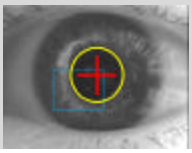
Arrington Research, Inc.

ViewPoint EyeTracker®

ViewPoint EyeTracker®

PC-60 Software User Guide



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Chapter 1Introduction

1.1 Congratulations

Congratulations on your purchase of the *ViewPoint EyeTracker®*. It has been designed to be the easiest to use, most reliable and best value eye tracker on the market. Because the solution is primarily software, it has several advantages:

- No expensive and cumbersome hardware to configure and maintain.
- Easy integration with other application programs.
- Standard user interface panels.
- Upgrades are trivial to install and relatively inexpensive.
- Performance will increase when the computer is upgraded.

It provides:

- A comprehensive solution for eye tracking research.
- An embeddable eye tracking solution for 3rd party products and end user custom applications.

The *ViewPoint EyeTracker®* was originally developed in 1995 for the Apple Macintosh platform. It has now been ported to the Microsoft Windows platform. It is our intention to make both versions essentially identical. However, product development cycles mean that new features will sometimes appear on one platform before appearing on the other. Please visit our web site regularly for further hardware and software developments and platform specific variations

1.2 Custom Software & Hardware Development

Special software and hardware development for particular laboratories or organizations may be performed under individual consulting agreements. *ViewPoint EyeTracker®* is easily customized as an embedded eye tracking solution for OEMs. We also help OEMs to interface *ViewPoint EyeTracker®* with their equipment by providing custom camera and optical solutions. Please email inquiries to: info@ArringtonResearch.com

1.3 User Feedback

Suggestions for improvements to this manual or to the ViewPoint EyeTracker® software are always welcome and appreciated. Please email comments to: info@ArringtonResearch.com

1.4 License Information and Conditions of Use

Use of the software constitutes consent to the terms of the "ARI Software License" on page 182. The contents of this user guide and any other documentation provided with the ViewPoint EyeTracker® is for the use of registered ViewPoint EyeTracker® users only. No part of this or other

ViewPoint EyeTracker® documentation or Software Developer Kit (SDK) information may be distributed or shared with others, without prior written permission from Arrington Research, Inc.

1.5 High-Risk Activities Warning

Every effort has been made to provide a bug-free product. Nevertheless, this software is not intended for use in the operation of nuclear facilities, aircraft navigation or communications systems, or air traffic control, or medical treatment and diagnosis, or for any other use where the failure of the software could lead to death, personal injury, damage to property or severe environmental damage.

1.6 Special Thanks

The initial stages of the ViewPoint EyeTracker® project were greatly facilitated by the generosity of Professor Richard Held, M.I.T., Dr. Yasuo Nagasaka, Rikkyo University; many thanks and deep gratitude is given to them.

1.7 How to Use this User Guide

New users should study Chapters 2, 3 and 4 to get started:

Chapter 2: Overview of *ViewPoint* Describes the theory and provides an overview of the design of the ViewPoint EyeTracker®.

Chapter 3 Installation and Setup of the video capture hardware and driver installation process and ViewPoint EyeTracker® software installation.

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Window	Function:
EyeCamera:	Displays the video image of the eye and image analysis graphics
EyeSpace:	Corresponds to the geometry of the EyeCamera image. This window displays an array of the relative locations of the pupil, glint, or difference vector, which were obtained during calibration. These provide information about calibration accuracy and allow rapid identification and correction of individual calibration errors by allowing manual calibration of individual points. Refer to Chapter 6.
Controls:	Allows the experimenter to adjust the image-analysis and gaze-mapping parameter settings and to specify the feedback information to be displayed in both the Stimulus window and the GazeSpace™ window. VideoImage tab: Image quality adjustments and tracking method specification. DataCriteria tab: Specify smoothing and other criteria to apply to the data. Data Display tab: Specify information to be displayed in the Stimulus and GazeSpace windows. Regions tab: Setup regions of interest (ROIs). Scene tab: Adjust brightness and contrast of scene image (scene camera option only)
Status:	Gives details about processing performance and measurements

Stimulus:	(what the subject views) that is designed to be presented full screen, preferably on a second monitor. Upon which may be displayed the subject's calculated position-of-gaze information and region of interest boxes. Refer to Chapter 8
Penplot:	Plots X and Y position of gaze, velocity, ocular torsion, pupil width, pupil aspect ratio etc. in real time. The user may select which penPlots to display using menu item PenPlot > *. The range of many of the penPlot displays can be adjusted by clicking the right mouse button in the PenPlot graph well.

Tutorial_ A brief tutorial designed to help new users start recording eye movements very quickly and easily.

Chapter 13 ViewPoint Interface: GUI, SDK, CLP is the most comprehensive reference section for all aspects of the eye tracker and should be referred to often.

The remaining chapters each deal with a different task or set of tasks that the user will want to perform and provide some helpful background to eye tracking.

Use menu item: Help > Documentation ... to quickly access the Documentation folder.

Type fonts are used with the following meanings:

Table 1: **Meaning of Type Fonts**

Type Font	Example Meaning
Eye tracking has many applications.	Normal text
`stimulusWindowDimensions`	Program variable, or SDK code
Load PICT image	User selection: Menu Item or Button
Video window	Program Window
sFigure 1:	Link to section, figure or table

1.8 Info Window

The Info window can be displayed using menu item Help > Info. This provides system information, a list of keyboard shortcut keys, display devices that *ViewPoint* has detected, calibration mapping precision information, etc.

1.9 Support

For support questions send email to: **Support@ArringtonResearch.com**

1.10 Citing ViewPoint

Please use the following format when citing the ViewPoint EyeTracker®.

***ViewPoint EyeTracker®* by Arrington Research, Inc.**

Note that ViewPoint is one word with only the letters V and P capitalized, and that EyeTracker is also one word, with only the letters E and T capitalized. It is a registered trademark and should be followed by a capital R within a circle, ®, or if not available, a capital R within parenthesies, (R).

You may also wish to include the web site address (www.ArringtonResearch.com), where ArringtonResearch is one word. Correct capitalization is not required for the web link to work properly, however using only a capital A and a capital R is the preferred form and it makes the link more readable. We love to hear about your research, published or not, please let us know what you are working on!

Chapter 2 Overview of *ViewPoint*

2.1 General Description

The *ViewPoint EyeTracker*® provides a complete eye movement evaluation environment including integrated stimulus presentation, simultaneous eye movement and pupil diameter monitoring, and a Software Developer's Kit (SDK) for communicating with other applications. It incorporates several methods that a user can select from to optimize the system for a particular application. Also provides three methods of mapping position signals extracted from the segmented video image in *EyeSpace*™ coordinates to the participant's point of regard in *GazeSpace*™ coordinates.

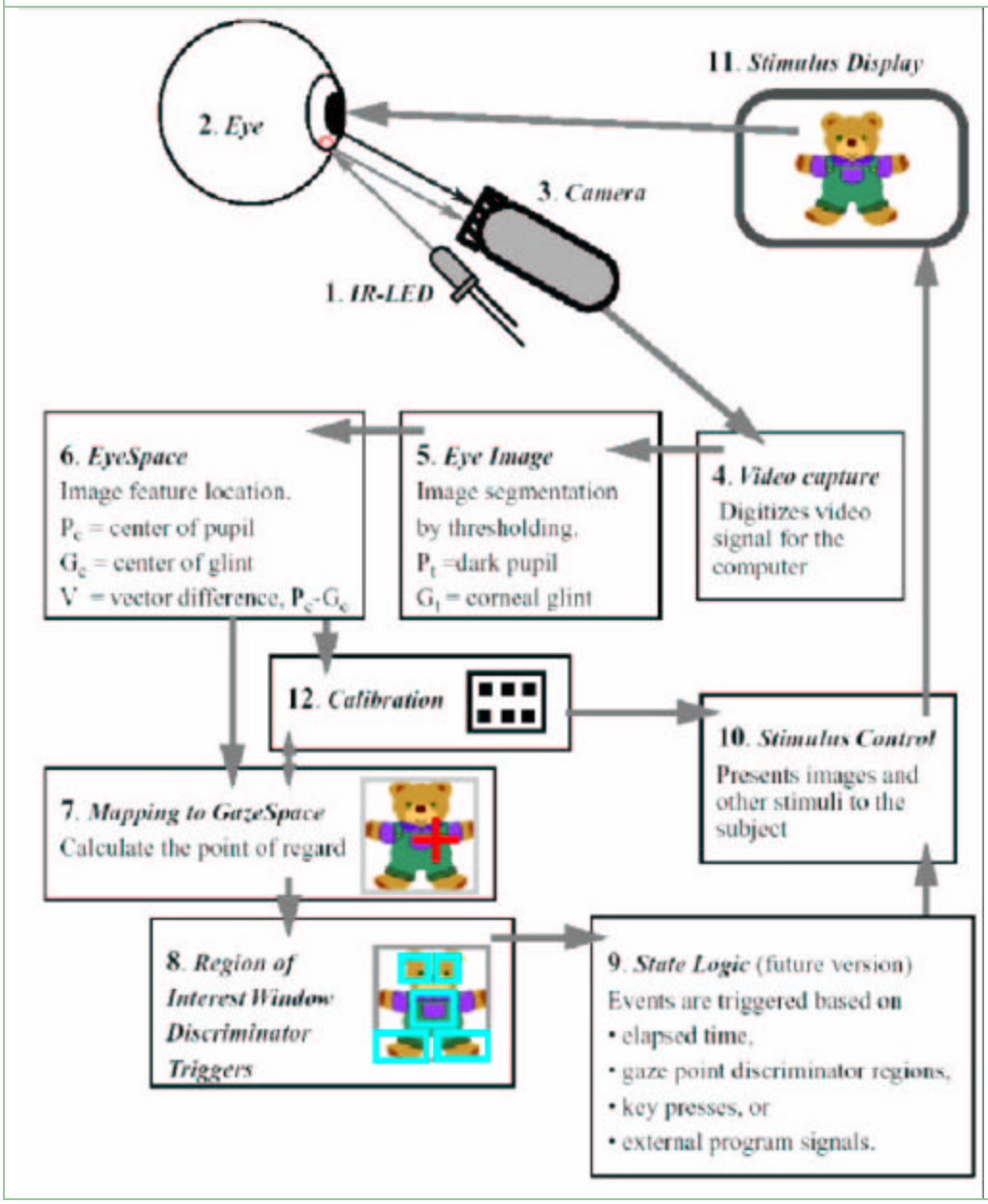
Figure 1: Shows how the *ViewPoint EyeTracker*® works in a typical head fixed configuration. The numbers in this section refer to the item or block numbers in the figure.

The infrared light source (item ***1***.) serves to both illuminate the eye (item ***2***.) and also to provide a specular reflection from the surface of the eye, i.e., from the smooth cornea. In dark pupil mode, the pupil acts as an infrared sink that appears as a black hole; see Figure 2:. In bright pupil mode, the "red eye" effect causes the pupil to appear brighter than the iris. (Note that a different camera and illuminator configuration is required for bright pupil operation.)

The video signal from the camera (item ***3***.) is digitized by the video capture device (item ***4***.) into a form that can be understood by a computer. The computer takes the digitized image and applies image segmentation algorithms (item ***5***.) to locate the areas of pupil and the bright corneal reflection (glint). Additional image processing (item ***6***.) locates the centers of these areas and also calculates the difference vector between the center locations. A mapping function (item ***7***.) transforms the eye position signals (item ***6***) in *EyeSpace* coordinates to the subject's *GazeSpace* coordinates. (Item ***8***.) Next, the program tests to determine whether the gaze point is inside of any of the region of interest (ROI) that the user has defined.

The calibration system (item ***12***.) can be used to present calibration stimuli via (item ***10***.) to the user and to measure the eye position signals (item ***6***.) for each of the stimulus points. These data are then used by (item ***12***.) to compute an optimal mapping function for mapping to position of gaze in GazeSpace (item ***7***.).

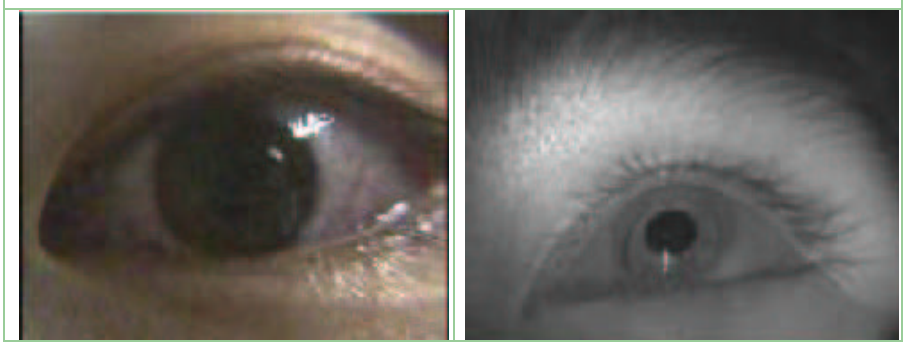
Figure 1: Schematic of the *ViewPoint EyeTracker*® System (head fixed)



2.2 Infrared Light

The value of using infrared light is illustrated in Figure 2:. The left side of the figure shows an image in normal light; in this subject the pupil of the eye is almost impossible to discriminate from the dark iris. The right side of the figure shows an image of the same eye, but viewed with an infrared sensitive camera under infrared lighting conditions; the pupil is easily discriminated. Note that in each case the subject is wearing a contact lens.

Figure 2: Infrared light allows for pupil discrimination



There should always be the utmost concern for the safety of the subject. The issue of safe limits of infrared (IR) irradiance is frequently discussed.

10 mW / cm sq is probably the safe maximum figure for corneal exposure over a prolonged period (Clarkson, T.G. 1989, Safety aspects in the use of infrared detection systems, I. J. Electronics, 66, 6, 929-934).

The infrared corneal dose rate experienced out of doors in daylight is of the order of 10^{-3} W / cm^{-2}. Safe chronic ocular exposure values particularly to the IR-A, probably are of the order of 10^{-2} W/ cm^{-2}" (D.H. Sliney & B.C. Freasier, Applied Optics, 12:1, 1973).

ISO/DIS 10342 (page 7) gives maximum recommended fundus irradiance for use in Ophthalmic Instruments of 120 mW / sq cm but this is for short-term exposure.

All IR-illuminator and camera systems provided by Arrington Research, Inc. are designed to be well within safe limits of exposure.

2.3 Mapping to Gaze Point

It is often necessary to determine where a person is looking, that is, to determine the *gaze point*, also called the *point of regard*. This task is performed by using a mathematical function to *map* the eye position signal in the *EyeSpace* coordinates of the video image to the gaze point in the *GazeSpace* coordinates of the visual stimulus. There are many algorithms that can be used to perform such a mapping and many of them are company proprietary. By far, the best algorithms are non-linear. This is because the eye movements are rotational, i.e., the translation of the eye position signal that is apparent to the camera is a trigonometric function of the subject's gaze angle. Moreover, the camera angle may provide an oblique line of sight. *ViewPoint EyeTracker®* employs one of the most powerful and robust methods available.

