><br>However, this only compensates for angles as seen in the stimulus plane. If three dimensional physical objects are used as stimulus, and these have a certain height that take them far away from the stimulus plane, this will cause a parallax error. The size of this error is related to the difference in point of view from the scene camera and the test subject.<br><br>Therefore, to minimize parallax errors, it is recommended to place the scene camera in an angle fairly close to that of the test subject, for example slightly behind and to the side of the subject or immediately over the subject's head. |

## *Recording*

The film clap icon brings up the Record view used to make recordings on stimuli with subjects created/added in the Prepare view.

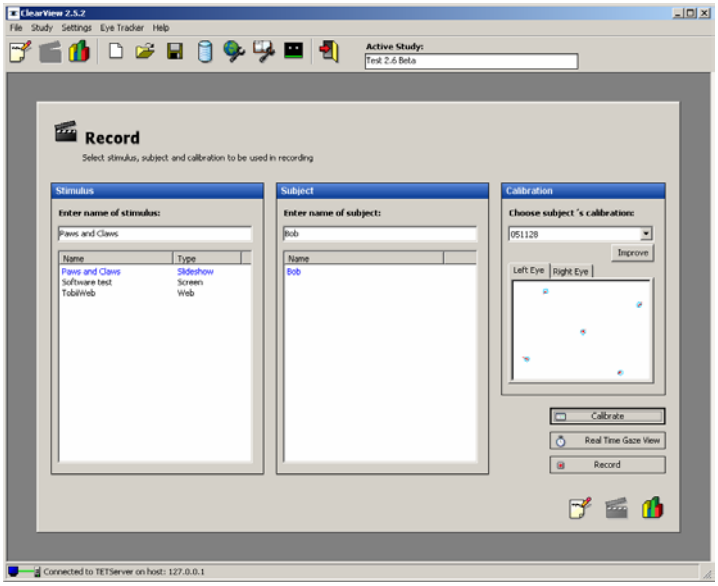



**Figure 14: The ClearView recording view**

The Recording view contains a list of stimuli prepared, a list of subjects added to the study, a calibration area and function buttons for calibration and recording. To start a recording simply choose a subject and calibrate if no accurate calibration already is available, choose a stimulus and click the **Record** button.

## Track status meter

The track status meter is shown before each calibration, real-time gaze display and recording. It can also be activated directly by clicking the track status icon in the ClearView toolbar. In double monitor mode the track status meter can be shown on both the subject screen and the operator panel (See also the chapter **Global Settings**)

The purpose of the track status meter is to verify that the test subject is in the correct position in front of the eye tracker, and that system is able to robustly track the subject.

The track status meter shows a black box with two white circles and a text bar at the bottom. The black box represents the field of view of the eye tracking camera and the white dots represents the eyes of the text subject. As long as at least one of the subject's eyes are within the box, the system can track eye movements.

For best results, both eyes should be within the box. It is also recommended to start each recording session by having the subject's eyes placed in the middle of the track status meter at about 60 cm distance. This enables the subject to move as much as possible during the test without moving outside the box. The text bar indicates the tracking ability. If the bar is colored dark green with the text "both" and is not flickering, the system is tracking the test subject well. If the text bar is red or flickering between red, yellow and green, the system has difficulties tracking the particular subject for some reason. In most cases, this means that tracking will not be successful, even though it is possible to try by continuing with calibration and recording.

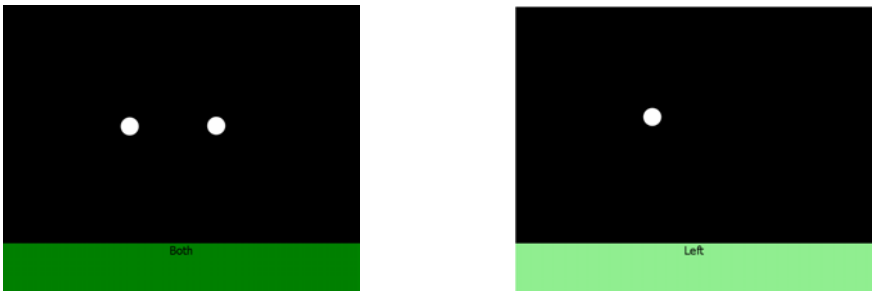



**Figure 15: The track status meter to the left shows perfect tracking while the one to the right indicates that only the left eye of the user can be found.**

## Calibration

The calibration "teaches" the eye tracker the characteristics of a particular subject's eyes. This is necessary for accurate estimation of a subject's gaze point.

### Perform a calibration

To calibrate a subject already added to the study, go to the **Record** view, choose the subject to calibrate from the subject list and click the **Calibrate** button.

After showing the track status meter, the calibration routine displays a series of calibration points on the screen. During calibration, the subject should concentrate on focusing the eyes on these points. The subject does not have to keep the head

still during calibration – in fact, relaxed movement tends to improve calibration quality.

The Tobii tracker has unique "long-lasting" calibrations as described in the chapter **Properties of the Tobii Eye Tracker**. This allows individual calibrations to be re-used for later test sessions. However, for maximum accuracy, it is recommended to verify calibration quality using the real-time gaze display and, if required, perform a new calibration before each separate test session.

There are several options to customize the calibration routines to suit a particular subject or study. These options can be found under **Study settings** and include number, size, speed and color of calibration points. Also, there are two special calibration routines intended for subjects with poor eye site or short attention spans called *low-vision calibration* and *infant calibration*.

### *Low vision calibration*

The low vision calibration is a operator paced calibration procedure with special graphics during the calibration procedure. The number of calibration points and their locations are the same for the low vision calibration as for normal calibration but instead of a pulsating dot two lines intersecting in the calibration point are displayed. When the space bar is pressed the lines change color while calibration is performed and the lines move to the next calibration point

**Important note:**
The calibration is performed after space bar is pressed. Make sure the test subject doesn't move his/her gaze at the sound of the key press

### *Infant calibration*

The infant calibration uses small AVIs to capture the user's attention and then calibrates on the point where the AVI was shown. These AVIs are defined in the ClearView Study settings.Several AVIs that can be used for calibration are provided in the ClearView Sample pack available on the installation CD (compliments of Scott Johnson at New York University).

ClearView can also display multiple attention grabbing AVIs if test subjects respond poorly or grow tired of a particular AVI. These attention grabbing AVIs should be named 1.avi, 2.avi and so on up to 9.avi and be placed in the Stimuli folder as defined in Global settings (default is C:\Program Files\Tobii\ClearView\Stimuli.

To control the calibration process, the following keys are used

| | |
|---|---|
| Right arrow | Displays the calibration AVI at the next calibration point. If the calibration AVI is already visible, a calibration is made on that point before proceeding to the next one. |
| Left arrow | Pause. Hides the calibration AVI or the full-screen attention-grabbing AVI |
| Up arrow | Displays the full screen attention grabbing AVI |
| Keys 1 to 9 | Displays the small attention grabbing AVIs 1-9.avi respectively |

## Interpreting the calibration plot

When the process is complete a calibration plot is displayed. The plot is used to indicate the quality of the calibration. Each of the calibration points that were shown on the screen during calibration is now displayed as a blue circle, and each

calculated gaze data in relation to this is shown as a red or green line. One plot is shown for each eye (red for left, green for right).

The calibration is of high quality if:

- There are red and green lines for each of the blue circles across the screen, indicating that calibration data was collected for every calibration point
- The red and green lines are very short, indicating that the calibration data collected is accurate.

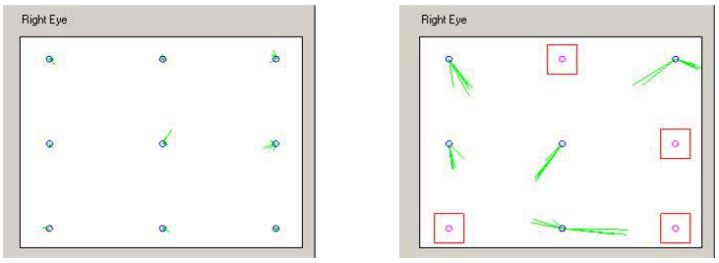



**Figure 16: Two calibration plots. One perfect to the left and one poor to the right**

If calibration data is poor or missing for certain calibration points ClearView will automatically suggest recalibration of these points by marking them with red squares. To choose additional points to recalibrate, simply click on these with the mouse. Clicking the button **Recalibrate** starts a recalibration of the selected points, Clicking the **Accept** button saves the calibration.