2.4 Software Developer's Kit (SDK)

The *ViewPoint EyeTracker*® software includes a powerful software developer's kit (SDK) that allows programs to seamlessly interface with *ViewPoint* in real-time. It provides real-time access to all *ViewPoint* data. It provides for calibration stimuli in the user's stimulus window, or the user's application to draw into *ViewPoint*'s Stimulus and GazeSpace windows. It provides complete external control of the *ViewPoint EyeTracker*. The SDK interface is based on shared memory in a distributed linked library (DLL).

MATLAB® (as of version R17) is now designed so that the *ViewPoint* DLL can be loaded directly into MATLAB, which means that a user can call *ViewPoint* SDK functions, as easily as calling MATLAB functions.

The SDK software includes:

- The DLL library interface,
- .h and .lib files
- plus sample source code written in C.

This is documented in detail in Chapter 13 ViewPoint Interface: GUI, SDK, CLP

The SDK is designed to be very easy to use. A complete program interface is shown here below:

```
#include "vpx.h"

main()
{
  for( int ix=0; ix<999 ; ix++ )
  {
    VPX_RealPoint gp;         // a structure with two floats for (x,y) values
    VPX_GetGazePoint( &gp );  // pass by reference
    println("ViewPoint gaze point: %g, %g ", gp.x, gp.y );
  }
}
```

This very simply lists the X and Y positions of gaze calculated by *ViewPoint*.

All eye data is available via easy to use, high level, access functions. Here are a few examples:

```
VPX_GetComponentVelocity(&vel);
VPX_GetFixationSeconds(&secs);
VPX_GetTorsion(&degrees);
```

Important status items are also available, for example:

```
VPX_GetStatus(VPX_STATUS_DataFileIsPaused )
```

2.5 Command Line Parser (CLP)

Every graphical user interface (GUI) selection and adjustment that the user makes in *ViewPoint* (e.g., menu item selection, radio button selection, slider value) can be saved in a Settings file, so that they can be loaded again next time the program is run. The control values are stored as single line ASCII commands in the form of a keyword and parameters. When a Settings file is loaded, each line in the file is sent to the *ViewPoint* command line parser (CLP).

These command strings can also be sent to *ViewPoint* from other programs while *ViewPoint* is running , which means that outside, layered, programs can have complete control of the *ViewPoint EyeTracker®*. These command strings can be sent via the software developers kit (SDK) function VPX_SendCommand("some command string"), or they can be sent from programs running on remote computers via an Inter-Computer Link.

There are more CLP commands than there are GUI controls in *ViewPoint*. For example there are commands to allow fine control of *ViewPoint* operations and behavior. There are also commands for all the GUI controls, for example, to adjust the amount of data smoothing, to display / hide various pen plots, freeze / un-freeze the eye camera video. There are commands to open, pause, resume, and close *ViewPoint* data files. There are commands to insert remote synchronization data into the *ViewPoint* data files. If there is an action that you need to perform but cannot find a GUI control for it, refer to the Chapter 13 ViewPoint Interface: GUI, SDK, CLP to see if a CLP command exisits.

Chapter 13 ViewPoint Interface: GUI, SDK, CLP provides a complete description of each type of control.

2.6 Inter-Computer & Inter-Application Communication

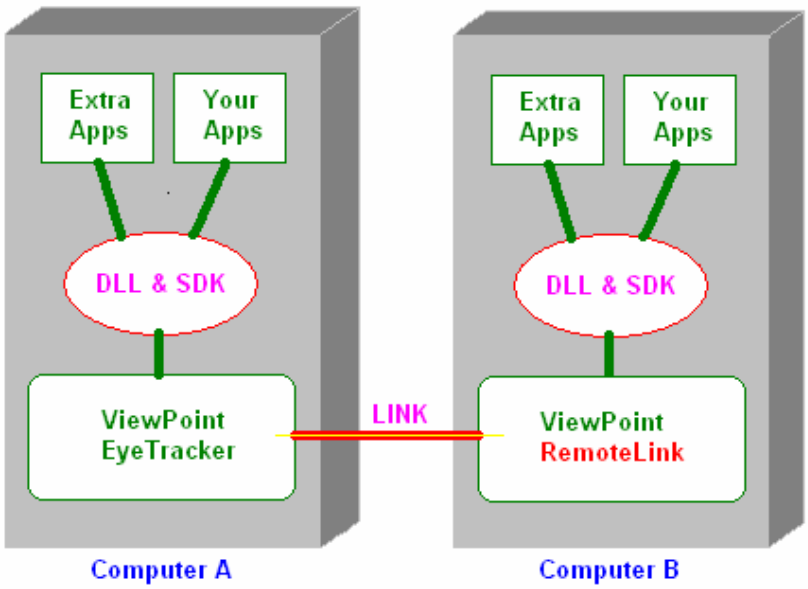
The *ViewPoint EyeTracker®* communicates easily with other applications, either on the same computer or on a remote computer. *ViewPoint* can send eye data and status information to other applications and it can receive instructions from other applications for program control and data synchronization.

The *ViewPoint EyeTracker®* software includes the auxiliary program ***RemoteLink ™*** to help take care of inter-computer communication. *RemoteLink* can present calibration stimuli on a remote computer's display screen. It can also listen for ViewPoint data and update a copy of the DLL on the remote machine, so the application believes that it is talking to ViewPoint on the same machine. RemoteLink also includes a *ViewPoint* data simulator, for development where *ViewPoint* is not available.

For details about the use of ***RemoteLink ™*** refer to the documentation on the RemoteLink folder on the disk provided with *ViewPoint*.

This link is currently only via the serial port, however we are developing an Ethernet link that should be available soon. The former is documented in detail later in Chapter 12 Serial Port Communication .

Figure 3: RemoteLink Communication



Chapter 3Installation and Setup

This chapter describes the procedure for the video capture hardware and driver installation process and *ViewPoint EyeTracker*® software installation.

IMPORTANT: The display must be set to True Color (32 bit).

3.1 Computer System Requirements

This is the manual for *ViewPoint PC60* that runs on the Windows 2000 and Windows XP operating systems. As of version 2.8.3, we no longer officially support Windows NT, Windows 98, or Windows ME.

* DELL computers models Optiplex and Dimension are not officially supported, because historically the system bios in these models did not release the IRQ necessary for real-time video capture. Some newer versions of these DELL models reportedly do no suffer from this problem, however we currently have no clear specification for distinguishing between the versions. Other DELL models do not have this problem.

3.2 Video Requirements

We recommend that end users purchase the *ViewPoint EyeTracker*® software together with the *QuickClamp EyeTracker Hardware*, as a total eye tracking solution. This includes a video camera and video capture device that provides 60 Hz eye movement monitoring. This is a closed system between the NTSC video camera and the NTSC video capture device so it can be used in countries that have PAL or other video standard without problem.

To work properly, the *ViewPoint EyeTracker*® *PC 60* version requires the special high performance PCI video capture board supplied by *Arrington Research*. It will not work with other video capture devices.

3.3 Using with Third Party Video Input Equipment

Video input may now include the PAL and SECAM standards, as well as the previously supported NTSC standard. The user should use Video > Video Standard > * to select the standard that corresponds to the type of video camera, videocassette recorder (VCR), etc., that is used.

The selected video standard is stored in the preferences file and will be used as the default when *ViewPoint* is next run.

The default setting is NTSC and this should not be modified unless third party video equipment is used that specifies a different video standard.

3.4 PCI Video Capture Card and Driver Installation

Important: If you are updating from version 1.x of *ViewPoint EyeTracker*® or have had another BT848 video capture device previously installed, you must FIRST remove all of the video capture software and drivers from your computer. SECOND, after the driver software has been removed, physically remove the old video capture device from your computer before proceeding with the new frame grabber installation.

A. Installing the New Frame Grabber

1. Turn off the computer, and then disconnect the power cable.
2. Remove the cover panel from your computer. If necessary, consult your computer system manual for instructions.
3. Remember to discharge your body's static electricity by touching the metal area of the computer chassis.
4. Select an empty PCI slot and remove the slot cover.
5. Place the card into the slot, paying particular attention that the card is inserted correctly.
6. Screw the card into place.
7. Replace the cover panel.
8. Reconnect the power cable and turn on the computer.

B. Installing the New Driver

WINDOWS XP ONLY

1. Insert the *ViewPoint EyeTracker*® CD-ROM into your CD-ROM drive.
2. If the Windows "Found New Hardware Wizard" asks you if you would like to connect to Windows Update to search for the drivers select "No, not at this time" and "Next".
3. Select "Install the software automatically" and "Next"
4. At the next dialogue box, with the top line item highlighted select "Next".
5. At the "not digitally signed" warning select "Continue Anyway".
6. Select Finish

NOTE: you will have to repeat the above steps for each input if you have a binocular or scene camera version of the eye tracker.

Other WINDOWS Operating Systems

1. If the update device driver wizard starts, click "Cancel".
2. Insert the *ViewPoint EyeTracker*® CD-ROM into your CD-ROM drive.
3. Click Start.
4. Click Run.
5. Type the following: F:\driver\lc1_2\english\disk1\setup.exe (If F is not the device letter of your CD-ROM drive, substitute with the correct drive letter).
6. Click OK.
7. Follow the onscreen instructions to complete installation.
8. Restart your computer when instructed to.

This directory structure must be maintained for proper functioningof the software. The ViewPoint software will not run without the .dll file. Do not make illegal copies.

This directory structure must be maintained for proper functioning of the software. The ViewPoint software will not run without the .dll file. Do notmake illegal copies.

Note 1: With Windows XP it may be necessary to let the "Install New Hardware" wizard take care of the installation.

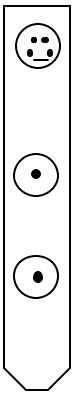
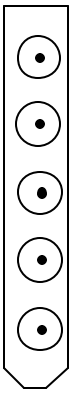
Note 2: For the binocular option and scene camera options it will be necessary to run

through the driver install routine for each input. You will be prompted to do this.

Note 3: The video cable must be connected to the composite input number 1 of the frame grabber for monocular ViewPoint. Refer to Figure 3

Note 4: The video cable must be connected to the composite input numbers 1 and 2 of the frame grabber for binocular ViewPoint. Refer to Figure 3

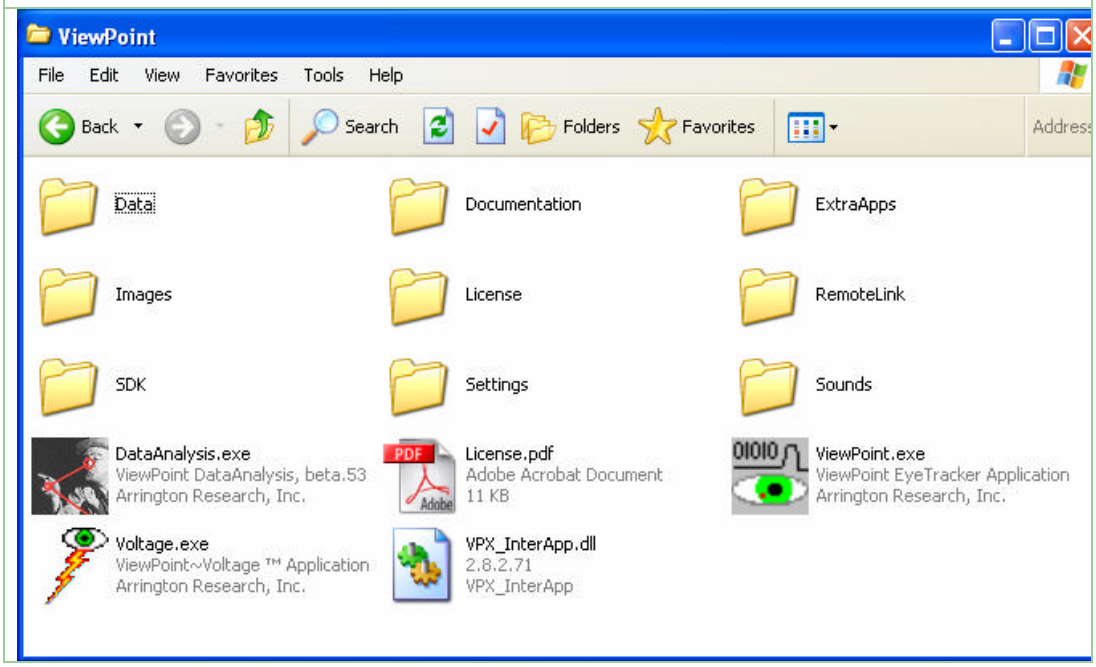
Figure 4: Frame Grabber Board Connections

Single Real-Time Input "Monocular" Card	Dual Real-Time Input "Binocular / Scene Camera Option card
 Input S-VHS = Not Used Composite Input 2 = Not used Composite Input 1 = **EYE_A**	 White Sync = Not used Composite Input 4 = Not used Composite Input 3 = **Scene** Composite Input 2 = **EYE_B** Composite Input 1 = **EYE_A**

3.5 ViewPoint EyeTracker® Software Installation

Copy the *ViewPoint* EyeTracker® folder from the CDROM to the hard drive of your computer. This folder is illustrated in Figure 5:. This directory structure must be maintained for proper functioning of the software. The ViewPoint™ software will not run without the .dll file. Please do not make illegal copies. You may start the program immediately by double clicking the icon of the ViewPoint application program.

Figure 5: The ViewPoint EyeTracker® Folder



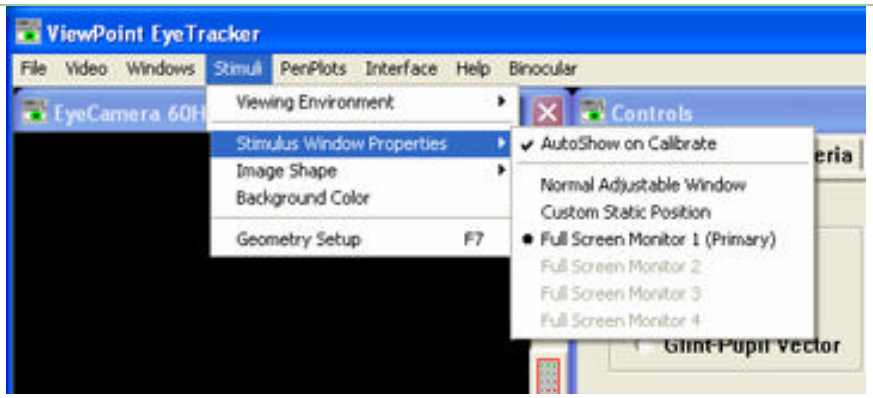
3.6 License Agreement

Use of the ViewPoint EyeTracker® software constitutes consent to the terms of the "ARI Software License" and contained in the document License.PDF in the ViewPoint folder. The ViewPoint EyeTracker® folder contains a License folder with a .vpl file that specifies your License settings for the ViewPoint EyeTracker® and optional programs. The .vpl file is named in the format `YourName.vpl`.

3.7 Menu Navigation

The ViewPoint EyeTracker® menu navigation system consists of various options, organized by function presented in a dropdown menu bar at the top of the ViewPoint window.

Figure 6: The ViewPoint EyeTracker® Menu Navigation Bar



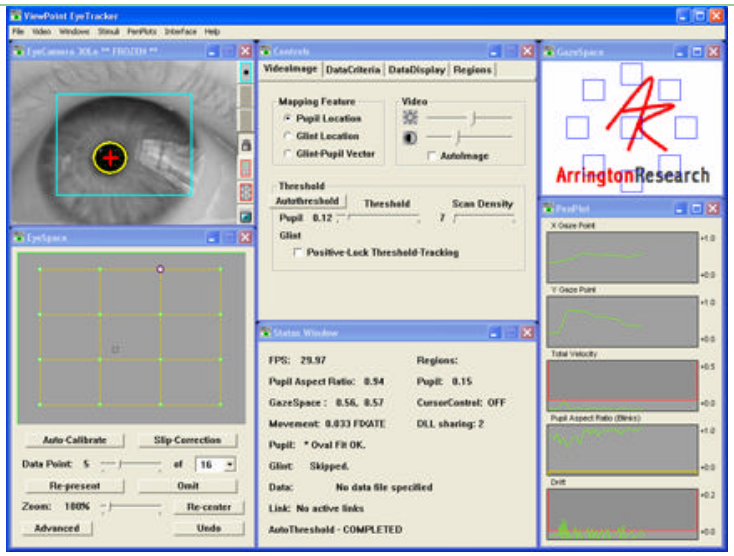
Menu Item	Use this Menu to:
File:	Open, pause and close data files, Save and load sesttings files, Load Images and picture lists, and Print windows
Video:	Control the incoming video signal, and Specify the tracking modes and methods
Windows:	Open and close windows.
Stimuli:	Specify the type of stimuli to be used, Control the stimulus window settings, and Specify the Geometry Grid settings
Penplots:	Hide or show PenPlots, and Specify PenPlot window settings
Interface:	Use the cursor control feature, and Use the serial port interface.
Help:	Access system configuration information, View license Holder information, Access the Documentation folder, and Link to the Arrington Research, Inc. web site

3.8 User Windows

When the ViewPoint EyeTracker® program is started it displays several windows arranged as

shown below.

Figure 7: Start-up arrangement of the user windows



Note: *The normal window layout requires a display at least 1024 x 768.*

To set up for multiple monitors you will need to install a second display card into your computer and consult the operating manual for your computer for configuration settings.

Table 2:	**Window function descriptions**
Window	Function:
EyeCamera:	Displays the video image of the eye and image analysis graphics
EyeSpace:	Corresponds to the geometry of the EyeCamera image. This window displays an array of the relative locations of the pupil, glint, or difference vector, which were obtained during calibration. These provide information about calibration accuracy and allow rapid identification and correction of individual calibration errors by allowing manual calibration of individual points. Refer to Chapter 6.
Controls:	Allows the experimenter to adjust the image-analysis and gaze-mapping parameter settings and to specify the feedback information to be displayed in both the Stimulus window and the GazeSpace™ window. VideoImage tab: Image quality adjustments and tracking method specification. DataCriteria tab: Specify smoothing and other criteria to apply to the data. Data Display tab: Specify information to be displayed in the Stimulus and GazeSpace windows. Regions tab: Setup regions of interest (ROIs). Scene tab: Adjust brightness and contrast of scene image (scene camera option only)
Status:	Gives details about processing performance and measurements
Stimulus:	(what the subject views) that is designed to be presented full screen, preferably on a second monitor. Upon which may be displayed the subject's calculated position-of-gaze information and region of interest boxes. Refer to Chapter 8
Penplot:	Plots X and Y position of gaze, velocity, ocular torsion, pupil width, pupil aspect ratio etc. in real time. The user may select which penPlots to display using menu item PenPlot > *. The range of many of the penPlot displays can be adjusted by clicking the right mouse button in the PenPlot graph well.

Chapter 4 Tutorial

This Chapter provides a brief tutorial designed to help you get started very quickly and easily. For simplicity it assumes use of the dark pupil only method, however for normal subject testing the Glint-Pupil vector method may be more appropriate. For further information refer to 5.1 Pupil only or Pupil-Glint Vector Difference?

This tutorial describes the steps for using the **Head Fixed** product (which includes HMD mounted systems), not the Head Mounted product, however many of the steps are the same.

4.1 Stimulus Window Positioning (Head Fixed)

Position the monitor, on which the Stimulus window is to be displayed, so that when the subject is looking straight ahead, their position of gaze is approximately two thirds of the way up the monitor vertically and centered horizontally. The Stimulus window should be placed so that the subject can see it easily when positioned comfortably. This is best achieved using a second monitor and full screen stimulus display. Refer to Chapter Chapter 8

4.2 EyeCamera Window Setup

Instructions for proper positioning of the Camera & LED.

1. Position the camera at 45 degrees below the line of sight of the subject (as they are viewed from the side).
2. Position the LED so that it appears at the 11 o'clock position when looking at the camera lens, such that the top surface of the LED and the camera lens are along the same horizontal plane. This allows both the LED and the camera to simultaneously be as high as possible, while still not occluding the vision of the monitor.
3. Move the camera mount sideways, such that the LED is centered along the optical axis of the eye while the eye is looking in the center of the display. This will mean that the camera is slightly off axis (as viewed from above). In other words, if the subject looks straight down she should be looking at the LED, not at the camera lens.
4. Adjust the camera so that the pupil is centered in the EyeCamera window as the subject looks at the center of the display and the eyeball fills the maximum possible area as shown in Figure 7. Movement between the head and the EyeCamera must be minimized. This can be achieved by using the *Arrington Research Precision Head Positioner* and camera system.
5. Defocus the camera so that the corneal glint is spread to about the size of an eighth (or more) that of the pupil. Besides making the glint larger, defocusing also effectively lowers the intensity of small bright extra reflections (by virtue of the point spread function). Defocusing may be achieved by rotating the camera lens or by adjusting the slide bar to move the camera closer or farther from the eye. Generally, the image of the eye should be such that the corners of the eye (the canthi) are at the horizontal edges of the camera window.
6. The LED may produce a doughnut shape of illumination. If that is the case, adjust the LED so that the darker center of the doughnut is in the center of the camera image, this will put the brighter ring around the edges near where the canthi and lids are located. This doughnut may

be more easily observed by placing the palm of the hand, or a piece of paper, at the location of the eye and then moving the LED slightly.

7. If the video image is too dark or too bright you can adjust the contrast and brightness settings by adjusting the brightness and contrast sliders on the Controls window. When adjusting the brightness and contrast controls in *ViewPoint*, the general goal is to increase the range of gray levels as far as possible that is to DECREASE the contrast as much as possible, while MAXIMIZING the blackness of the pupil and the whiteness of the glint. However, the glint should be the only spot that is saturated to maximum brightness.
8. decrease the brightness until you obtain a pupil that is as black as possible and adjust the contrast so that the glint, and only the glint, is of maximum white.

4.3 Corrective Lenses (Eye Glasses)

There are two main effects relating to the fact that the front and back surfaces of the lens will reflect light. First of all, the reflected light is wasted so that the illumination of the eye (light source path) and the image of the eye (light to camera) will be attenuated. Second the reflection from the illumination may be bounced back into the camera, which will be very bright and cause the auto-iris of the camera to produce a darker (and often varying brightness) image of the eye.

If there is a problem with the front surface reflection of corrective lenses, try adjusting the angle of the lens relative to the camera-LED assembly. There are two ways to do this:

1. Slightly tilt the corrective lenses by moving the earpiece so that it is near the auditory canal (hole in the ear) rather than resting on top of the ear; this is fairly easy for lightweight springy metal frames, but may not stay in place with heavier frames.
2. Slightly move the camera so it is more than 45 degrees below the line of sight.

4.4 Thresholding

The software attempts to locate the pupil by searching for a dark region within the pupil search area. In the Controls window : Mapping Feature group, select Pupil Location. Follow the steps below to undertake the thresholding process for this method:

1. Select menu item Video > Mode > Setup Mode. The EyeCamera Window will display the message: “30Lo” and the video preview image of the eye. Toggle show threshold dots “ON” using the button in the EyeCamera window, or Menu item Video > Show Threshold Dots.
2. Ask the subject to fixate at the center of the display screen. If self-testing move the EyeCamera window to the center of the display screen.
3. Select the Pupil Search Area Adjustment icon at the top right of the EyeCamera window, illustrated in Figure 9: Use the mouse to drag out a rectangle that limits the area in which to search for the pupil. In particular, use this to eliminate dark shadow areas that could be confused with the pupil.
4. Press the AutoThreshold button on the Controls window: threshold group. If necessary, adjust the dark pupil threshold setting in the Controls window to ensure that the green dots appear only in the pupil and that the yellow oval outlines the pupil and is fairly circular. (Note that the Status window displays the oval’s aspect ratio, 1 = perfect circle) The yellow oval

indicates where the program has located the area of the pupil.

5. If too many dark areas other than the pupil have green dots, adjust the dark pupil threshold slider to the left. Alternatively, if insufficient pupil area is being identified as dark (with green dots), adjust the dark pupil segmentation threshold slider to the right.
6. After the pupil has been isolated, adjust the scan density to use the minimum number of dots that can reliably and consistently locate the pupil. Correct thresholding of the dark pupil is illustrated in Figure 9:. The default set on startup is optimal for most situations and you should very rarely need to adjust this.

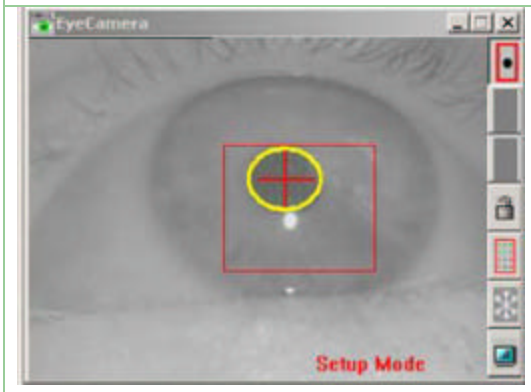
Note: Unnecessarily high scan density settings together with large scan areas can cause the frame rate to drop.

7. Ask the subject to look at each of the four corners of the Stimulus window to ensure that the pupil remains in the search box and to ensure accurate thresholding for all potential eye movements. i.e. the yellow oval outlines the pupil and is fairly circular. If self-testing, move the eye camera around to the four corners of the display to view the effects of pupil segmentation at different position of gaze. At any point the experimenter can toggle the image display On/Off. When Off it provides a still image of the eye to aid identification of successful thresholding. This is accomplished by either (a) pressing the Freeze Video icon button at the bottom right of the EyeCamera window, or (b) by selecting the menu item: Video > Freeze Video. When frozen, the icon button will be outlined in red and a check mark appears next to the menu item. The EyeCamera window will also indicate "*** FROZEN ***" in the title bar.

Note: It takes time to paint the threshold dots on the screen, but it is very useful for determining what Segmentation Threshold and Scan Resolution settings are optimal. Once optimal settings have been found, the Toggle show threshold dots may be turned off to remove the computational burden of painting the colored dots.

Note: this section describes pupil only thresholding. With the Pupil only method, any X, Y plane head movement will be confounded with eye movement. To measure movement that is invariant to X, Y plane head movement, use the glint-pupil vector method. For instructions on how to set up for glint-pupil vector method, please refer to Chapter 5

Figure 8: Thresholding to identify the dark pupil



Pupil Search Area Adjustmen

Lock Search Area Adjustments

Toggle Show Threshold Dots

Freeze Video

Operation Mode Toggle

4.5 Calibration (Head Fixed)

After successful thresholding as outlined in Section 4.3 follow the steps below:

1. Select menu item: Video > Mode > High Precision (30Hz 640 x 480) The EyeCamera window will display the message: "30HP".
2. Warn the subject of the onset of the calibration stimuli to ensure successful calibration.
3. Instruct the subject to look directly at the center of each stimulus until it converges to a point. The calibration stimulus points will appear in random order.
4. Start the calibration by pressing the Auto-Calibrate button on the EyeSpace window. The message "Get Ready" will appear briefly on the screen to draw the subject's attention to the start of the calibration process. This can be suppressed or the display time adjusted via the Advanced section in the EyeSpace window.
5. During the calibration process, ensure the pupil is accurately located at all times by monitoring the green dots and the yellow oval, i.e., monitoring the image segmentation.
6. Check the calibration by using the plot of the calibration data points in the EyeSpace window. Successful calibration will be indicated by a rectilinear and well-separated configuration of green dots corresponding to the locations of the pupil at the time of calibration point capture.
7. Stray calibration data points can be identified and recalibrated. The data point slider in the EyeSpace window allows the user to select stray calibration points to be recalibrated. The active data point is highlighted in the graphics well. Data points can also be selected with the mouse by left clicking the calibration point.
8. Select the stray calibration point by right mouse clicking the point in the EyeSpace window.

9. Instruct the subject to look at the center of the stimulus and represent the calibration point by pressing the re-present button in the EyeSpace window. The message "Get Ready" will appear briefly on the screen at the calibration point location to draw the subject's attention to the re-presentation location. This can be suppressed or the display time adjusted via the Advanced section in the EyeSpace window. This exercise can be repeated with as many calibration data points as necessary. If the calibration points are not rectilinear, for example, there are lines crossing then complete re calibration is necessary.
10. A quick check of calibration accuracy may be done by asking the subject to look at particular points on the stimulus and using the GazeSpace window to verifying that the gaze point matches up with the points looked at.

4.6 Data Collection and Analysis

Now that the system is calibrated, data can be collected. To start recording data to file Select menu item: File > Data > New Data File. This will prompt you to create a new file in the directory Data. When data is being stored the Status window will show**:** DATA: OPEN "datafilename.txt"

The menu item: File > Data > Unique Data File will create a new data file with a unique name to be opened without having to go through the File Dialog box.

Recording can be paused at any time by selecting menu item: File > Data > Pause Data Capture. When data storage is paused the Status window will show: "PAUSE". To stop recording, select menu item: File > Data > Close Data File. The Status window will indicate that the file is closed.

For further information on data file formats refer to Chapter 9 Data Collection

4.7 Sampling Rate

Menu Item: Video > Mode > * can be used to select the required sampling rate. The icon button on the EyeCamera window tool bar can be used to sequence through the operating modes (SetUp – High Precision – High Speed – SetUp). Refer also to Chapter 9 Data Collection.

4.8 Frequently Used Settings

You can use the settings file **startup.txt** that is located in the folder named "Settings" to specify frequently used settings. For example, you may wish to specify brightness and contrast settings applicable for your subject population. When *ViewPoint EyeTracker®* is launched it loads in the content of this file which can reduce setup time.