## *Real time gaze display*

The real time gaze display is useful as a tool to verify the quality of tracking and the quality of calibration for a certain test subject. The tool displays an image as a background, and the gaze point superimposed on this image. In dual monitor mode the point of gaze is only displayed on the operator screen.

During real-time gaze display, a blue dot indicates that the system can track both eyes. A red dot indicates that only the left eye is tracked, and a green dot that only the right eye is tracked.

The real time gaze display tool is found under the **Recording** view. After clicking on **Real time gaze display**, select an image file to use as background during real time gaze display. To quit real time gaze display, press **ESC** to quit. Pictures intended for testing the tracking accuracy can be found in the ClearView samples package in the folder **Image Samples\Accuracy test images**.

## *Live Viewer*

The Live Viewer is a tool for monitoring an eye tracking session live. It shows a live picture of what is being shown on the test subject's screen with the gaze point overlaid. The Live Viewer can also take the picture from an external camera such as a web camera and show that live. The UserCam picture is also saved to file and can be exported after a finished test along with a screen capture with gaze overlay.

All settings for the Live Viewer can be found in **Global Settings** under the Live Viewer tab and include what pictures to show and save to file and if the Live Viewer should be shown in full screen during the course of the recording.

### Important notes

| | |
|---|---|
| Reduce CPU load | Use a double computer setup<br>Reducing the resolution and frame rate on UserCam, screen capture and video capture<br>Showing the LiveViewer in a small window only<br>Do not show the UserCam picture live |
| LiveViewer for Slideshow | The LiveViewer only shows every other image when running with the slideshow stimulus. In order to see all images, insert an empty image between every slide and have it show for just a fraction of a second. |

## *Controlling ClearView from other applications*

ClearView has capabilities for presenting a large range of stimuli and collecting data from numerous different sources. However in some cases other applications are used for data collection in parallel with ClearView, e.g. EEG recorders, logging applications or psychology testing applications.

For this purpose ClearView is fitted with a mechanism to receive control signals over the TCP/IP interface. The Tobii Software Development Kit (Tobii SDK), which is purchased separate from ClearView includes details on how to build an application which sends such signals to ClearView.

Several applications including E-Prime from Psychology Software Tools, INTERACT from Mangold and The Observer from Noldus have implemented the interface and can control ClearView.

### How to set up ClearView to receive trigger signals

The ClearView trigger mechanism is a way of passing information and control signals to ClearView from outside applications. When using trigger signals, ClearView listens for communication over TCP/IP (Ethernet connection) on port 4456 which needs to be open for communication through any firewalls or similar. To open this port, find the settings for the firewall on the ClearView computer and specify that port 4456 is safe for TCP communication.

There are different types of signals that can be sent by an external application

| Function call | Description |
|---|---|
| Initialize | Connect to ClearView and performs internal initializations. Initialization needs to be performed before the start of a recording can be triggered. |
| Close | Disconnect from ClearView and perform internal cleanups. |
| Start | Start a recording. This function call replaces the pressing of the button "Start" in ClearView. |
| StartWithName | Start a named recording. By using this method the name of the recording is specified when it starts. |
| Stop | Stop an ongoing recording. |
| LogEvent | Add a text data record to an ongoing |

| | |
|---|---|
| | recording. The text data entered shows up time stamped in the ClearView Event log file. |
| SendGenericEvent | Sends a generic event which forwards an image or AVI slideshow to the next image/movie the same way a key stroke would do on the ClearView computer. |
| GetLastError | Get error details if any function call returned error. |

When running a study in ClearView using trigger signals the work done in ClearView is identical to how it's run up to and including clicking the "Record" button in the Record view of ClearView. At this point an external application can send a start signal to start recording and a stop signal to stop it. During recording an external application can log events which are time stamped when they reach ClearView and are inserted into the ClearView event file. Also a generic event can be sent to forward slide shows which are controlled by key stroke in ClearView.

## Analyzing data

The analysis and export tools in ClearView aim to provide powerful mechanisms for gaze visualization, data abstraction, and to combine data from multiple sources. For actual quantitative analysis, the intention is that you will export appropriate data from ClearView and use other off-the-shelf software for analysis (Excel, SPSS, Matlab etc).

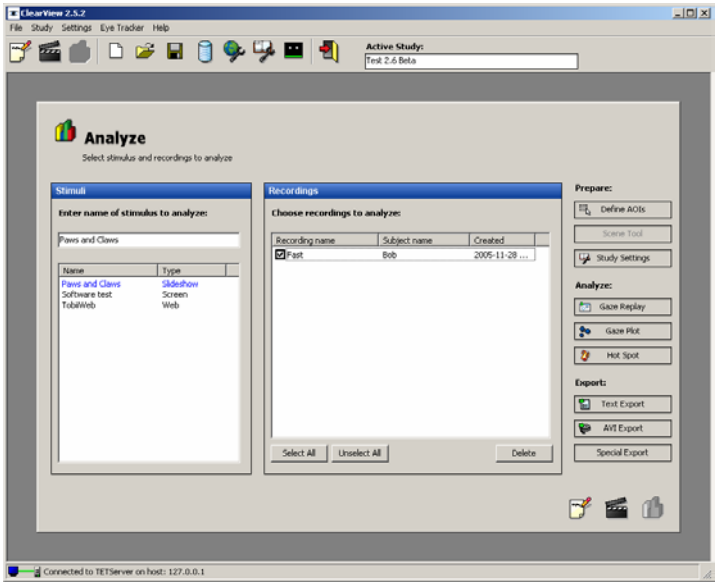



**Figure 17: The Analysis view contains tools for analysis and different types of data exports**

### AOI definition

A very useful tool for quantifying gaze data on a higher level is to use area-of-interest (AOI) analysis. When using AOI analysis, you can define areas of interest within your stimuli. Instead of intepreting your data based on the direct gaze coordinates of the test subjects, you base the analysis on the frequency, time etc that the subject(s) have been looking within the areas of interest. This is applicable to a

range of different analysis applications, for instance psychology studies and web usability studies.

Defining can be done before but in most cases it is best done after you make your recordings. Click on the **Define AOIs** button in the analysis view to enter the AOI definition tool. You can create any number of AOIs in any frame of your stimuli. A frame can either be a single image (for image stimuli), one of the slides in a slideshow (for slide show stimuli) an image of each frame visited during web browsing (for web stimuli) or a static image representing a whole AVI.

To define a new AOI, select which slide to define AOIs, select a frame in the top left list. Add a new AOI either by right clicking the image and choose to create a new rectangular or polygon AOI or by clicking the rectangle or the polygon on the toolbar and then drag n' drop the desired shape on the picture. All AOIs can be moved around or resized by moving its corner points.

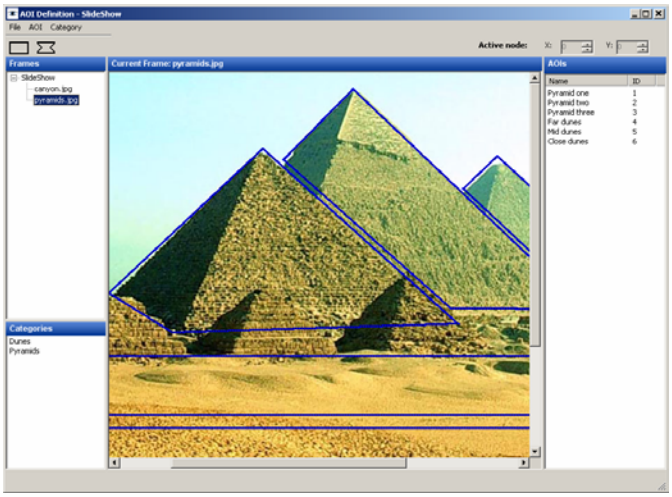


**Figure 18: The AOI tool allows for definition of AOIs of any shape**

AOIs can also be grouped in categories. This can be useful if several AOIs represent the same type of objects in the stimulus and need to be treated together in statistical calculations. Create new categories by choosing **New Category** on the **Category** menu and chose which AOIs belong to what categories by choosing **Edit Categories** on the same menu and checking the appropriate checkboxes.