4.9 Preferred Window Layout

A preferred startup window layout can be saved using menu item: File > Settings > Save Window Layout. This can then be reloaded using the load settings menu item. Alternatively the contents of the saved settings file can be added to the startup.txt settings file so that your preferred window layout is set each time that you launch ViewPoint.

4.10 Accelerator Keys

Accelerator keys are used to make menu selections with the keyboard, rather than the mouse. The most current list can always be found within *ViewPoint* by selecting menu item: Help > Info, and ShortCuts. The circumflex character '^' represents the Control key held down as a modifier key.

The user can associate an FKey with a CLP command action. These associations can be viewed in the Info panel: menu Help > Info > ShortCuts tab. Refer to 13.23

4.11 Printing

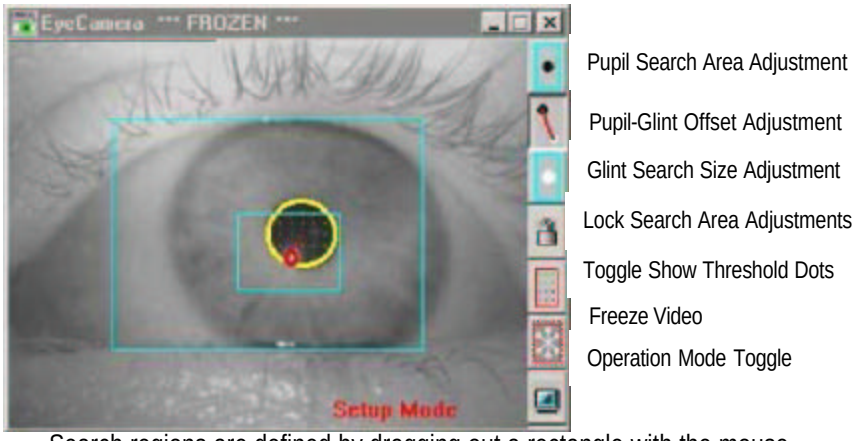
Many of the ViewPoint windows can be printed using menu item: File > Print > … To include the current date and time on the prints, check menu item File > Print > DateTimeStamp Printouts…

Note: you may want to select Freeze before Print to prevent pull down menu occlusion.

Chapter 5 Locating the Pupil and Glint

The EyeCamera window displays the video-image as well as image segmentation information (e.g., green dots indicating dark areas, yellow oval fit to pupil). The eye-tracking algorithm paints performance results over the video image of the eye, as shown in Figure 9: These include: thresholding results, pupil location and diameter calculation results, corneal reflection location results, and the pupil-center to corneal-reflection-center difference-vector result. The mouse is used in this window to pull a rectangle to define a limited search area for both the pupil and glint (see 5.2 Setting the Search Regions)

Figure 9: EyeCamera Window



Search regions are defined by dragging out a rectangle with the mouse.

5.1 Pupil only or Pupil-Glint Vector Difference?

The major problem that the user will face is to increase the signal to noise ratio. In the Glint-Pupil Vector mode, the basic measure of signal is the length of the vector from the center of the pupil to the center of the specular corneal reflection. Noise comes from many things, for example: eyelid droop, eye blinks, extreme direction of gaze angles that produce a reflection from the less smooth sclera (white part of the eye), shadows, extraneous specular reflections, as well as the internal electrical video noise.

The first most obvious way to increase the signal is to move the camera closer or zoom in, so the pupil to corneal reflection difference vector appears larger in the EyeCamera window. The trade-off here is that smaller head movements can move the eye out of the view of the camera. The mapping function is calculated based on the calibration data, and it is only as good as the calibration. There are many sources of non-linearity. Consequently, mapping the raw eye-image-feature data to direction-of-gaze requires a sufficiently sophisticated non-linear mapping function. Obviously, if the subject is not looking at the calibration point when the data is sampled, then the

calibration function that is calculated is not going to produce accurate direction of gaze information.

The experimenter may switch between three mapping feature modes by selecting the desired radio button on the Controls window. The mapping modes fall into two basic categories: single data point methods and multiple data point methods. The single data point methods, for example using Pupil Location Only or specular corneal Glint Location Only are sensitive to slight sideways head movements.

The multiple data point method uses the Glint-Pupil Vector Difference between (i) the center of the pupil and (ii) the center of the specular corneal reflection. This is more robust against small movements of the subject within the tracking apparatus. The corneal reflection (CR) and the dark pupil (DP) move together as the head translates in the x-y plane. By taking the vector difference between these two signals, a relatively translation invariant point-of-regard eye tracking system can be achieved.

The disadvantages are (a) there are now two sources of video and segmentation noise instead of one, (b) given a change in viewing direction, the vector variation is smaller than the variation of the pupil (or the glint) alone. The result is a lower signal to noise ratio. Moreover, the vector method is sensitive to a different type of translation error. The CR and DP methods are particularly sensitive to translation of the head in a horizontal (sideways, x-axis) or vertical (up/down, y-axis) direction and less sensitive to in-and-out (closer or farther from the camera, z-axis) movement of the head. By contrast, the Vector Difference method is robust against x-axis or y-axis movement, but is more sensitive to z-axis movement of the head, because this affects the length of the calculated vector; that is, the vector becomes shorter as the head is moved backward away from the camera. This is particularly true when the camera is close to the eye, because the angular field of view is wider. If a more remote camera is used it will be less sensitive to Z axis variation.

Which method to use is probably best determined through experimentation.

5.2 Setting the Search Regions

The eye tracker's performance is significantly increased as the size of the search areas are reduced. Limiting a search area also provides a convenient way to eliminate areas with video noise, extraneous specular reflections or dark shadow areas, any of which may confuse the location process. Buttons on the side of the EyeCamera window are used to select the adjustment mode for:

1. pupil search area,
2. glint search size, or
3. pupil-glint vector offset.

These top buttons act like "radio buttons", so only one selection may be made at a time. Depending on which mapping mode is selected, the user can easily adjust any of these by simply using the mouse to drag out the rectangle or vector within the EyeCamera window, as illustrated in Figure 8:Thresholding to identify the dark pupil

You can lock the adjustments to protect them from accidental changes by selecting the "Lock all adjustments" icon button.

When the mapping feature mode is set to Pupil Location, the pupil is found by searching for

the dark region within the pupil search area. To adjust this area, first press the button to select pupil search area adjustment mode, then use the mouse in the EyeCamera window to drag out the smallest rectangle that catches the pupil over its full range of movement.

When the mapping feature mode is set to Glint-Pupil Vector the large pupil must be found first as above, then the smaller corneal reflection is searched for relative to the pupil:

1. Make *pupil scan area* and *pupil threshold adjustments* to get a good lock on the pupil boundaries.
2. Press the button to select pupil-glint offset vector adjustment mode, then use the mouse in the EyeCamera window to drag out the offset vector: drag a line from the center of the pupil to the center of the corneal glint.
3. Press the button to select *glint search size adjustment* mode, then use the mouse in the EyeCamera window to drag out smallest rectangle that catches the glint at all possible eye positions. Because the glint search size moves relative to the calculated center of the pupil, the absolute placement of the glint search size specification rectangle with the mouse is not important, only its size is important.

The oval fit algorithm will continue to fit the pupil beyond the limits of the pupil search area. Consequently, the pupil search area can be substantially smaller than may initially be imagined.

5.3 Brightness and Contrast Adjustments

The default values of the video image Brightness and Contrast should provide good operation for most subjects when used with the close focus camera system provided by Arrington Research. However, with other camera configurations you may need to make fine adjustments. Also, subjects with very dark iris pigmentation may need the brightness reduced slightly. Adjust to provide optimal segmentation of the pupil and iris with gradually varying gray scale. High contrast is not as good as a large range of gray scale values. Select the Setup Mode using menu item: Video > Mode > Setup (30 Hz 320 x 240) or use the icon button on the EyeCamera window tool bar to sequence through the operation modes. During this mode the temporal resolution is 30 Hz and the internal processing 320 x 240.

5.3.1 Video AutoImage

When the AutoImage check box on the Controls Window Video Image tab is checked *ViewPoint* will automatically adjust the brightness and contrast values to optimal settings. Only the region within the pupil scan area is examined, so the pupil scan area rectangle must be of sufficient size for the algorithm to sample a range of gray levels, otherwise the algorithm will fail.

5.4 Thresholding and Setting the Scan Density

Thresholding

The program scans over the video image for the dark pupil and / or for the light corneal reflection. Adjusting the Threshold sliders on the Controls window: Threshold group controls which luminance values to include or exclude. The pupil threshold slider adjusts the threshold level (sensitivity) for the pupil. Moving the slider to the right raises the dark pupil threshold ceiling, allowing more (lighter) gray levels to be counted as part of the dark pupil. The glint threshold slider

adjusts the threshold level (sensitivity) for the white corneal reflection. Moving the slider to the left lowers the light reflection threshold floor, allowing more (darker) gray levels to be counted as part of the reflection.

Clear focus is not always optimal for obtaining good segmentation, because display screen reflections over the pupil can sometimes confuse the image segmentation process. Also, defocusing can cause the specular corneal glint to appear larger, which can make it easier to locate.

5.4.1 Setting the Scan Density

The resolution at which the program samples pixels in the video image is adjusted by the Scan Density sliders. The finest resolution is with the slider set to the left, as the slider is moved to the right, only every n'th pixel is examined, where n is the number of clicks to the right. The *ViewPoint EyeTracker*® works by isolating the pupil and corneal reflection in the video image. To segment the image properly, the intensity-threshold levels must be appropriately set. The pupil and the corneal reflection are located by first taking the mean position of all sample points within threshold limits. The spatial resolution of the sampling may need to be adjusted to optimize speed or accuracy. Moving the slider to the right increases the sample spacing (coarse) which reduces the sampling resolution and correspondingly the number of dots shown. Moving the slider to the left increases the resolution (fine). The results of the sampling resolution is graphically displayed when the Show Threshold Dots button on the EyeCamera Window or Menu item Video > Show Threshold Dots is selected.

Note: It takes time to scan pixel values and to paint them. It is very useful for determining what Segmentation Threshold and Scan Resolution settings are optimal. Once optimal settings have been found, the scan density should be reduced as far as possible to reduce the computational burden. If fine scan resolution and a large scan area is required, then the Show Threshold Dots may be turned off to remove the computational burden of painting the colored dots.

5.4.2 AutoThreshold

Pressing the AutoThreshold button automatically sets desirable Light-Reflection and Dark Pupil threshold levels. After this is done, the user may want to make further adjustments, which is easily done using the sliders.

5.4.3 Positive Lock Threshold Tracking

Positive Lock provides continuous automatic feature threshold adjustment. To activate this feature select Positive-Lock Threshold-Tracking in the Controls window.

5.5 Pupil Aspect Criteria

The program can reject a dark segmented area as being the pupil based on the ability to fit a circle to the area. If the ratio of the minor-axis to the major-axis is less than the Pupil Aspect Criteria, then that area is rejected. If you are going to use this feature, then typically a criteria level of 0.6 is a good place to start. Use the PenPlot window and adjust the slider so that the threshold bar is below the pupil aspect ratio for all potential eye movements, and above that for blinks. The PenPlot window displays the pupil aspect ratio in real-time and a line indicating the Pupil Aspect Criteria. The pupil oval fit changes color from yellow to orange when criterion is violated.

The variation of aspect ratio over the range of eye movements will depend on the viewing

angle of the camera. The eye image in Figure 9: was taken with a micro camera (arranged as in Figure 1: Schematic of the *ViewPoint EyeTracker*® System). The pupil will appear more oval as the angle increases between the optical axis of the camera and the line of sight of the eye.

The circle fit around the pupil in the EyeCamera window changes from yellow to orange when the specified criterion is violated.

5.6 Step by step guide to using the Glint-Pupil Vector Method

For a step by step guide to successful location of the pupil, refer to 0

Window	Function:
EyeCamera:	Displays the video image of the eye and image analysis graphics
EyeSpace:	Corresponds to the geometry of the EyeCamera image. This window displays an array of the relative locations of the pupil, glint, or difference vector, which were obtained during calibration. These provide information about calibration accuracy and allow rapid identification and correction of individual calibration errors by allowing manual calibration of individual points. Refer to Chapter 6.
Controls:	Allows the experimenter to adjust the image-analysis and gaze-mapping parameter settings and to specify the feedback information to be displayed in both the Stimulus window and the GazeSpace™ window. VideoImage tab: Image quality adjustments and tracking method specification. DataCriteria tab: Specify smoothing and other criteria to apply to the data. Data Display tab: Specify information to be displayed in the Stimulus and GazeSpace windows. Regions tab: Setup regions of interest (ROIs). Scene tab: Adjust brightness and contrast of scene image (scene camera option only)
Status:	Gives details about processing performance and measurements
Stimulus:	(what the subject views) that is designed to be presented full screen, preferably on a second monitor. Upon which may be displayed the subject's calculated position-of-gaze information and region of interest boxes. Refer to Chapter 8
Penplot:	Plots X and Y position of gaze, velocity, ocular torsion, pupil width, pupil aspect ratio etc. in real time. The user may select which penPlots to display using menu item PenPlot > *. The range of many of the penPlot displays can be adjusted by clicking the right mouse button in the PenPlot graph well.

Tutorial.

1. In the Controls window select Glint-Pupil Vector.
2. Ensure that menu item: Video > Mode > Setup (30Hz 340 x 240) is selected.
3. Ask the subject to fixate at the center of the display screen. If self testing, move the EyeCamera Window to the center of the display screen.

4. Select the Pupil Search Area Adjustment icon at the top right of the EyeCamera Window, illustrated in Figure 9:
5. Use the mouse to drag out a rectangle that limits the area in which to search for the pupil. In particular, use this to eliminate dark shadow areas that could be confused with the pupil. If necessary adjust the brightness and contrast settings and move the illuminator to provide uniform illumination over the eye image.
6. Press the AutoThreshold button on the Controls window. If necessary, adjust the dark pupil threshold setting in the Controls window to ensure that the green dots appear only in the pupil and that the yellow oval outlines the pupil and is fairly circular. (Note that the Status Window displays the oval's aspect ratio, 1 = perfect circle) The yellow oval indicates where the program has located the area of the pupil.
7. If too many dark areas other than the pupil have green dots, adjust the dark pupil threshold slider to the left. Alternatively, if insufficient pupil area is being identified as dark (with green dots), adjust the dark pupil segmentation threshold slider to the right.
8. After the pupil has been isolated, adjust the scan density to use the minimum number of dots that can reliably and consistently locate the pupil. Correct thresholding of the dark pupil is illustrated in Figure 8:.
9. Ask the subject to look at each of the four corners of the Stimulus window to ensure that the pupil remains in the search box and to ensure accurate thresholding for all potential eye movements. i.e. the yellow oval outlines the pupil and is fairly circular. If self testing move the eye camera around to the four corners of the display to view the effects of pupil segmentation at different position of gaze.
10. Select the Pupil-Glint Offset Adjustment icon on the EyeCamera window, illustrated in Figure 9: Use the mouse to drag out the offset vector from the center of the pupil to the center of the corneal glint.
11. Press the button to select the glint search size adjustment mode, then use the mouse in the EyeCamera window to drag out smallest rectangle that catches the glint at all possible eye positions. Because the glint search size moves relative to the calculated center of the pupil, the absolute placement of the glint search size specification rectangle with the mouse is not important, only its size is important.
12. After the glint has been isolated, adjust the scan density to use the minimum number of dots that can reliably and consistently locate the glint. Correct thresholding of the glint is illustrated in Figure 9:
13. Ask the subject to look at each of the four corners of the Stimulus window to ensure that the glint and pupil both remain in the respective search boxes and to ensure accurate thresholding for all potential eye movements. i.e. the yellow oval outlines the pupil and is fairly circular and the red oval outline the glint and is fairly circular. If self testing move the eye camera around to the four corners of the display to view the effects of pupil and glint segmentation at different position of gaze.