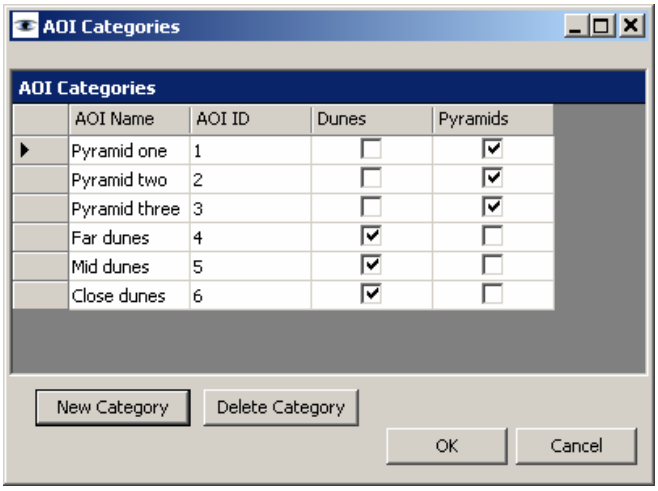



**Figure 19: By grouping AOIs into categories, statistical analysis is made even easier.**

If the same set of AOIs is to be used on several images, they can be exported and imported using the Export/Import AOIs options on the File menu in the AOI Definition tool.

For more information on how to use the results from area of interest analysis, please refer to the **Text export** and **Direct Excel** export chapters below.

### Important issues

| | |
|---|---|
| AOI "buffer zones" | Errors in gaze estimation might be as large as one degree (corresponds to about 30 pixels for 1024x768 screen resolution in normal conditions). Therefore, we recommend defining AOIs with a "buffer zone" of roughly 30 pixels around the intended object when this is possible. Also, avoid defining AOIs that are too small. |

## *Gaze replay*

The gaze replay is a way to dynamically visualize a gaze recording. It replays the gaze path overlaid on top of the stimuli, whether a still image, a slide show or a movie. There is also the option of showing a track status meter, a UserCam picture and play the audio from the recording.

The tool bar at the bottom of the window contains controls for playing, pausing and stepping through the Gaze Replay. The blue time bar is clickable and can be dragged back and forth.

The menus in the Gaze Replay tool contains the following

**File Menu**

| | |
|---|---|
| Export as AVI | Launches the AVI Export for the current recording (see the chapter on AVI export) |
| Save Static Representation | For AVI, External Video and Scene stimuli this option is enabled when the replay is paused. The static representation is a copy of the current movie frame which is used as background image in Hot Spot and Gaze Plot analysis. |
| Exit | Believe it or not, but this exits the Gaze Replay tool. |

**View Menu**

| | |
|---|---|
| Trackstatus, UserCam and Tool bar | These options shows or hides the respective tools. The Gaze Replay itself is always visible. |

**Audio**

| | |
|---|---|
| Mute | This turns off the sound in the replay |

**Settings**

| | |
|---|---|
| Replay Color | The color of the gaze trail displayed in the replay |
| Trail length | The length of the gaze trail in milli seconds |
| Replay rate | The speed of the Gaze Replay as a percentage of normal speed |
| Flip User Cam | By flipping the UserCam picture horizontally (by having this box checked) the users eyes will move to the same side as the gaze trail in the replay movie. |

## *Gaze Plot*

The gaze Plot displays a static view of the gaze data for each image of the stimuli and is a useful tool when visualizing scan paths. Each fixation is illustrated with a semi-transparent dot where the radius represents the length of the fixation.

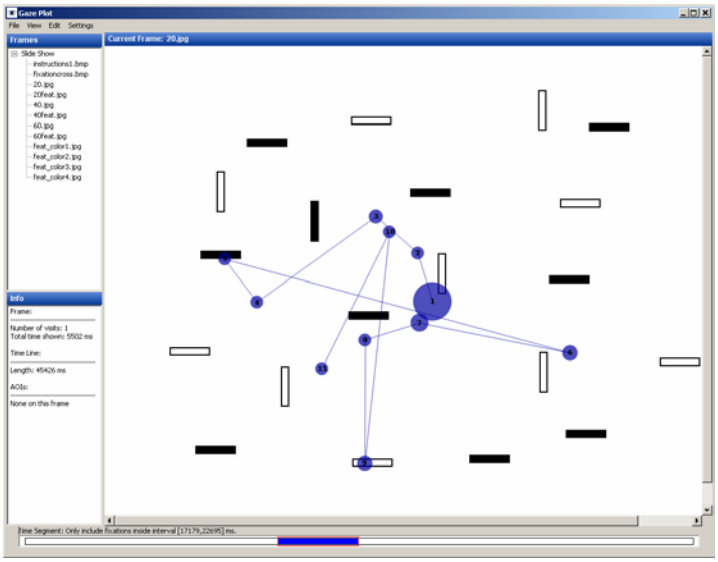



**Figure 20: The Gaze plot visualizes the scan path of a user**

The left frames in the Gaze Plot window include a list of the frames displayed in the chosen recording and basic information about the selected frame. By moving the mouse cursor over a fixation, additional information about the fixation is displayed.

On the bottom of the Gaze Plot window a time axis shows when the current frame was displayed in time (blue segments) and what time segment fixations are drawn for (red rectangle). By dragging the edges of the red rectangle, the fixations displayed will change accordingly. For more details about how fixations are calculated, read the section on **Study Settings**.

The Gaze Plot tool includes the following menus.

**File Menu**

| | |
|---|---|
| Save image | Saves the Gaze Plot image to file. The saved image also includes statistical information to identify the data behinds the image. |
| Exit | Believe it or not, but this exits the Gaze Plot tool. |

**View Menu**

| | |
|---|---|
| Full screen | Displays the Gaze Plot in full screen. Hit any key or click the mouse to return to the Gaze Plot tool. |

**Edit Menu**

| | |
|---|---|
| Copy image | By choosing this option or pressing Ctrl+C the Gaze Plot image is copied to the Windows Clipboard and is available for pasting in other programs like Word or Powerpoint. The copied image also includes statistical information to identify the data behinds the image. |

**Settings Menu**

| | |
|---|---|
| Color and Transparency | The color and the transparency of the gaze trail can be altered to be clearly visible against the background image. |
| Start numbering from one | By checking this box the numbers in the fixation circles will always start from one in an image, even if the time segment plotted changes.<br>If this box is left unchecked all circles will have the number of the fixation counted from the start of the recording. This is also the number which is shown in the fixation info when the mouse cursor is moved over a fixation circle. |
| AOI settings | AOIs can be drawn on top of the Gaze Plot. The color and transparency of the AOIs and their names can be changed. |

## *Hot Spot plot*

The Hot Spot plot is a powerful way to visualize the gaze behavior of an entire group of recordings. To use this, select the recordings you want to include in the plot, and thereafter click on the hotspot plot button in the Analyze view.


**Figure 21: The Hot Spot shows areas of interest as brightly.**

The Hot Spot plot consists of the stimuli as background image and a hotspot mask superimposed on top of this. The Hot Spot mask consists of a black background, with high lighted areas where test persons have been looking.

### Merging images into one Hot Spot

The left pane of the Hot Spot tool includes a list of all images shown during recording. In some cases there is a need for merging the data from several images into one Hot Spot, e.g. if a web page has some dynamic content or unique session URLs. By creating Hot Spot groups and dragging frames which are to be merges into the same group such Hot Spots can be created. For these Hot Spots the Hot Spot mask consists of data from all images in the group while the background image can be chosen among the members of the group. In the image above one group has been defined containing two images, the first of which is currently shown as the background of the Hot Spot.

### Time segmenting hotspots

In some cases it is if interest to create a Hot Spot based on only a smaller time segment than the image was shown during recording. At the bottom of the Hot Spot window a time scale shows a representation of the different recordings and the time segment chosen for the Hot Spot. One or more green markers indicate the starting point of the different recordings and one or more red markers indicate the end of the different recordings. By dragging the ends of the blue bar the time segment to include in the Hot Spot can be changed. Note that by making the time segment smaller some recordings might be excluded from the calculations all together.

## Hot Spot settings

Most settings and controls in the Hot Spot can be accessed by right clicking the HotSpot image. These same settings can also be found under the different menus in the Hot Spot tool.