At any point the experimenter can toggle the image display On/Off. When Off it provides a still image of the eye to aid identification of successful thresholding. This is accomplished by either (a) pressing the Freeze Video icon button at the bottom right of the EyeCamera window, or (b) by selecting the menu item: Video > Freeze Video. When frozen, the icon button will be outlined in red and a check mark appears next to the menu item. The EyeCamera window will also indicate "*** FROZEN ***" in the title bar.

Scan adjustments can be locked by selecting the icon on the EyeCamera window tool bar.

5.7 Alternative Segmentation Methods

Two algorithms are available for determining the pupil location. Lighting conditions and performance considerations will determine which method is best for a particular job.

5.7.1 Oval Fit Method

The default pupil search algorithm is set as Oval Fit. This is the method of choice for most situations. The pupil location is the center of the extreme values obtained during an edge trace around the pupil, starting from the point at 3 o'clock from the weighted centroid. This algorithm first scans rightward to find the right edge of the pupil. Next the algorithm traces the edge of the pupil, using the dark pupil threshold limit as the edge criterion. The extreme positions obtained during the edge trace are used to fit an oval, the center of which is taken to be the pupil location.

Select Menu item Video > Pupil Segmentation Method > Oval Fit.

5.7.2 Centroid Method

This method may be useful if there is difficulty discriminating the edge of the pupil, or if the pupil is very small.

The pupil location is at the average position of all points above threshold, weighted according to how much above threshold. Locations below threshold are weighted more if they are darker. The oval fit to the pupil uses this location as its starting point.

Note: centroid means “center of mass”.

Select Menu item Video > Pupil Segmentation Method > Centroid.

5.7.3 Glint Segmentation Methods

It is also possible to change the default segmentation method for the glint using menu item: Video > Glint Segmentation Method > …..

5.8 Automatic Slip Compensation

This method combines the advantages of the larger signal space and reduced signal noise of the Pupil Location method, together with the translation-error robustness of the Glint-Pupil Vector method. Select SlipCompensation from the Feature Method pull down menu on the Controls window VideoImage tab.

5.9 Pupil Scan Area Shape

The user can specify whether to change the scan area for the pupil to either rectangular or

elliptical using CLP commands. Elliptical scan area can be effective at eliminating dark spots that the software may interpret as a pupil. Refer to 13.6.

5.10 Manual Simulation of Position of Gaze

The user can use the mouse to simulate position of gaze. Select Manual Simulation from the Feature Method pull down menu on the Controls window VideoImage tab. Click and hold the mouse button in the GazeSpace window. Note that the smoothing operation is still applied, so unless smoothing is set to one (turned off) it may take several clicks at a location before the gaze point indicator moves to the location of the mouse. The pupil and glint quality codes are set to best-quality (as soon as the user moves the mouse in the GazeSpace window) so that subsequent operations are not impeded.

Chapter 6 Calibration

6.1 Calibration Description

The *ViewPoint EyeTracker*® starts up in a **coarsely calibrated** state that provides precise timing of eye movements, but only approximate mapping of the point of regard. This is sufficient for many applications, such as quadrant-wise preference of looking. If your application requires more precise *gaze point* information, then further calibration will be required.

Raw pupil and corneal reflection locations do not indicate where the subject's position-of-gaze is. These raw data points in **EyeSpace™** (i.e. the *video-display space)* must be mathematically mapped to the subjects **GazeSpace™** (i.e. the *visual-stimulus space)*. When using the Glint-Pupil Vector method it is still important to obtain separate calibrations for each individual, because of individual variations in corneal curvature.

Before calibration, the pupil and corneal reflection must have been isolated with appropriate threshold settings.

Calibration stimuli are presented to the subject in the Stimulus window and also indicated to the user in the GazeSpace window. The subject should be instructed to foveate each point in turn, so the system can determine appropriate coefficients for the mathematical mapping. The calibration mode is Tunnel Motion calibration, where shrinking motion of a rectangular frame arrests the subject's visual attention and smooth pursuit brings the subject's gaze point to each of the desired calibration spots in turn.

6.2 Calibration Procedure (Head Fixed)

For a step by step guide to successful calibration refer to 4.5. Calibration

Menu Item: Video > Mode > High Precision (30 Hz 640 x 480) must be selected prior to starting calibration to ensure the highest degree of accuracy. The icon button on the EyeCamera window tool bar can be used to sequence through the operating modes (SetUp – High Precision – High Speed – SetUp).

The EyeCamera window can be completely hidden or minimized at any time during the eye tracking process without disrupting video capture.

Calibration is started either by pressing the Auto-Calibrate button in the EyeSpace window. If menu item: Stimuli > Stimulus Window Properties > AutoShow on Calibrate is also selected, then the Stimulus window will automatically be displayed full screen on the primary monitor.

The message "Get Ready" will appear briefly on the screen to draw the subject's attention to the start of the calibration process. This can be suppressed or the display time adjusted via the Advanced section in the EyeSpace window.

The automatic calibration sequence may be stopped by pressing the STOP Calibration button in the EyeSpace window. Pressing the ESC key will both stop the calibration and remove the full screen display if it is on the primary monitor.

The number of calibration points is selected by the user using the pull-down menu item in the

EyeSpace window. The number of calibration points may be set to: 6, 9, 12, 16, 20, 25, 30, 36, 42, 49, 56, 64 or 72. A higher number of points may help with subjects that have corneal abnormalities or difficulty foveating. The current setting is indicated by a check mark. A setting of 12 or 16 is usually quite adequate. With fewer calibration points, good calibration accuracy is essential for each point. When a large number of points are used, the effect of any single point will be less.

Speed of presentation of the calibration stimulus points can be adjusted via the Advanced section in the EyeSpace window.

6.3 Assessing Calibration Success

A quick check of calibration accuracy may be done by asking the subject to look at particular points on the stimulus and using the GazeSpace window to verify that the gaze point matches up with the points looked at.

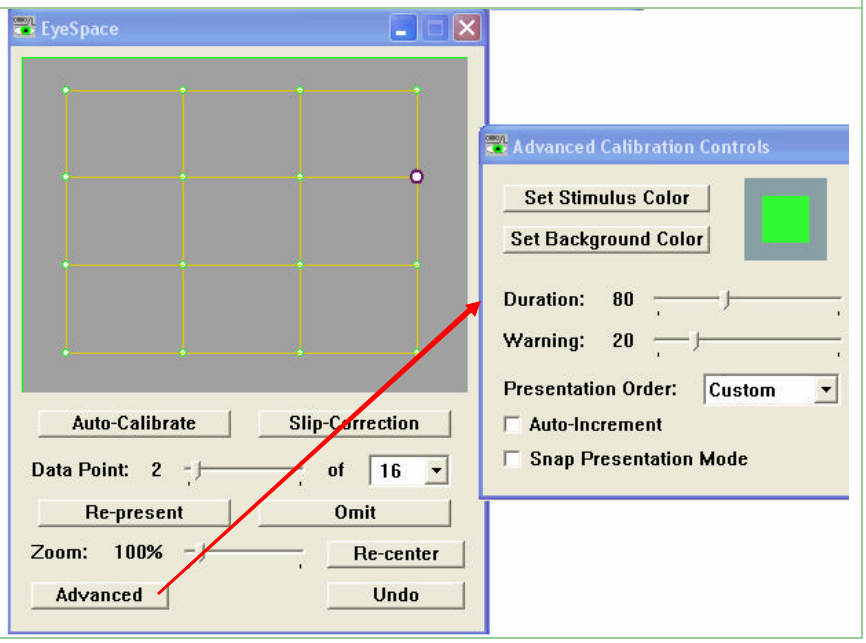
The arrangement of calibration data points in the EyeSpace window provides a method of assessing how good the calibration data is.

Successful calibration will be indicated by a relatively rectilinear and well separated configuration of dots. The mapping method (selected in the Controls Window) determines how these data points are plotted. If Pupil Location is selected, then the plot shows green dots corresponding to the locations of the pupil at the time of calibration point capture. The dots are joined by yellow lines that indicate the spatial relationship between the dots. If Glint-Pupil Vector is selected, the plot shows blue dots corresponding to the locations of the pupil at the time of calibration point capture, but now they are shifted so that they are all relative to the corneal glint (red dot) that is plotted at the center of the data point chart. The dots are joined by yellow lines that indicate the sequence in which the dots were presented.

The EyeSpace window is shown in Figure 10:.

The top part of the window shows a 320x240 graphics well that represents of the coordinate space of the EyeCamera window. If Pupil Location or Glint Location modes are selected, a black square shows the current pupil location, or the current glint location, respectively. In Glint-Pupil Vector mode the black square shows the vector difference between the pupil and glint locations, with the glint end of the vector fixed at the red dot.

Figure 10: EyeSpace Window



6.4 Geometry Grid

This option allows the user to present grid lines over the stimulus image, which helps visualization of the size of the display and the size of eye movements in degrees of visual arc. The grid lines are presented as light blue lines separated by one degree of visual arc. The grid spacing depends on the viewing distance and also on the horizontal and vertical size of the image on the monitor. ViewPoint. provides an easy way to take these measurements and to enter them, so that the program can perform the trigonometry and display the grid lines accurately.

The Stimulus window should be made full screen size on the display that will beused for visual stimulus presentation. If this has not been done, the Stimulus window will be set to full screen on the primary monitor when the Apparatus Geometry window is raised. When the Apparatus Geometry window (see Figure 11:) is displayed, the Stimulus window will display two thick red lines, one vertical and one horizontal. The Apparatus Geometry window contains three sliders. The user should adjust these sliders to indicate:

- The viewing distance from the subjects eye to the center of the display screen,
- The lengths of the horizontal and vertical red lines in the Stimulus window.

The units of measurement are arbitrary, but they must be consistent, e.g. all measurements in millimeters, or all measurements in inches. The Apparatus Geometry window also displays various numerical calculations that may be useful.

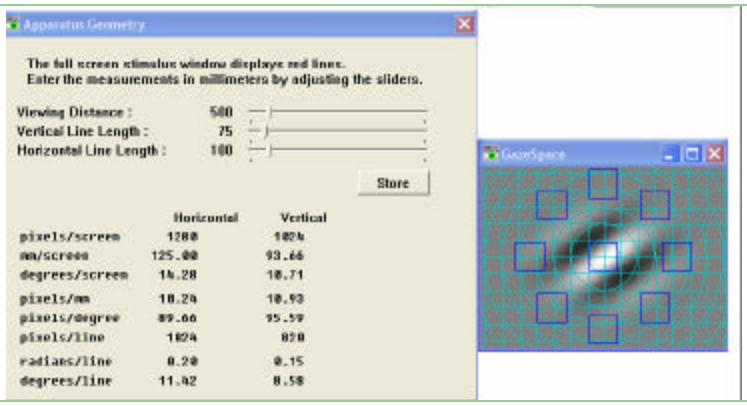
After adjustments have been made, the measurements should be saved by pressing the Store button. Subsequent runs of ViewPoint will maintain the stored settings.

Selecting menu item: Stimuli > Geometry Setup will open the Stimulus window full screen

on the selected monitor with the Apparatus Geometry window so that further adjustments can be made.

The GeometryGrid can be displayed on the Stimulus window and or the GazeSpace window by using the check boxes on the Controls window DataDisplay tab.

Figure 11: Apparatus Geometry Window



6.5 Re-presenting Individual Calibration Data Points

The data point slider allows the user to select stray calibration points to be recalibrated. The active data point is highlighted in the graphics well. Data points can also be selected by left clicking the mouse. To re-present the selected stray calibration point, press the Re-present button in the GazeSpace window.

The message “Get Ready” will appear briefly on the screen to draw the subject’s attention to the location of the calibration point. This can be suppressed or the display time lengthened via the Advanced section in the EyeSpace window or by using settings files. Refer to Chapter 11.6.

For ease of data point viewing, the calibration data points and real-time feature points (pupil and / or glint) can be zoomed in or out using the Zoom slider, and can easily be moved by dragging with the right mouse button. The Re-center button repositions the data points in the center of the graphics well.

6.6 Slip Correction

During data collection, the subject may move in the X and Y planes which can cause the measured position of gaze to no longer correspond to actual position of gaze. The Slip-Correction button in the EyeSpace window will re-present the currently selected calibration point to the subject and automatically adjust the remaining points to compensate for the measured slip in the X and Y planes.

The message “Get Ready” will appear briefly on the screen to draw the subject’s attention to the location of the calibration point. This can be suppressed or the display time lengthened via the Advanced section in the EyeSpace window or by using settings files. Refer to Chapter 11.6.

Slip-Correction is generally not required when using the pupil-glint vector difference method; it is most useful when using the pupil-only or glint-only methods. Generally the selected point for slip-correction should be one near the center of the display.

6.7 Omitting Individual Calibration Points

The Omit button in the EyeSpace window will allow the user to omit an individual calibration data point from the mapping calculations. This may be required if for some reason an individual calibration point is far out of the rectilinear distribution and represent is not successful. Use the data point slider or mouse click to select the required data point. Pressing the Restore button restores the omitted point.

6.8 Instructions to Subject

For auto-calibration, it is usually preferable to randomize the presentation order of the calibration points, which is the default setting. With sequential presentation order of stimulus point, a leading source of calibration error is that the subject anticipates the presentation location of the next point, before the current stimulus point has finished. It is required that the subject fixate on the calibration stimulus point until the point has completely disappeared.

The calibration stimulus presentation order may be changed. Press the Advanced button in the EyeSpace window for access to the controls.

6.9 Dominant Eye

If the subject is known to have a dominant eye, a better calibration is obtained if this eye is used.

6.10 Saving Calibration Eye Images

Troubleshooting calibration difficulties can be made easier by viewing the eye image at the time the calibration data point is taken. The following CLP command saves these eye images in a folder named “Calibration”:

```
SaveCalibrationEyeImages Yes
```

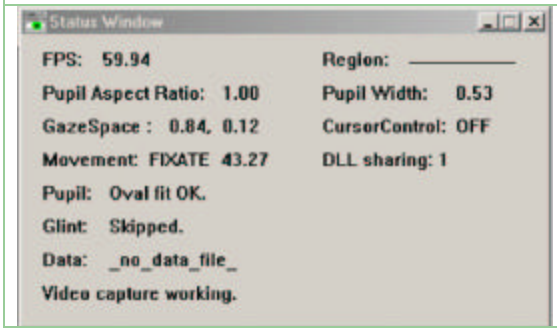
This command will also create the folder if it does not exist.

6.11 Cursor Control Feature (Head Fixed)

The CursorControl feature will allow the subject to move the cursor with their position of gaze. Select menu item: Interface > CursorControl > Eye Moves Mouse. The Status window will display CursorControl: ON. Increasing the amount of smoothing will substantially increase the usability of the cursor. Menu item Interface > CursorControl > Fixation Clicks Buttons when toggled ON will cause a button click event to be issued when the fixation duration reaches a pre-set dwell time. The “dwell time” in seconds can be specified using the MouseClick If Fixated slider in the Data Criteria panel of the Controls window and also specified using settings files. Menu item Interface > CursorControl > Blinks Clicks Buttons when toggled ON will cause a button

click event to be issued when the eye tracker detects a blink.

Figure 12: Status Window



6.12 Advanced Calibration Controls

The user can change the default color settings of the calibration stimulus rectangles and the background using the Advanced Calibration Controls window. This window is reached from the Advanced button on the EyeSpace Window.

The Duration slider specifies the approximate duration in milliseconds of each of the concentric contracting "tunnel motion" calibration stimulus rectangles.

The Presentation Order pull-down menu allows the user to choose to present the calibration stimulus points in one of three orders. The default presentation mode is Random.

- Sequential: Calibration stimulus rectangles are presented from the top left hand corner of the screen to the bottom right hand corner of the screen.
- Random: Calibration stimulus rectangles are presented in random order. The series is re-randomized every time the set finishes, so that there is a new random order for the next loop.
- Custom: Using CLP commands the user can specify the presentation order of the calibration stimulus rectangles.

6.12.1 Snap and Increment Calibration Modes

If manual calibration is preferred, then the user can select Snap Presentation mode. In this mode the currently selected calibration data point is active and the Re-present button will immediately perform the calibration based on the eye position at the time

When in this mode the behavior of the Re-Present and the Slip-Correction buttons/commands is changed as described and and is indicated by the appearance of an asterisk (*) on these buttons.

When operating in this mode the user can choose whether to automatically advance to the next calibration data point by selecting the Auto-Increment button. This mode is indicated by the appearance of *++ on the Re-Present and the Slip-Correction buttons. If Auto-Increment is not selcetd then the selected calibration point will not change. The data point advanced to is

determined by the Presentation Order mode selected.

6.12.2 Adjusting the Calibration Area

The user may want to adjust the size and position of the area within which the calibration stimulus points are presented. This is especially useful when part of the display screen is occluded, as in fMRI environments. In the Advanced Calibration Controls Window press the Adjust Calibration Area button. Refer to Figure 10:EyeSpace Window. This opens the Regions Tab on the Controls window. Use the left mouse button in the GazeSpace window to drag out the required size and position of the calibration area. The size and position coordinates are displayed in the Regions tab and in the GazeSpace window. Refer to Chapter 13.8 Calibration controls for details of CLP command **`calibrationRealRect.`** The Revert button will undo the last change and the Default button will return the calibration areas size to the default setting.

6.13 Custom Calibration Point Positions

ViewPoint now allows the user to specify the locations of the calibration stimulus points. Note: the nearest-neighbor grid-lines in the EyeSpace are not automatically draw when this option is used, because the points could be in any configuration. Refer to section 13.8.21

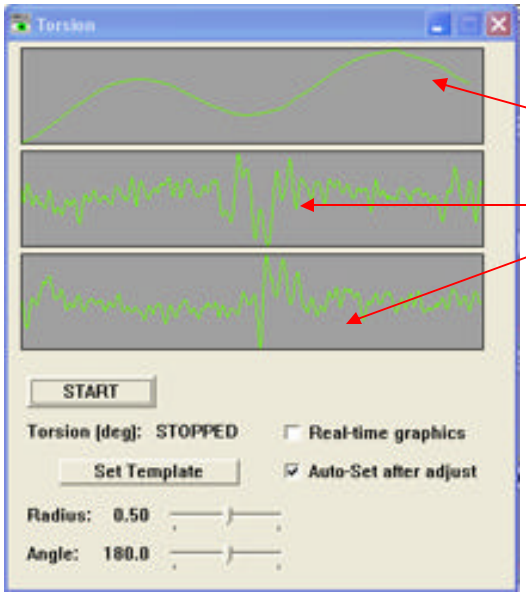
Chapter 7Ocular Torsion

7.1 Introduction to Torsion

Ocular Torsion is the rotation of the eye ball about the line of sight, i.e. rotation about the z-axis. *ViewPoint* measures ocular torsion by determining the rotation of the iris striation patterns. A representative striation pattern *sample* is stored as the *template* (presumably taken when the eye was at zero degrees torsion). Subsequent samples are compared against the template to determine how much rotation has occurred.

To open the Torsion window Select the menu item: Windows > Torsion. The Torsion window is shown in Figure 13: below. To start torsion measurement, press the Start button. When torsion is being calculated, the EyeCamera window will contain additional overlay graphics that indicate the circle along which the iris striations are sampled, as well as the starting point on the circle for the sample array. These additional overly graphics are shown in Figure 14: below.

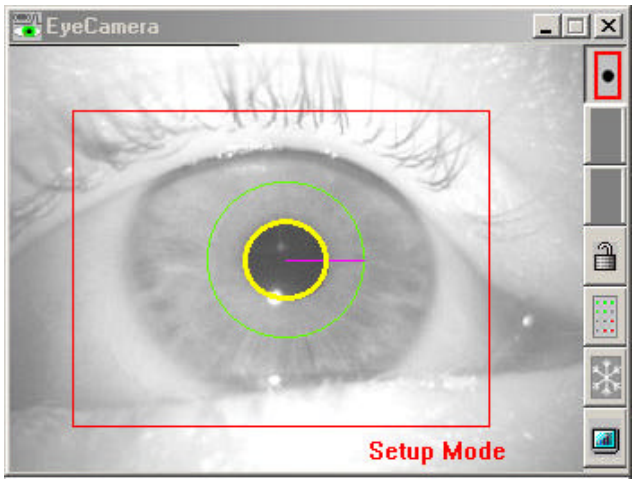
Figure 13: Torsion Window



Graphic well descriptions:

- Correlation between the current sample (middle graph) and the template (bottom graph).
- Current sample of iris striations.
- Samples that were stored as the template.

Figure 14: EyeCamera window with Torsion ON



The samples of iris striations are taken along a circle around the pupil. The radius of the sampling circle is adjusted using the Radius slider in the Torsion window. The user should adjust the radius to a location where there is good variation in the iris. Regularly periodic variation of the iris striations, as like a sine wave, does not allow identification of rotation beyond the period of oscillation, so an irregular marking is better to track. The location of the sample circle is drawn in the EyeCamera window.

Important: fixation is required for accurate measurement of ocular torsion.

The threshold dots are automatically turned off when using torsion. This is important because the threshold dots are painted in the video image before the torsion sample is taken and this can adversely affect the performance of the torsion calculation.

The amount of calculated torsion in degrees is displayed in the Torsion window, the PenPlot window and stored in the data file

7.2 Procedure for Measuring Torsion

This section describes the procedure for obtaining ocular torsion measurements using *ViewPoint*. It is assumed that the user is familiar with setup and thresholding as described in Chapters 0 and Chapter 5.

1. Select the menu item: Windows > Torsion to display the Torsion window.
2. Ensure Auto-Set After Adjust is checked.
3. Ensure that the subject is in a comfortable position that will allow them to remain still for the duration of the experiment.
4. Press the START button on the Torsion window.

5. Adjust the camera so that the video image of the subject's pupil is in the middle of the EyeCamera window and the iris is in sharp focus.
6. Adjust the brightness and contrast if necessary. Threshold the image.
7. Instruct the subject to fixate at a given point.
8. Using the Radius slider, adjust the size of the sampling circle to a location where there is strong irregular variation in the iris striations.
9. Ensure that the sample area circle does not include specular reflections, the eye lid, and any other non-moving areas of brightness or shadowing.
10. Press the Set Template button, when the subject's eyes are at zero torsion.
11. Collect data as usual.

Notes: When the Real-time graphics check box is checked, the graphics windows are updated with every new field. To reduce the computational burden, uncheck Real-time graphics. This will cause the graphics to be updated every 30th field. This does not affect the real-time data stored in the data file.

7.3 Torsion Demonstration Test

Normally the sample array starts from the 3 O'clock position on the circle and proceeds to sample pixels along the circle in a clock-wise direction. This starting point can be adjusted using the Angle slider. This is shown in the EyeCamera window by a line drawn from the center of the pupil to the point on the edge of the circle where sampling begins. (Shown in Figure 17) This can be used for testing and demonstrating the torsion calculation as follows:

- Uncheck Auto-Set After Adjust.
- Adjust the sample angle using the Angler slider.

As the pattern shifts away from the template pattern, the correlation peak shifts and the torsion calculation changes.

When not performing this demonstration, Auto-Set After Adjust should always be checked, since a new autocorrelation template will be required if the radius of the cirde and angular starting point on the circle is adjusted. The autocorrelation template can also be re-fixed manually at any time by pressing the Set Template button.

7.4 Overriding the Default Torsion Parameters

The default setting is for *ViewPoint* to look for torsion over +/- 9 degrees. Beyond this will cause a "Range Error" to be reported in the Torsion window. The default precision is 0.5 degrees of arc. These defaults are in place as a trade off between range of torsion measured and resolution due to the high computational burden of the calculations performed.

Since the eye does not normaly rotate about the line of sight more then about 9 degrees there is usually no need to perform the auto-corralation past this range, because increasing the range increases the cpu load uneccesaraly. There are some situations in wich this range needs to be increased, such as when the entire head is rotated.

The user may adjust the torsion parameters with settings file commands; however, the user is responsible for testing that the combination they choose will provide valid results. Valid combinations should work up to +/- 20 degrees at 0.5 resolution.

Chapter 8 Stimulus Presentation (Head Fixed)

This section describes stimulus presentation options using the ViewPoint EyeTracker® PC-60 head fixed system which includes HMD module systems.

8.1 General

The eye tracker is integrated with the ability to display stimuli. By selecting menu item: File > Image > Load Image … a stimulus picture (BITMAP file) can be chosen using the standard open file dialog box. The picture will appear in both the GazeSpace window and in the Stimulus window. *ViewPoint*™ assumes that the BITMAP (.bmp) files are stored in the folder named "**Images**" that is located in same folder as the *ViewPoint*™ application program. To override this the full path can be specified in the settings file.

Hint: Make the bitmap image large so to avoid smooth lines being displayed as jagged.

The user has control over how images will be proportioned when they are displayed in the Stimulus window and GazeSpace window. By selecting menu item Viewing Source > Image Shape >:

Actual size: the image will be displayed in the two windows at actual size.

Center**:** the image will be displayed actual size and centered in the windows.

Stretch to Window: the image will be scaled to fit the window.

Stretch isotropically: the image will be stretched equally in all directions, maintaining the original proportions.

Menu item: Viewing Source > Background Color allows the user to change the background color in the Stimulus windows. This is useful to provide "matting" color when the user has selected the image shape to be isotropic and there is is space at the sides of the sides or at the bottom of the image.

8.2 Picture Lists

A list of picture file names may be loaded by using the settings file commands:

`pictureList_Init` and `pictureList_AddName myImageFileName.bmp`

Refer to Chapter 13.4 PictureList for a full list and description of commands.

After being loaded, this list can be randomized and sequentially presented using the following menu commands:

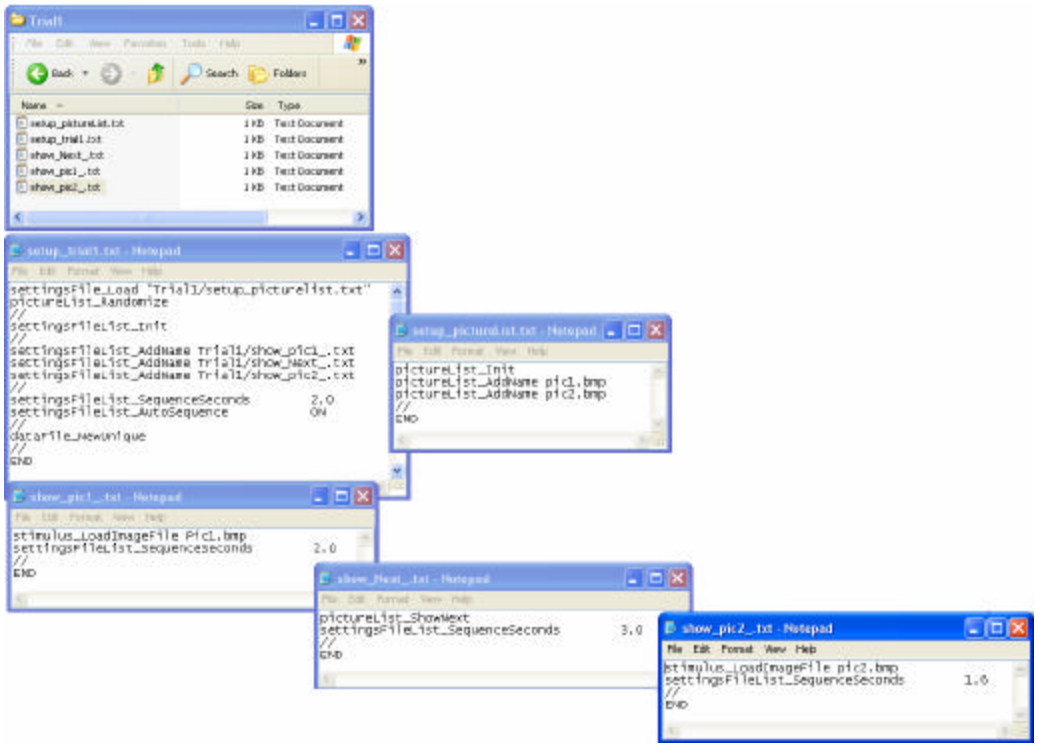
File > Image > Picture List > Next Picture List Image
Presents the next image in the currently setting file list

File > Image > Picture List > Restart PictureList Returns to the top of the currently loaded settings file

File > Image > Picture List > Randomize PictureList Randomizes the list of images in the currently loaded settings file.

The user can create a list of settings files. Each settings file may contain not only commands for displaying picture images, but also for loading unique regions of interest (ROI) for each picture, for playing a cue sound, etc. Figure 15: below demonstrates how settings files can be used very simply to present a series of stimulus images at intervals determined by the user.