**File Menu**

| | |
|---|---|
| Save image | Saves the Hot Spot image to file. The saved image also includes statistical information to identify the data behinds the image. |
| Exit | Believe it or not, but this exits the Hot Spot tool. |

**View Menu**

| | |
|---|---|
| Full screen | Displays the Gaze Plot in full screen. Hit any key or click the mouse to return to the Gaze Plot tool. |

**Edit Menu**

| | |
|---|---|
| Copy image | By choosing this option or pressing Ctrl+C the Gaze Plot image is copied to the Windows Clipboard and is available for pasting in other programs like Word or Powerpoint. The copied image also includes statistical information to identify the data behinds the image. |

**Settings menu**

*Legend Settings*

| | |
|---|---|
| Colors and Transparency | The colors and the transparency of the Hot Spot mask can be altered to be clearly visible against the background image. Click a color box to change that color in the scale or move the slider to change the transparency. |
| Legend Scale | By changing the max value for the legend, the Hot Spot uses as much as possible of the color range for the legend. In order for different frames to be easily comparable, the maximum values are the same for all Hot Spots. |

*Data Settings*

| | |
|---|---|
| Raw/Fixation Data | By using fixation data for the Hot Spot calculations, jitteryness and noise in the eye tracking data is filtered out before the Hot Spot mask is calculated. This is suitable for studies with few recordings while raw data normally provides a more smeared out picture which is representative when there are many recordings and errors can be assumed to cancel. |

| | |
|---|---|
| Hot Spot Type | There are four types of Hot Spot calculations<br>1. Fixation count: Adds up all the fixations from all the recordings (or gaze points for raw data).<br>2. Fixation length (Absolute): Total fixated length on each spot of the image.<br>3. Fixation length (Relative): The sum of the individual fixation lengths relative to the total fixation time on the image for each recording. If in recording A the subject looked on the image for 10 *seconds* and on a specific object for 3 *seconds*. In recording B the subject looked at the image for 10 *minutes* and on the specific object for 3 *minutes*. In this kind of hotspot the data from recording A and recording B will have the same weight.<br>4. Subject percentage: This hotspot shows how many percents of the subjects saw an area of the image. |
| *AOI settings* | |
| Color and Transparancy | AOIs can be drawn on top of the Gaze Plot. The color and transparency of the AOIs and their names can be changed. |
| *Time Segments* | |
| Refence point | This defines which points in time of different recordings, start, end or both should be treated as one.<br>When choosing *Start* as reference point, there will be only one green start marker on the Hot Spot time line and the blue time segments will *include* all data from a certain time after *Start* to another time after *Start*.<br>If *End* is selected, data from a time segment relative the End of recordings is included in calculations.<br>By choosing *Both*, data from the first x seconds and from the last y seconds is *excluded* from the calculations. For instance "Exlude data from the first 1000 ms and the last 1000 ms" – this will exclude data from the first and last second of each recording in the analysis. |

| | |
|---|---|
| Visits | **All** will include all visits to the page in the analysis.<br>**First only** includes only the first visit of a frame in the analysis even if it was visited several times during a recording |

## Scene tool

Moving stimuli do not consist of separate images which can be made into Gaze Plots and Hot Spots like slideshows and web sessions can. The scene tool makes it possible to split recordings made with the AVI, Scene, External Video and Screen stimuli into scenes, effectively making them into slide shows.

To make a movie into a slide show, the movie is first divided into scenes and after that these scenes are grouped into scene groups. This way scenes appearing in different order in different recordings or several times during one recording can be analyzed together in Hot Spots.

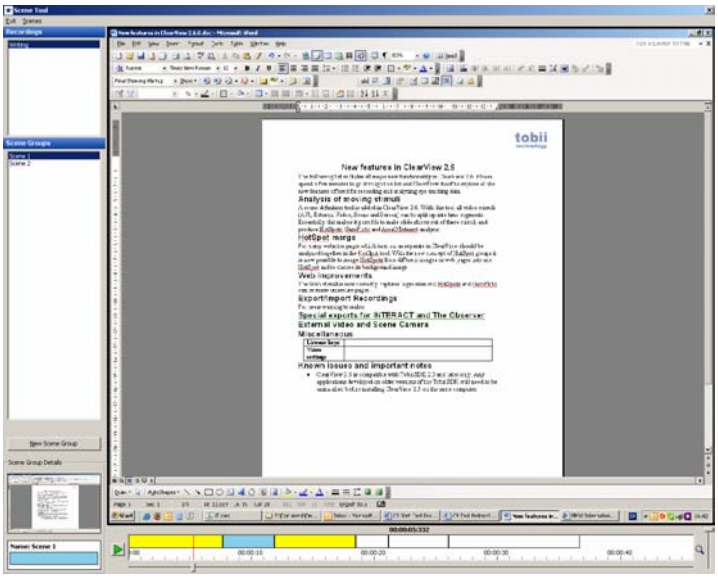


**Figure 22: With the scene tool movies can be analyzed as slide shows**

To split a movie into scenes the movie is played and scene change markers are inserted by pressing Ctrl+M on the keyboard. Uncoloured time segments not belonging to any scene group appear on the time bar.

To attribute a scene group to a scene, the scene group is simply dragged to the time segment on the time bar. Drag either the name of the scene group or its colour to the time bar. A scene group can also be dragged onto an empty segment of the time bar, in which case a scene belonging to that group is created.

When a new scene group is created by clicking the button *New Scene Group* the movie frame currently visible is set as the static representation for this scene. To change the static representation right click the name of the scene group, choose *Edit Scene Group* and drag the time slider to the proper frame in the movie before clicking *OK*.

### Important notes

| | |
|---|---|
| Exporting scenes | Scene definitions are not exported along with the recording data. If recordings from different computers are merged into one stimulus for analysis, scenes can only be defined after the import has been completed.The LiveViewer can be very resource intensive. Reduce load by |
| AOIs on scenes | AOIs can be defined on scene groups defined with the scene tool, but if the name of a scene group is changed the AOIs defined are lost. |

## *Exporting data from ClearView*

### *Text export*

ClearView can export data from a number of sources in a variety of formats in order to use other software for quantitative data analysis. To make a text export, select the recordings that you wish to export (you can export multiple recordings concurrently). Then click on **Text Export**, and select the data types you wish to export.

All data is exported as tab-delimited text files.

The files that are created are given the name of the recording plus a short three letter word in capital letters indicating the type of file. For example, a gaze data recording with the name "myfirstrecording" is given the filename "myfirstrecordingGZD.txt".

All export files start with a header containing information about the recording date and time, study name, test subject name, recording name, screen resolution and coordinate unit used for gaze data.

The following text exports are available:

#### Gaze data (GZD)

This exports the raw gaze data from each recording with the columns below.

| Data column | Description |
|---|---|
| Number | A sequential serial number given to the gaze point |
| Time | The timestamp, in ms, for this gaze point from the start of the recording |
| Screen X (left eye) | The horizontal position of the gaze point, measured in pixels from the left. |
| Screen Y (left eye) | The vertical position of the gaze point, measured in pixels from the top |
| Cam X (left eye) | The horizontal location of the pupil in the camera image, on a scale from 0 to 1 |
| Cam Y (left eye) | The vertical location of the pupil in the camera image, on a scale from 0 to 1 |
| Distance (left eye) | The distance from the camera to the left eye, in mm |
| Pupil (left eye) | The size of the pupil, in mm |
| Code (left eye) | The validity of the gaze data |

| | |
|---|---|
| Screen X (right eye) | The horizontal position of the gaze point, measured in pixels from the left |
| Screen Y (right eye) | The vertical position of the gaze point, measured in pixels from the top |
| Cam X (right eye) | The horizontal location of the pupil in the camera image, on a scale from 0 to 1 |
| Cam Y (right eye) | The vertical location of the pupil in the camera image, on a scale from 0 to 1 |
| Distance (right eye) | The distance from the camera to the right eye, in mm |
| Pupil (right eye) | The size of the pupil , in mm |
| Code (right eye) | The validity of the gaze data |

### Fixation data (FXD)

This exports one data row per fixation. The validity filter, eye filter and fixation filter settings are used to filter the data. Gaze data that do not belong to any fixation are omitted. The following columns are created:

| Data column | Description |
|---|---|
| Number | A sequential serial number given to the gaze point |
| Time | The timestamp, in ms, for start of this fixation from the start of the recording |
| Duration | The duration, in ms, of the fixation |
| Screen X | The horizontal position of the fixation centre, measured in pixels from the left |
| Screen Y | The vertical position of the fixation centre, measured in pixels from the top |

### Event data (EVD)

This exports the event data for each recording. The following columns are created:

| Data column | Description | |
|---|---|---|
| Time | The timestamp in ms indicating when the event occurred from the start of the recording | |
| Event | The type of event in text format. This can be either of the following: | |
| | Showslide | The command to show the next slide in a slide show has been received by the graphics board. |
| | Hideslide | The command to remove the active slide in a slide show has been received by the graphics board. |
| | Keyboard | A key has been pressed. |
| | LmouseButton | Left mouse button has been pressed. |
| | RMouseButton | Right mouse button has been pressed. |
| | TCPData | A trigger event has been received by ClearView. |
| | TCPKeyPress | A trigger keypress event has been received by ClearView. |
| | ShowAVI | The command to show the next AVI movie in a AVI stimuli has been received by the graphics board. |
| Event key | An unique identifier for each event type. | |
| Data 1 | A data field for the event. The contents of this field vary depending on what type of event this is. See below table. | |
| Data2 | As above. | |
| Description | A description of the event. The contents vary depending on what type of event this is. See below table. | |

| Event | Event Key | Data 1 | Data 2 | Description |
|---|---|---|---|---|
| Showslide | 4 | Slide number | - | Slide label |
| Hideslide | 5 | Slide number | - | Slide label |
| Keyboard | 3 | ASCII code for key pressed | - | Key name |
| LMouseButton | 1 | X mouse coordinate | Y mouse coordinate | - |
| RMouseButton | 2 | X mouse coordinate | Y mouse coordinate | - |

| | | | | |
|---|---|---|---|---|
| TCPData | 6 | - | - | A text string sent over TCP/IP |
| TCPKeyPress | 7 | - | - | - |
| ShowAVI | 8 | - | - | AVI movie file |

### AOI data (AOI)

This exports one data row per fixation. The validity filter, eye filter and fixation filter settings are first used to filter the data. Thereafter, the data is compared to the AOIs defined for the study. The following columns are created:

| Data column | Description |
|---|---|
| Time | The timestamp in ms indicating start of the fixation |
| Duration | The duration in ms of the fixation |
| AOI ID | The unique identifier for the AOI that this fixation was in. |
| AOI Name | The name of the AOI that this fixation was in. |

Two special AOI idenfiers and AOI names exist:

- **Blank (ID 0).** This denotes a fixation on a blank slide in a slideshow.
- **Content (ID 0).** This denotes a fixation on the screen, but outside any of the defined AOIs.

### AOI List (AOIL)

This export contains a list of all AOIs defined for the stimulus and the categories they belong to.

### Combined data (CMD)

This exports nearly all data from the system in one combined data file. The purpose of this is to make parsing of the data easier for certain types of analysis tools.

The combined export contains all the information from the gaze data export, the event data export, the fixation export, the moving bitmap export and the AOI export, with the following changes:

- Change in validity code. If the data in a certain row is an event instead of a gaze data, the validity codes for both eyes are set to 5. This is done to facilitate easy parsing of the data file.
- Fixation number. The fixation number is given in the column "fixation". If the particular gaze data does not belong to a fixation, the value is set to blank.

## *AVI export*

AVI export is used to create an AVI movie of the gaze replay (see above chapter). Any rendering codecs installed on the computer can be used. For screen capture data the Techsmith Screen Capture Codec (TSCC) is recommended. To view a movie made in TSCC this codec needs to be installed on the computer where the movie is played as well. TSCC can be downloaded free from www.techsmith.com. Other common codecs include MS Video 1. However this codec does not support AVI export in higher resolutions.

## Merging stimuli from separate studies

If data collected with different copies of ClearView but based on the same stimulus is to be analyzed together individual recordings can be exported from the respective stimulus and into a stimulus of the same type but without any other recordings.

To export or import recordings open the study to export from/import to, go to *File* menu, *Export/Import* and choose *Recordings*. On the *Export* tab the stimulus and recordings to export can be chosen. On the *Import* tab the location to import data from is defined, available recordings defined and the stimulus to import to chosen.

**Note:**
Scene definitions are not exported along with the recording data. If recordings from different computers are merged into one stimulus for analysis, scenes can only be defined after the import has been completed.

## Special Exports

ClearView also offers export options to other programs which can be used for analysis of eye tracking data. These special exports include export to Microsoft Excel, The Observer by Noldus and INTERACT by Mangold. The special export is found in the Analyze view of ClearView.

### Direct Excel Export

A powerful, yet flexible analysis tool in ClearView is the DirectExcel export. This enables quick export of data into a pre-defined template in Excel. This template may include formulas, graphs and visual basic code to post-process the data to generate a wide range of different statistics. A set of pre-defined templates are shipped together with ClearView. The templates can be found in the folder *DirectExcel Templates* in the *Samples* folder on the installation CD and on the Tobii web site.

To use a DirectExcel template, select the recordings to analyze. Click the **Special** Export button and choose *Excel export*. Find the Excel template to use, and click **OK**. The data from the selected recordings are now inserted into the selected excel document, and a macro in Excel is executed.

#### *Excel limitations*

Excel has a number of built in limitations relating to the size of spreadsheets and the number of characters that fit into a single cell. The most important implications this has on data exported with the DirectExcel functionality are listed below.

| | |
|---|---|
| 20 minutes of gaze data | If gaze data is exported the maximum length of a recording is roughly 20 minutes which corresponds to the Excel maximum of 65000 rows |
| 16 recordings of gaze data | Each recording takes up 16 columns for gaze data. Since Excel only has 256 columns a maximum of 16 recordings of gaze data can be exported |
| 150 minutes of fixation data | If fixation data with an average of 7 fixations per second is exported, the maximum recording length is roughly 150 minutes (corresponding to the Excel maximum of 65000 rows) |
| 51 recordings of fixation data | Each recording takes up 5 columns for fixation data. Since Excel only has 256 columns a maximum of 51 recordings of fixation data can be exported |

### *Using the AOI template*

The AOI template *AOI_Template_1_x.xls* is a sample template provided by Tobii. This template can be used to quickly and accurately calculate a number of basic fixation measures on area-of-interest data from stimuli with Areas of interest (AOIs) defined. The AOI Template can be found in the ClearView Sample pack available on the ClearView installation CD.

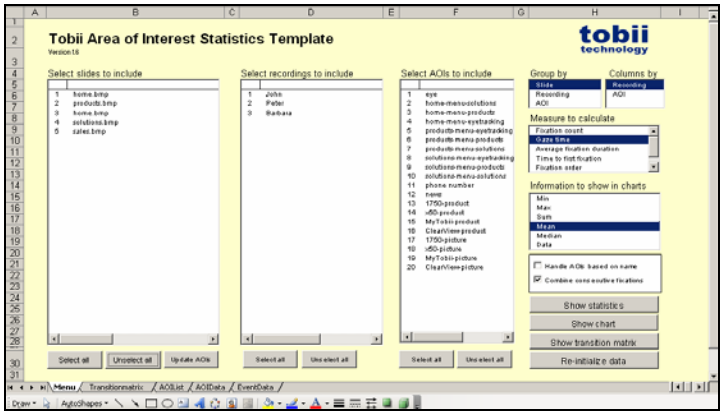



**Figure 23: The main view in the AOI template**

The main view of the AOI template includes three lists which are used to select the data to base statistical analysis on. The first list shows the slides/web pages shown or visited by during the recordings in the second list. In the third column a list of the defined AOIs can be found. To select what AOIs to analyze, choose the appropriate slides/web pages, recordings and AOIs by clicking their names or using the "(Un)Select all" buttons below the lists. Use the "Update AOIs" button under the slide list to hide all AOIs not present in the slides/pages selected.

Based on the set of AOIs and recordings selected a number of different statistical measures can be calculated. These statistics can be displayed either in a table by clicking the button **Show Statistics** in the bottom right section of the main view or as a chart by clicking the button **Show Chart**.

The *Transition matrix* in the AOI template shows how focus moved between different AOIs for the recordings. The bottom table shows the transitions in absolute numbers and the top table in percent. A transition from one AOI to another is registered if a test subject has a fixation within the first AOI and then moves to the second AOI with out fixating on any other AOIs in between. However, fixations on general content/blank part of slide/picture are allowed between the AOIs.

There are several different statistical measures calculated in the AOI template. These measures are *Fixation count, Gaze time, Average fixation duration, Time to first fixation* and *Fixation order*.