Figure 15: Picture List Example



Further examples can be found in the settings folder provided on your *ViewPoint EyeTracker*® software disk.

8.3 Using the Stimulus Window (Head Fixed Option)

The Stimulus window is the window the subject sees. Calibration stimulus points and stimulus images are shown to the subject in this window. It is best when displayed full screen on a second monitor!

Use the Controls window DataDisplay tab to remove or show the stimulus picture image. When unchecked the image is removed and all you see is the plain background color selected by the user.

- Stimuli > Viewing Source > Stimulus Window Properties > Normal Adjustable

Makes the Stimulus Window a resizable, moveable window.

- Stimuli > Viewing Source > Stimulus Window Properties > Custom Static Position
  Sets the Stimulus Window to be a custom size as specified by the currently loaded settings file. This window is not resizable or moveable. This feature is for use with non-standard display cards.
- Stimuli > Viewing Source > Stimulus Window Properties > Monitor 1 (primary)
  Sets the Stimulus Window to be full screen on the primary monitor.
- Stimuli > Viewing Source > Stimulus Window Properties > Monitor 2
  Sets the Stimulus Window to be full screen on the secondary monitor

Note: To use a second monitor you will need to install a second display card into your computer and configure your computer for multiple monitors. Please refer to your computer manual.

- Stimuli > Stimulus Window Properties > AutoShow on calibrate (toggle) automatically shows the Stimulus window and also automatically hides the cursor (only during calibration, re-present or slip correction) when the AutoShow occurs.

8.4 Using the GazeSpaces Window

The GazeSpace window is a miniature representation of the Stimulus window. The experimenter may select from a number of ways to show and view the subject's instantaneous position-of-gaze, using the check boxes on the Controls window as follows:

- Calib Region shows the area within which the calibration is performed.
- Gaze Point shows the subjects position of gaze.
- Trace Lines shows the path of eye movements.
- Fixation Time displays fixation duration through the area of a circle increasing as the duration increases.
- Pupil Size will display a yellow oval corresponding to pupil size at the position of gaze.
- ROI Regions displays the region of interest boxes.
- GeometryGrid to display the GeometryGrid. For GeometryGrid setup details refer to (6.4)
- Raw Data to display the raw, uncalibrated data.
- Picture Image to display the currently loaded stimulus picture image.

Eye movement traces are usually only presented to the experimenter in the GazeSpace window, but they can also be presented to the subject in the Stimulus window. Presentation of gaze information is controlled through the Controls window. Display of eye traces in the Stimulus window is useful during setup and self testing, but is not recommended during normal operation, since they can be very distracting to the subject. The experimenter may select from a number of ways to show and view the subject's instantaneous position-of-gaze.

8.5 Regions of Interest (ROI)

It is possible to specify up to 100 ROI boxes (box numbers 0-99) to simplify the task of data analysis. When the gaze position moves inside a ROI, the ROI box number is displayed in the Status window and stored in the data file record if a data file is open. If the boxes are overlapping and the gaze is inside multiple boxes, then both the Status window and data file will list all "hit" boxes.

To adjust individual ROI, check the Region of Interest radio button on the Controls window: Regions tab. Individual ROI (sometime called discriminator boxes) may be selected by clicking the right mouse button inside the ROI. The selected ROI will be drawn in red and the others in blue. Use the left mouse button to move and resize the selected ROI. Clicking the right mouse outside of any ROI will set the adjustment mode to the locked state. Region boxes can also be made active and locked through the Regions tab on the Controls window. Use the slider to sequence through the RIO. Use the mouse wheel to sequence through and add new ROI. The active ROI coordinates are displayed and updated as you adjust the size and position both in the GazeSpace window bar and the Regions tab. The Revert button in the Controls window Regions tab will undo the last change and the Default button will return the ROI boxes to the start-up setting.

8.6 Data Smoothing

The eye trace lines displayed in the GazeSpace and Stimulus windows can be smoothed to reduce noise. The degree of smoothing of gaze calculation may be varied using the slider on the Controls window (see Figure 9). When placed at the far left, no smoothing is performed. Incrementing the slider to the right increases the number of previous points included in the average calculation. A value of 4 makes attractive and useful real-time graphics. Two smoothing algorithms can be used, in each case the number of back points equals the number set by the user. Refer to Section 10.1.1.

Smoothing effects the real-time calculations. Because smoothing effects the velocity calculations the saccade velocity threshold must be adjusted proportionately. Smoothing will also affect which ROI boxes are triggered.

By default, smoothing does **not** influence the data values that are stored to file, because the real-time smoothing uses a trailing average technique, whereas post hoc data analysis should use a symmetrical smoothing technique. The user can choose to store the smoothed data by selecting menu item File > Data > Store Smoothed Data.

Note: For post-hoc analysis it is preferable to use a symmetric smoothing kernel on unsmoothed data.

8.7 Using the SDK, settings files and Serial Port Interface for Stimulus Presentation

There are two ways to control the *ViewPoint EyeTracker*® from other applications and other computers:

1. Programming functions – handled by the SDK in the DLL
2. Command strings – handled by the Command Line Parser (CLP) in the *ViewPoint* application.

The same CLP is used for command strings received from:

- *Settings* files that are loaded.
- serial port packets of type COMMAND_LINE.
- The SDK using the VPX_SendCommand function.

The SDK is described in Chapter 14, Settings Files in Chapter 11, and the Serial Port Interface in Chapter 12. Chapter 13 lists all of the available ViewPoint features, the GUI control, CLP command and any applicable SD function. There are many features available through CLP commands or SDK functions only.

8.8 Integrating with Third Party Products

The *ViewPoint EyeTracker*® has been integrated with many of third party experiment generation software products. Please contact us for the latest information.

Chapter 9 Data Collection

9.1 Sampling Rate

The *ViewPoint EyeTracker*® includes three modes of operation that provide flexibility in the selection of resolution and sampling rate. Which mode you choose will depend on your research or project requirements. However, you should always calibrate using the High Precision Mode.

- Setup Mode:
  Temporal Resolution: 30Hz
  Internal Processing: 320 x 240
- High Precision Mode:
  Temporal Resolution: 30Hz
  Internal Processing: 640 x 480
- High Speed Mode:
  Temporal Resolution: 60Hz
  Internal Processing: 640 x 240

Menu Item: Video > Mode > * can be used to select the required operating mode. The icon button on the EyeCamera window tool bar can also be used to sequence through the operating modes (SetUp – High Precision – High Speed – SetUp).

9.2 Saving Data to File

The data file will contain information about (x, y) gaze point, elapsed time since the last entry, total time, pupil diameter, and a region of interest box number, etc. Data files are stored in the folder named "**Data**" that is located in same folder as the *ViewPoint* application program.

The default data file extension is ".wks", which allows it to be opened more conveniently under Microsoft Excel or Works spreadsheet packages. Optionally, a named file may be saved as ".txt". In all cases the internal format is tab-delimited text.

To start recording data to file either:

- Select menu item: File > Data > New data file…. This allows the user to open a data capture file, and to specify a file name using the standard *Open File* dialog box. Or,
- Select menu item: File > Data > Unique data file … This opens a new data capture file with a unique file name without having to go through the standard *Open File* dialog box.

File > Data > Pause Data Capture will temporarily stop the recording of data to file while processing continues. Data recording can be continued by toggling this menu item off. This is feature is different to menu item Video > Freeze which stops all processing and recording of data to file. File > Data > Close Data File terminates the writing of data and closes the open file.

9.3 Data File Format

Each line of the data-file is a unique data record. The record entries are tab separated into column positions. The number of columns in the data file will depend on the options selected for data collection. For example, if torsion is not being measured there will be no such column in the data file.

9.3.1 Synchronous vs. Asynchronous data inserts

ViewPoint provides for synchronizing eye movement data with other events and other data. This is usually performed by inserting extra data into the ViewPoint data file. This extra data can include Markers, String, and Head data. These can be inserted in two ways, either (a) on the same line as the eye tracker data (synchronously), which makes reading into spreadsheets much easier, or (b) on separate data lines (asynchronously), interleaved with the eye tracker data, which allows individual time stamps for each inserted item.

Synchronization is achieved through insertion of ASCII character markers into the data stream. By default, menu item File > Data > Asynchronous Marker Data is toggled OFF and data markers will be synchronously added into the data file stream, in the Marker column. If more than one character was inserted, they will appear as a comma separated list of characters. If this menu item is checked ON, ASCII character data markers will be asynchronously inserted into the data file stream as they arrive, with individual time stamps, and there will be no Marker column.

By default, menu item File > Data > Asynchronous String Data is toggled ON and string markers will be asynchronously added into the data file stream with individual time stamps.

The type of record in the data file is specified by the integer that begins each line in column #1. There are seven record types as follows:

1. Tag #10: EyeData containing a variable number of columns depending on the options selected for data collection. Table 3
2. Tag # 2: ASCII Character Marker. If menu item File > Data > Asynchronous Marker Data is checked ON, then single ASCII character event markers will be inserted asynchronously into the data file. Certain ASCII characters are automatically entered into the data stream to indicate a particular event has occurred. The type-2 record contains three entries, as described in Table 4
3. Tag # 12: An ASCII character string asynchronously inserted during certain events. For example, by the CLP in response to certain commands.
   E.g. `"pictureList_ShowNext.", "dataFile_InsertString picture of a cat"`
   from a settings file, or a serial port packet. Table 7:
4. Tag # 3: An ASCII character string generated by *ViewPoint* to provide general information, such as when the data file was created. Refer to Table 6
5. Tag # 5: An ASCII character string generated by *ViewPoint* to provide column heading information. Refer to Table 8.
6. Tag # 6: A 3 character data column identifier generated by *ViewPoint*. Refer to Table 8.
7. Tag # 14: Asynchronously inserted head tracker data.

Note: The user can insert uniquely tagged data from their own sources into a ViewPoint data file using the CLP command DataFile_InsertUserTag. The insertion is done asynchronously with respect to the eye movement data records and the insertions are uniquely time stamped.

Table 3: **DataFile: EyeData Record Structure, Tag = 10**

Column Heading	Type	Description
Record Tag	integer	The value 10 in the first column indicates an eye data record.
TotalTime	float	TotalTime = time elapsed in seconds
DeltaTime	float	dt = delta time in milliseconds since the previous data entry
X_Gaze	float	X = direction of gaze normalized with respect to the x-axis
Y_Gaze	float	Y = direction of gaze normalized with respect to the y-axis
Region	list	Which ROI or ROIs the gaze point is in
PupilWidth	float	Pupil width normalized with respect to the EyeCamera window width
PupilAspect	float	Dimensionless aspect ration of the pupil, i.e. 1.0 is a perfect circle
Quality	integer	Quality of eye movement data. Codes are as follows: 0 glint and pupil both successfully located. (glint-pupil vector method) 1 pupil successfully located. (pupil only method) 2 in glint pupil vector method the glint was not successfully located. Defaults to pupil only method.. 3 pupil exceeded criteria limits set. 4 pupil could not be fit with an ellipse 5 pupil scan threshold failed
Fixation	float	Fixation duration in seconds
Torsion	float	Torsion in degrees. -998 indicates Torsion not being calculated. -999 indicates “Range Error” Only displayed if torsion is being measured.
Count	integer	Eye movement data record count
Mark	char	Any ASCII character, e.g., {a-z, A-Z,0-9,=,#,+,%, etc.} Automatically inserted tags: + Start or resume data collection = Pause data collection

Table 4:	**Asynchronous Marker Record Structure, Tag = 2**	
Column #	Type	Value
1	integer	2 = integer indicates data structure type 2
2	float	Time Stamp
3	character	Any ASCII character, e.g., {a-z, A-Z,0-9,=,#,+,%, etc.} Automatically inserted tags: + Start or resume data collection = Pause data collection

Table 5:	**Asynchronous HeadTracker Data Record Structure, Tag = 14**	
Column #	Type	Value
1	integer	14 = integer indicates data structure type 14
2	float	Time Stamp
3	float	Head position and angle data. With head tracker option only. HPX, HPY, HPZ, HAX, HAY, HAZ

Table 6:	**String Data Record Structure, Tag = 3**	
Column #	Type	Value
1	integer	3 = integer indicates data structure type 3
2	string	An ASCII character string generated by *ViewPoint*

Table 7:	**String Data Record Structure, Tag = 12**	
Column #	Type	Value
1	integer	12 = integer indicates data structure type 12
2	float	Time stamp
3	string	ASCII character string

Table 8: **Column Header Data Record Structure (Tag # 5 and 6)**				
Column #	Type	Value		
1	Integer	5	6	Eye
2 – n	String	Total Time	ATT	Eve A
		Delta Time	ADT	
		X-Gaze	ALX	
		Y-Gaze	ALY	
		ROI	ARI	
		Pupil Width	APW	
		Pupil Aspect	APA	
		Quality	AQU	
		Fixation	AFX	
		Total Time	BTT	Eve B
		Delta Time	BDT	
		X-Gaze	BLX	
		Y-Gaze	BLY	
		ROI	BRI	
		Pupil Width	BPW	
		Pupil Aspect	BPA	
		Quality	BQU	
		Fixation	BFX	Head Tracker Option only
		HPX	X	
		HPY	Y	
		HPZ	Z	
		HAY	Yaw	
		HAX	pitch	
		HAZ	roll	
		Record Count	CNT	
		Marker	MRK	

9.4 Direction-of-gaze Coordinates

The values **X** and **Y** are the coordinates of the direction-of-gaze with respect to the Stimulus window coordinate systems. For example, 0.0, 0.0 will mean that the position of gaze is in the top left hand corner of the Stimulus window; 0.5, 0.5 will mean that the position of gaze is in the center of the Stimulus window; and 1.0, 1.0 means that the position of gaze is in the bottom right hand corner.

It is possible to display the eye-traces in the GazeSpace window as averaged position, that is with data smoothing. Refer to 8.6 Data Smoothing. By default, the smoothing of the data in the GazeSpace window display does **not** influence the XY data values that are stored in the trace-file (but the ROI box numbers are triggered by the smoothed eye traces). However, the user can

choose to store the trailing average smoothed data in the data file using menu item File > Data > Store Smoothed Data.

The calculated (x, y) gaze location is initially in the same space as the calibration point locations. The calculated gaze is then normalized with respect to the x-axis and y-axis respectively. *ViewPoint* allows the GazePoint to be extrapolated outside of the calibration window. This is particularly important for using the CursorControl Feature. (see 6.9 Cursor Control Feature)

9.5 Timing Measurement

The *ViewPoint EyeTracker*® includes high precision timing (HPT) with resolution in the order of 0.0000025, i.e., 2.5E-6 or 2.5 microseconds. The HPT is available to integrators via the SDK function call: `VPX_GetPrecisionDeltaTime` Refer to 13.6 for details.

Total Time is the elapsed time in seconds starting with the first record of data collection. By default Menu item File > Data > Start Data File at Zero is checked (ON) which causes the first record of the data file to start at time zero. If this menu item is unchecked (OFF), the data records will start at the current High Precision Time maintained in the DLL and sharable between applications using the ViewPoint SDK.