- Fixation count [Unit 1] – Number of fixations in the respective AOIs. This measure is based on fixations as defined in the fixation filter in ClearView at the time of the Direct Excel export. Combining consecutive fixations also effects this measure
- Gaze time [Unit ms] – The total time of all fixations in the respective AOIs.
- Average fixation duration [Unit ms] – The average length of all fixations during all recordings on the respective AOIs.
- Time to first fixation [Unit ms]– Time from the beginning of the recording until the respective AOIs were first fixated upon

- Fixation order [Unit 1] - The order in which the respective AOIs were fixated upon. If an AOI turns up several times in the fixation path of the recording it is given the lowest order number of those instances. E.g. if the fixations fall on AOIs in the following order: A-B-A-C, A gets order 1, B order 2 and C order 4.

There are different ways of grouping the data in the AOI template. Grouping data in different ways can be useful in some cases when analyzing statistics. Normally all data is grouped by slide – showing e.g. how much time was spent on the different AOIs in the different recordings. However grouping the statistics by AOI instead shows statistics on how much time was spent on *any* AOI in the different slides/pages during the different recordings.

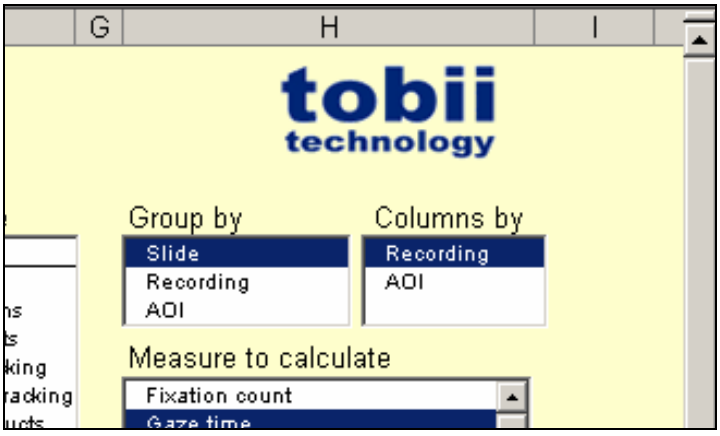



**Figure 24 The AOI template main view showing options for grouping data.**

Next to the option of grouping the data in different ways in the AOI Template main view is an list showing what will be placed in the columns in the statistics sheet hence as different series of data in the chart sheet.

There are other options available in the AOI template.

- Choosing information to show in charts defines what data to present as series in the data charts. This option does not effect what data is shown in the statistics view.
- Handle AOIs based on name groups together AOIs with identical names and treats them as one. This can be useful in cases where identical or similar objects appear on different slides or web pages and should be analyzed together.
- Combine consecutive fixations treat fixations occurring right after each other, all within the same AOI, as one.

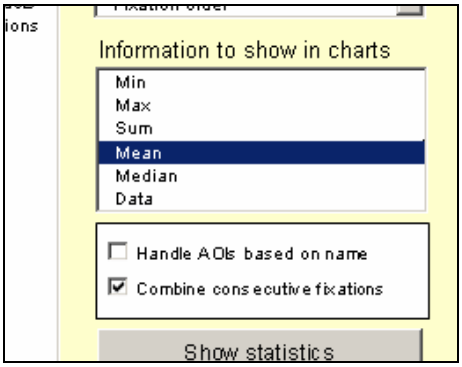



**Figure 25: Special options in the AOI template main view**

### *Limitations in the AOI template*

There are limits in the amount of data analyzable in the AOI-template. These limitations are due to limitation in data size in Excel or are imposed to ensure that calculations do not take excessively long times.

| | |
|---|---|
| 20 minutes of gaze data | If gaze data is exported the maximum length of a recording is roughly 20 minutes ( corresponding to the Excel maximum of 65000 rows) |
| 150 minutes of fixation data | If fixation data with an average of 7 fixations per second is exported, the maximum recording length is roughly 150 minutes (corresponding to the Excel maximum of 65000 rows) |
| 40 recordings | A maximum of 40 recordings can be exported to the AOI template |
| 1500 AOIs | A maximum of 1500 areas of interest can be defined in the data exported to can be exported to the AOI template |
| 2000 slides/URLs | A maximum of 2000 URLs or slides can be included in the data exported to the AOI template. |
| 40 recordings | A maximum of 40 recordings can be exported to the AOI template |
| 200 AOIs in the transition matrix | A transition matrix is only possible to calculate with less than 200 AOIs defined |
| URL length max 255 characters | URLs longer than 255 characters will be truncated and only the first 255 characters will be used in the AOI template |

### *Using the Empty template*

The Empty Excel template *emptytemplate.xls* is the simplest template available. After exporting data from ClearView to the Empty Excel Template there will be six sheets of data in Excel. These include the five data sheets *GazeData*, *EventData*, *AOIList*, *FixationData* and *AOIData* with data identical to what is exported by the text export from ClearView (See the chapter on Text export above). The last sheet, *StudyData* includes information about what stimuli, subjects and recordings are included in the data.

Data from the different recordings are placed after each other, left to right on the sheets with an empty column at the beginning. Since Excel only accepts 256 columns and the GazeData section includes 16 columns per recording, the maximum number of recordings that can be exported to the empty template is 15.

### *Creating your own Excel templates*

To create your own template, create an Excel document with empty sheets with any of the following names: GazeData, EventData, AOIList, StudyData, FixationData, AOIData. If the particular sheet exists in the Excel template, ClearView will automatically detect it and save the relevant data into the sheet. No column headers have to be created for the sheets, as these are automatically generated by ClearView.

The data for each recording is pasted into each Excel sheet according to the same format and with the same information as the text exports described above. If several recordings are exported, these are placed in separate columns. After the data has been pasted into Excel, ClearView looks for a macro called init() and if this is found calls this macro. This macro can be used to start a Visual Basic script or similar.

To get acquainted with creating DirectExcel templates, look into the Visual Basic code for one of the samples provided by Tobii (press Alt+F11 in Excel).

### The Observer 5.0 Export

ClearView offers functionality for exporting recorded data to a format usable by The Observer 5.0 by Noldus. By selecting which recordings to export and click the button *Observer Export* in the Analyze view The Observer Export dialogue is displayed. In step one of the export, browse and select The Observer's project file (ocp format) and media folder to export the data and media to. In step two, select codecs for AVI export and choose what to export in the movie file, background image, gaze data overlay or both.

Data exported from ClearView to The Observer is interpreted as follows:

***Mouse-*** and ***keyboard events*** are described by the "CV User Action" behavior class. Keyboard events are further specified by the "CV Keys" modifier class, where each modifier corresponds to a unique key.

| **CV User Action** | |
|---|---|
| **Behavior** | **Modifier Class** |
| CV Left Click | - |
| CV Right Click | - |
| CV Key Press | CV Keys |

***Image slide shows*** and ***AVI slide shows*** are described by the "CV Stimuli State" behavior class. Image slides are further specified by the "CV Slide" modifier class, where each modifier corresponds to a certain image. AVI slides are specified by the "CV AVI" modifier class, where each modifier corresponds to an AVI file. The behaviours in the "CV Stimuli State" class are *mutually exclusive* and *exhaustive*.

| **CV Stimuli State** | |
|---|---|
| **Behavior** | **Modifier Class** |
| CV Showing Slide | CV Slide |
| CV Showing AVI | CV AVI |

***Web events*** are described by the"CV Browser Event" behavior class. The events are further specified by the "CV URL" modifier class, where each modifier corresponds to a unique URL.

| **CV Browser Event** | |
|---|---|
| **Behavior** | **Modifier Class** |
| CV URL Opened | CV URL |
| CV URL Closed | CV URL |

***Fixation data*** is described by the"CV Fixation" behavior class. The behaviours in the class are *mutually exclusive* and *exhaustive*.

| **CV Fixation** | |
|---|---|
| **Behavior** | **Modifier Class** |

| | |
|---|---|
| CV Fixation | - |
| CV Non Fixation | - |

***AOI Data*** is described by the "CV AOI" behavior class. The AOI names in ClearView are converted to new names formatted like "CV AOI X", where X is an index. The real names can be found in the behavior descriptions. The behaviours in the "CV AOI" class are *mutually exclusive* and *exhaustive*.

| **CV AOI** | |
|---|---|
| **Behavior** | **Modifier Class** |
| CV No AOI | - |
| CV AOI 1 | - |
| CV AOI 2 | - |
| … | … |
| CV AOI n | - |

### INTERACT export

The INTERACT export exports event data, fixation data, gaze data and data on which areas of interest have been fixated on to a format readable by INTERACT by Mangold along with gaze videos and user camera videos.

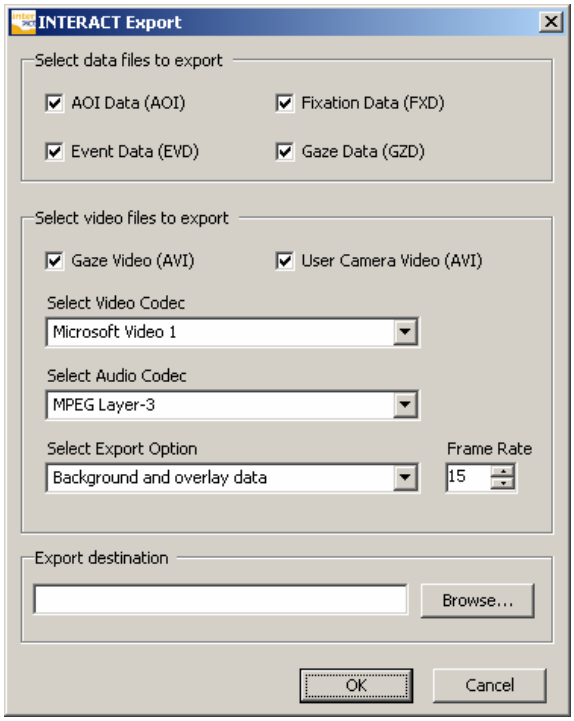



**Figure 26: ClearView can export data to INTERACT by Mangold**

# Settings and data filters

Settings in ClearView are divided into two logical parts. *Global settings* which include settings for physical setup of the hardware and data collection and *Study settings* which include settings for the conducting of a test including calibration and analysis. The Study settings also include settings for the filtering of eye tracking data.

## Global settings

Global settings contain all settings associated with the hardware setup of ClearView or settings which are the same for all studies made. The settings can be reached either by clicking the global settings icon in the toolbar or from the Settings menu.

**Recording**

| | |
|---|---|
| Stop recording key<br>(Esc or F10) | This universal key will always stop the current recording in ClearView. The default setting is F10. Make sure that the key used can not be confused with other keys or pressed by the subject during recording. |
| Screen recording frame rate | The frame rate of the screen capture in web recording and screen recording. Note that screen recording is extremely resource intensive and that keeping the frame rate low is of essence. For most applications it is recommended to stay below 10 fps. |

**Monitor**

| | |
|---|---|
| Monitor mode<br>(single or dual screen) | Decides if ClearView will use one or two monitors. In double monitor mode the subject is presented with only the stimulus while the operator will see all controls and the Live Viewer. |
| Show Trackstatus on both screens | When this option is checked, the Track Status meter is shown to the test subject as well as to the operator. |

**Live Viewer**

| | |
|---|---|
| Show<br>(Screen capture, UserCam, Track status, Full Screen) | Defines what to show in the Live Viewer and if the Live Viewer is to be displayed in full screen during recording. |
| Save<br>(UserCam and UserSound files) | Specifies whether the UserCam picture and/or User Sound is to be saved to file for later analysis and/or export |

| | |
|---|---|
| Video source | The source to use as UserCam picture – normally a camera connected to the ClearView computer |
| Inputs | Specifies the input on the video source to use as UserCam picture. Most cameras have only one input and this choice will have no options. |
| Video Codec | The codec to compress the UserCam picture with. Microsoft Video 1 works reasonably well. |
| Camera Settings | These are the settings of the currently installed camera and typically includes settings for brightness, contrast etc. |
| Video Settings | These are also hardware specific settings which typically include size and frame rate for the video captured |
| Audio Source | The source to use as Audio input for recordings – normally the microphone port on the computer or the microphone on a camera |
| **Network** | |
| Tobii Eye Tracker Server host | If using a two computer setup, this must be indicated by checking the "Remote computer" radio button and specifying the IP address to the computer hosting the TET Server. |

**Paths**

| | |
|---|---|
| ClearViewData folder | The folder containing the ClearView data base |
| Database import/export folder | The default folder where ClearView saves exported studies, subjects and stimuli or looks for studies, subjects and stimuli to import. |
| Stimuli folder | The default folder where ClearView looks for files to create stimuli from. This is a good place to save the ClearView samples package and. This is also the folder in which the attention grabbing AVIs 1-9.avi for the infant calibration should be placed. |

**License Key**

| | |
|---|---|
| Existing License Keys | A list of all ClearView license keys installed on the computer. Each key shows if it is valid for the current eye tracker, its expiry date and which Add Ons it is valid for. |
| New License Key | New license keys are entered in this field and added to the list of keys available for recording. |

## *Study settings*

**Calibration**

| | |
|---|---|
| No of calibration points<br>(2, 5, 9 or 16) | The default calibration routine is set to five points which takes roughly 10 seconds and is recommended for most studies. If shorter of calibration is required two point calibrations can be made with a trade off on tracking accuracy. Using nine or sixteen calibration points will increase accuracy some but not extensively. |
| Type of calibration (Normal, Infant or Low vision) | Three different calibration routines are available as follows:<br>**Normal**. This calibration is recommended for most subjects. A pulsating dot is displayed at each calibration point. The calibration is automatically forwarded between points.<br>**Infant**. This calibration is recommended for infants and other subjects with attention difficulties. Instead of a dot, AVI-movies are displayed for each calibration point. The following AVI-movies are used by the infant calibration procedure<br>**Low-vision**. This calibration is recommended for subjects with poor vision, who have difficulties seeing the standard calibration dot. A cross-hair is displayed for each calibraiton point, and space bar is used to forward between calibration points. |

| | |
|---|---|
| Background color | For maximum accuracy, we strongly recommend setting the background of the calibration screen to a color which is close in light intensity to that of the stimuli used during recording. If the calibration screen is very dark, and the stimuli very bright, a large degree of drift may occur which decreases the accuracy. The default calibration background is suitable for most web-site studies, since they are generally rather bright. |
| Object color | Always set the object color to a shade which provides good contrast to the selected background. |
| Normal Calibration settings | **Speed**. The speed for the normal calibration routine can be selected. **Dot size**. The size of the calibration dot for the normal calibration routine can be selected. |
| Infant calibration settings | **Big attention grabbing AVI** A full screen AVI to redirect subject attention to the screen – specified in Study settings as "Attention grabbing AVIs" |
| | **Calibration AVI** A small AVI displayed at the calibration point for calibration – specified in Study settings as "Calibration AVI"Small attention grabbing AVIs small AVIs positioned at the calibration point, but not used for calibration – these AVIs should be placed in the ClearView Stimuli folder and be named 1.avi, 2.avi, … 9.avi. With ClearView,default movies suitable for infant calibration are provided. A bouncing ball to be used for calibration and a number of small attention grabbing AVIs can be found in the ClearView Samples package (compliments of Scott Johnson at NYU). |
| Advanced | In some very specialized applications it might be of use to calibrate part of the screen only. In the advanced settings the region of the screen to calibrate can be changed. |

| | |
|---|---|
| **Analysis filter** | **Settings for post recording processing of the eye tracking data. (see also the section Data filters below)** |
| Validity filter | Higher validity filter exclude data which is not perfect |
| Eye filter | Specifies which eye(s) to use data from |
| Fixation filter | Defines the maximum distance between two points for them to be considered belonging to the same fixation and the minimum time for which gaze needs to be within the radius to be considered a fixation |
| **Analysis Replay** | |
| Trail | Specifies if a trail should be displayed behind the fixation dot in Gaze Replay and how long this trail should be in milliseconds |
| Color | To change the color of the fixation dot and trail, click the colored square and choose a new color. |
| **Web** | |
| Group web pages based on | Defines what ClearView looks after to determine whether two visited web pages are to be considered equal<br>**URL** – Pages with identical URLs are considered equal, disregarding their actual content<br>**URL and Size** - Pages with identical URLs and sizes are considered equal, disregarding their actual content<br>**Page content** – Pages with identical graphical content are considered equal, disregarding their URLs |

## *Data filters*

ClearView always records and stores unfiltered data. However, in the analysis steps, you have the option to use different types of filters to perform data abstraction or to remove bad data.

Settings for the data filters are available under the **Settings** -> **Study Settings** menu option. The settings made here are applied both to the different gaze visualization tools (such as the gaze replay and the gaze plot), as well as to the data export features available.

The basic filters in ClearView are the validity filter, the eye filter and the fixation filter.

### Validity and eye filter

The validity and eye filter is used to combine or sort binocular data, as well as to filter out bad data.

The validity filter is primarily used to remove bad data. For each gaze data that is recorded, a certain "validity code" is assigned to right and left eye respectively. Basically, this is a good indication of how certain the system is that it has recorded the correct data. See the chapter on **Tracking Ability** for more information on the interpretation of the validity code.

The validity filter translates these validity codes to which eyes were reliably found. The available settings for the validity filter are normal, medium and high and they translate validity codes as described in the table below.

| Left Validity | Right Validity | Result (Normal) | Result (Medium) | Result (High) |
|---|---|---|---|---|
| 0 | 0 | Both | Both | Both |
| 4 | 0 | Right | Right | None |
| 0 | 4 | Left | Left | None |
| 3 | 1 | Right | None | None |
| 1 | 3 | Left | None | None |
| 2 | 2 | None | None | None |
| 4 | 4 | None | None | None |

The eye filter may be used to base gaze analysis on either of the eyes, both eyes separately or on the average of the two eyes. The choice here has important implications for many types of studies.

For most purposes, we recommend using the average of the two eyes. This is generally more accurate, and more stable over long time and across changes in head position and light conditions. For studies of "where a person is looking", this setting yields the most accurate results.

For studies of more physiological characteristics, it is often interesting to study each eye individually, or possibly to study them simultaneously to see difference in behavior between the two eyes. For such purposes, we of course recommend setting the eye filter to either left or right eye.

Another case where either eye may be a suitable setting is if the test subject has high gaze accuracy on one eye, and low gaze accuracy with the other. In such cases, analysis should be performed only on the dominant and stable eye.

The validity and eye filter implemented in ClearView is based on the following algorithm:

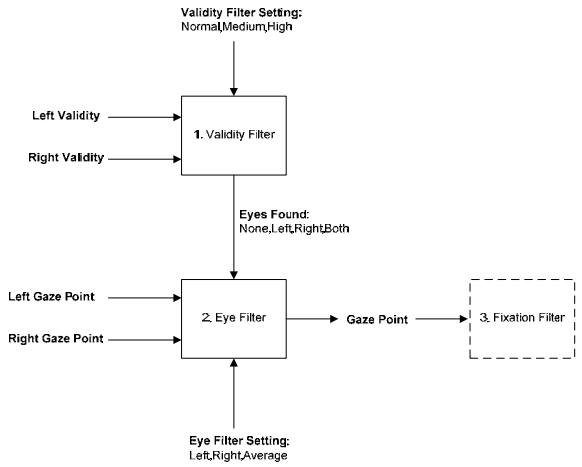



**Figure 27: Chart describing how the validity and eye filters provide data to the fixation filter.**

## Fixation filter

Fixation filters are used to group gaze data into meaningful fixations. Many different algorithms for fixation definition have been proposed and are available among researchers and practitioners. In part, the purpose of the study influences which types of fixation filters are most suitable.

The fixation filter implemented into ClearView is based on the following algorithm:

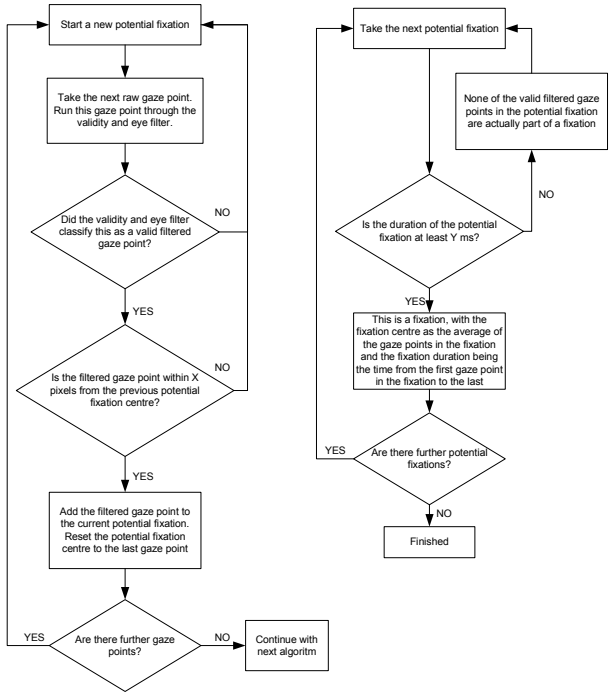



**Figure 28: The fixation filter algorithm**

# The ClearView Database

All of the information in the ClearView system, including stimuli, subjects, recordings, AOI definitions and more is collected, managed and saved into a database. After the creation of a stimulus, ClearView does no longer need access to the original files since copies are stored in the database. The database is structured into a set of files on the computer, which are not intended (and in most cases not possible) to read directly. This ensures that the data is intact and well structured. To alter, rename, move or delete files in the database structure may corrupt data recorded beyond repair.

To access the information obtained with the ClearView system using other applications and customized software, there are instead a number of import and export options available. Using these tools, a test leader can obtain full control of the raw data generated by the system.

## Data types saved by the system

Even though the information can not be accessed directly from the outside, it may be useful to understand what data is saved by the system. The following information is saved and managed by ClearView:

- Study information: This contains the name of the study, as well as study-specific settings.
- Stimulus information: All the stimulus information associated with each study, including settings, bitmaps, movies etc.
- Subject information: Information about each test subject, including name, subject information and a set of calibrations associated with the subject.
- Recording information: Information for each recording for each subject and stimuli. The recording information is separated into the following data classes:
- General recording information. Contains time and date of each recording.
- Gaze recording. Contains all gaze data provided by the eye tracker including time-stamps, gaze positions, eye positions, pupil size and validity codes. For more information on the gaze data provided by the system, see the chapter on **Properties of the Tobii Eye Tracker**.
- Event recording. Contains all events generated and collected by the system. This includes events generated by the stimulis presentation such as the precise time-stamps for showing and hiding slides as well as collected events like key stroke and mouse click events, external trigger events and more.
- Moving bitmap information. Contains information about the screen position of the different bitmaps when the "moving bitmap" stimulus is used.
- Video and audio recordings. Different files containing video and audio recordings from screen recordings, video capture etc.
- Web recording information. Contains information about scroll events, frame positions etc of web pages and more required for web studies.
- Analysis information and settings such as defined AOIs, color and length of gaze trail and so on

## *Editing studies and subjects*

To access the database functions of ClearView, select **Edit Database** under the **File** menu.

To move an entire study between computers (which is useful for doing prepration or analysis on a different machine from the recording PC), select the **Study** button and the **Export** tab. Select the study or studies you wish to export and click the **Export** button. This feature can also be used to backup your studies. An exported study is placed in the specified folder and gets the file extension .expst.

To export subjects (together with their calibrations), select the **Subjects** button and the **Export** tab. Select the subject or subjects you wish to export and hit the **Export** button.

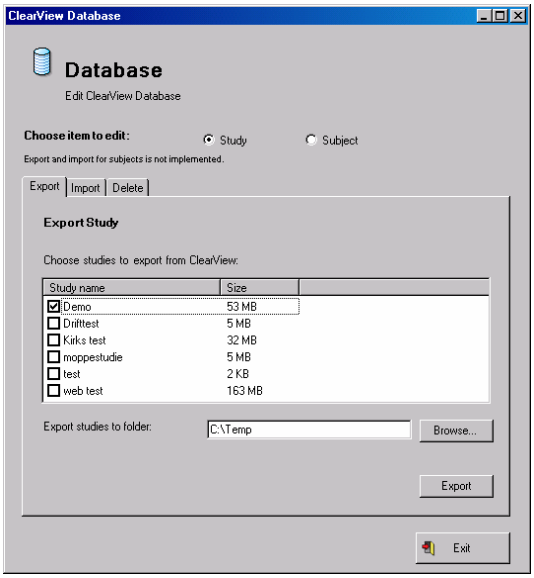



**Figure 29: The ClearView data base editor**

To import an exported study into ClearView, select the **Study** button and the **Import** tab. Use the browse button toe choose the folder containing the .expst-folder (i.e. no the .expst-folder itself, select the studies to import and click the **Import** button).

To delete studies or subjects use the **Delete** tab in the database view, choose the subjects or studies to delete and click the **Delete** button.

# Literature References

**Stanford Poynter Project**

http://www.poynterextra.org/eyetrack2004/index.htm

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