The value **Delta Time** is the number of milliseconds since the previous data stream entry. This represents the time that the software has finished processing each frame and the eye movement data is available.

9.6 Region of Interest (ROI)

Often one is only interested in whether the direction-of-gaze is at a specific location, or more generally, which of several possible locations towards which the gaze is directed. Regions of Interest may be defined as described in 8.5. When the calculated (possibly smoothed) gaze position is within one of these boxes, the region number is stored in the data file. The ROIs may overlap and so the gaze can be in more than one region at a time.

- -1 indicates that the position of gaze (POG) is not in any of the regions,
- n indicates that the POG is in region n,
- n,n indicates that the POG is in more than one, overlapping ROI.

9.7 Quality Marker Codes

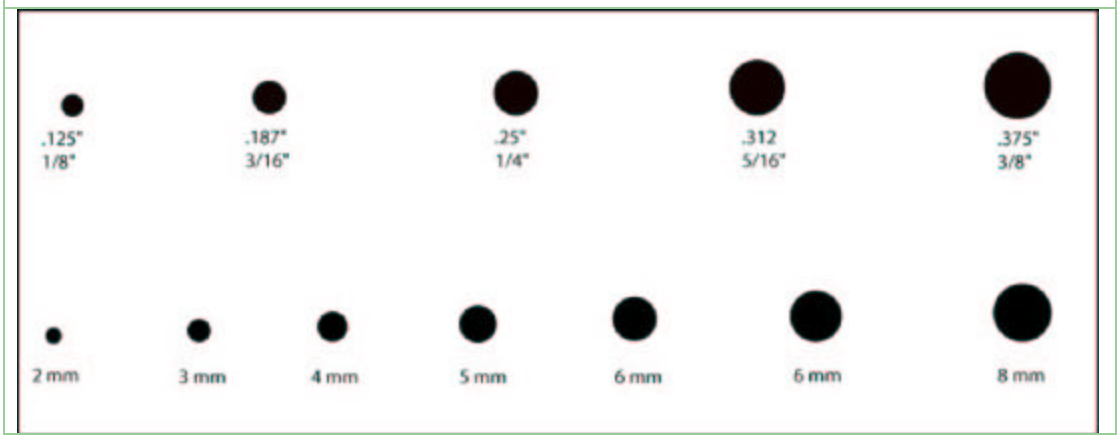
ViewPoint provides a data quality code for each source of recorded data. The Quality column contains an integer code ranging from 0, which is the best possible case, to 5. The hierarchical code structure allows the user to make their own assessment of whether the data is valid or not for their purposes. Quality marker codes are listed below:

Table 9: **Quality Codes**	
Code	Description
0	The user has selected to use the glint-pupil vector method and both features are successfully located.
1	The user has selected to use the pupil only method and the pupil was successfully located
2	The user has selected to use the glint-pupil vector method but the glint was not successfully located. Defaults to pupil only method for data recorded.
3	In either the pupil only or glint-pupil vector method, the pupil exceeded criteria limits set.
4	In either the pupil only or glint-pupil vector method, the pupil could not be fit with an ellipse.
5	In either the pupil only or glint-pupil vector method, the pupil scan threshold failed.

9.8 Pupil Diameter

An oval is fit to the located pupil. Pupil oval width and height is in pixels. Obviously the actual pupil diameter will depend on the camera placementrelative to the eye. Table 10 Artificial Pupil Diameters contains a set of black disks of specific diameters that can be used as "artificial pupils" for determining what actual pupil diameter (in inches or millimeters) the diameter in pixels corresponds to. Pupil diameters usually range between 2mm and 8mm.

Figure 16: Artificial Pupil Diameters



9.9 Pupil Aspect

Blinks can be detected by monitoring the pupil aspect ratio. This is a dimensionless value, where 1.0 indicates a perfect circle.

9.10 Display Screen Geometry

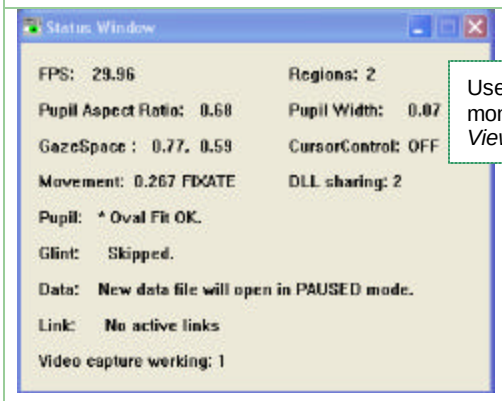
The data file also contains header information that specifies the results of the GeometryGrid calculations for screen size and viewing distance. The screen size values saved will be the values calculated for the entire screen width and height, not the measured lengths of the lines entered by the operator.

Chapter 10 Data Analysis

10.1 Real-Time

The ViewPoint EyeTracker provides many means of monitoring eye movements in real-time including the Pen Plot, GazeSpace and Status windows.

Figure 17: Status and GazeSpace Windows



Use the Status window for real-time monitoring of eye movement data and *ViewPoint* activities.

The GazeSpace window displays eye movements in real-time over the stimulus.

Figure 18: PenPlot Window

The inclusion of a particular penPlot may be toggled via the menu items at: Menu: PenPlots > * . They may also be specified in CLP instructions.

Zoom a particular penPlot by clicking the right mouse button in the penPlot graph well.

B = Blink
F = Fixation
S = Saccade.

For additional PenPlot features refer to Chapter 13.11

Time in seconds with tick marks plus any inserted dataMarker characters at the time point that they were inserted.

10.1.1 Data Smoothing

Data displayed in the Penplot and GazeSpace windows may be smoothed. The user can select the amount of smoothing using the slider on the Controls window DataCriteria tab or with settings files. Two smoothing algorithms can be used, in each case the number of back points

equals the number set by the user:

1. Simple Moving Average (SMA).
   The SMA method uniformly averages N pointsBack, i.e., all points having equal weight.
   SMA(t) = [x(t) + x(t-1) + ... + x(t-n)] / N ; where n = (N-1)
2. Exponential Moving Average (EMA).
   The EMA method uses the following algorithm:
   EMA(t) = (currentValue - EMA(t-1)) * K + EMA(t-1) ; where K = 2 / (pointsBack + 1).

NOTES:

SMA is the default setting.

The data is stored UNSMOOTHED unless specified by the user.

The successfully set method is currently reported in the Event History windowand the Status Window.

10.2 Fixation, Saccade, Drift and Blinks

10.2.1 Velocity Threshold

The Velocity Threshold slider on the Controls window DataCriteria tab provides a qualitative means for discriminating saccades from fixations with noise. Adjustments to this threshold should be done while examining the Total Velocity PenPlotYou can see when the subject is fixating and when they saccade from the spikes in this trace. The value of the spikes is simply the change in 2D position without begin divided by sampling interval time.

Looking at the Penplot when the subject is fixating you can see that the Velocity trace contains noise. (thermal, video noise etc.) If saccades are large then then the placement of the saccade threshold is not so critical. If saccades are small more are should be taken. There is a trade-off in terms of misclassifying noise as a saccade or a small saccade being below threshold.

10.2.2 Fixations

ViewPoint calculates fixation as the length of time that the velocity was below the saccade velocity criterion. Fixation duration is included in the data file as a cumulative value, is displayed as a value in seconds in the Status window, as a ramp function in the Fixation Time pen plot, and the fixation start time is indicated in the Events pen plot well by the letter 'F'. At the request of several customers, we have included the fixation duration value into the data file (in the AFX column). This are the same value as appear in the StatusWindow and is plotted in the PenPlot window in real-time, based on a trailing average smoothing algorithm and the qualitative saccade velocity threshold adjusted by the user (possibly during data collection). It may be preferable to apply a symmetrical smoothing kernel to the un-smoothed data during post-hoc data analysis and to determine the optimal saccade criteria at that time.

The velocity value is simply the difference between the current and the last calculated and smoothed gaze points, i.e., the change in the normalized position of gaze, – hence smoothing will affect the velocity magnitude.

10.2.3 Drift

Note that the eye may be slowly drifting or in a low velocity smooth persuit, such that the velocity is below the saccade velocity criterion. For this reason we also provide a drift criterion that establishes the maximum distance that the gaze point may move away from the putative fixation point. That is, we impose the additional criterion that the position of gaze must remain within a certain distance of the initial fixation point (or the previous drift point). Fixation drift is in normalized screen coordinates as the calculated position of gaze.

```
GUI: Controls window : DataCriteria tab : Drift Allowed slider
CLP: driftCriterion normalValue
```

The absolute drift distance and the specified Drift criterion level can be visualized in the Drift penPlot well as the letter 'D'.

```
GUI: menu Windows > PenPlots > Drift
CLP: penPlot +DRIFT
```

10.2.4 Blinks

As the eye lid comes down during a blink, the elliptical fit to the pupil becomes increasingly flat before it disappears. This characteristic change in the aspect ratio of elliptical fit to the pupil can be used to detect blinks. A blink is classified as the pupil aspect ratio crossing below the threshold.

10.2.5 Events

Fixation, Saccade, Drift and Blink events are displayed in the Events penplot graphics well as the following characters:

F – fixation

B – blink

S – saccade

D – drift

10.2.6 SDK

The real time values for all data points are available via the DLL based SDK.

10.3 Post-Hoc

The data file format is described in Chapter 9.

We also provide a basic data analysis program that allows displaying data in both a time plot and a 2D (x,y) plane overlayed on the visual stimulus. The DataAnalysis program can be launched by itself from the folder or it can be launched when the data file is closed.

Menu: File > Data > Close & Analyze Data File

CLP: dataFile_CloseAndAnalyze

Chapter 11 Using Settings Files

The user can store information about the current control and menu selections in special *Settings* files. Settings files contain information about program control panel settings, calibration values, region of interest box specifications and other program variables. *ViewPoint EyeTracker®* assumes that the *Settings* files are stored in the folder named "Settings" that is located in same folder as the *ViewPoint EyeTracker®* application program.

The *Settings* files are in tab delimited ASCII format. Settings files can be saved and loaded using menu selections, as described in 10.1 Saving and Loading Settings Files.

The *Settings* file consists of individual lines of ASCII text that may be edited using an editor. The document must however (a) be saved as text only (b) have each command separated by a semi colon, and (c) conform accurately to spelling and spacing requirements. An editor with good tab setting capabilities is recommended because the row entries are tab separated. The default settings file extension is .txt which helps exclude unusable files that contain extra formatting, such as rich text format (rtf) and Microsoft Word format files. Use menu item File > Settings > Edit Settings to select an existing settings file to edit.

Do not modify anything that you do not understand.

Important Notice: these commands (names and argument lists) may not be consistent with the Macintosh ViewPoint settings, and they are subject to changes in future versions. Note: The strings are not case sensitive.

Settings Files may be nested (i.e. one Settings file may call another Settings file, see: `settingsFile_Load`). Consequently, it is desirable for each file to be reasonable in length. Currently the Settings file is limited to 800 lines, including comment lines. Note however that the same settings file cannot be called recursively. *Example settings files are contained in the Settings folder on the ViewPoint EyeTracker® disk supplied with your system.*

11.1 CLP String Parsing

All white spaces are gobbled up until either the beginning of a string is specified by either a non-white space character, or a beginning quote is encountered. The string is read until the end of line; a closing quote is neither expected nor will it be stripped off. This may change in the future. Inline comments can be used.

11.2 Saving and Loading Settings Files

File > Settings > Load Settings
allows the user to read in the settings, using the standard open file dialog box.

File > Settings > Save Settings…
allows the user to store the current Settings to file, using the standard open file dialog box.

File > Settings > Verbose Loading
causes additional information from the CLP to be displayed in the Event History

window.

11.3 Pre-load Settings in a Startup file

When *ViewPoint EyeTracker*® is launched it loads in the content of the file `startup.txt` that is located in the folder named “Settings”. This can be used to load regularly used settings to reduce setup time.

11.4 Settings/LastRun.txt

ViewPoint automatically creates the settings file `Settings/LastRun.txt` upon quitting. The user may reload these manually at any time, or the user may edit the "`Settings/Startup.txt`" file to include the following command that will automatically load the previous settings whenever ViewPoint is restarted: **`settingsFile_Load LastRun.txt`**

11.5 Settings File Lists

A Settings File list to be sequenced through may be set up using the CLP command **settingsFileList_Init** and controlled using menu item File > Settings File > SettingsFileList. Refer to 13.16 SettingsFileList commands.

11.6 SettingsFile Examples

It is often a good idea to create individual settings files for different groups of related commands, and then call that settingsFile from a main settingsFile.

Example 1: create individual settingsFiles that contain the name of a bitmap image and the ROIs for that image.

File: imageAndRoi_1.txt

```
stimulus_LoadImageFile  picture1.bmp
setROI_RealRect  1  0.1  0.1  0.3  0.2
setROI_RealRect  2  0.4  0.4  0.5  0.5
```

File: imageAndRoi_2.txt

```
stimulus_LoadImageFile  picture2.bmp
setROI_RealRect  1  0.6  0.1  0.9  0.2
setROI_RealRect  2  0.4  0.7  0.5  0.9
```

File: startup.txt

```
settingsFile_Load  imageAndRoi_1.txt
```

Example 2: create individual settingsFiles that set the FKEY commands for a particular task

File: fkeysForCalibration.txt

```
fkey_cmd   9   calibration_selectPrevious
```

```
fkey_cmd   10   calibration_Snap
fkey_cmd   11   calibration_ selectNext
```

11.7 CLP Commands

The same Command Line Parser (CLP) is used for command strings received from:

- *Settings* files that are loaded.
- Serial port packets of type COMMAND_LINE.
- The SDK using the VPX_SendCommand function.

The total command line length should not exceed 255 characters. See ChapterChapter 11 for details about using CLP commands.

11.8 Associating CLP Commands with FKeys

CLP commands can be associated with FKeys. These associations can be viewed in the Info panel: menu Help > Info > **ShortCuts** tab. Refer to 13.23.1

Chapter 12 Serial Port Communication

ViewPoint™ provides real-time communication with other computers via a serial interface. This data includes (x, y) position, region of interest box numbers, pupil size, and timing data, calibration point locations and events, window discriminator box location changes, etc., as described in Chapter 9

For a matrix comparing CLP commands, SDK functions window buttons, and menu items refer to the Command and Control Matrix contained in the SDK folder on the *ViewPoint* disk.

12.1 Getting Started

Make sure that you are using a cable that is designed to connect two computers together (cross-over cable), rather than a computer and an external device. This is a cable that switches the send and receive wires so that the send from one computer goes to the receive of the other computer. (not straight through)

You may want to write your own interface program that uses the serial information, but to get started, you can test serial data transfer by using a copy of the *ViewPoint*™ program on the receiving computer. Select menu item Interface > and ensure that the correct port (the one your serial cable is plugged into) is selected and the baud rate matches that selected on the interfacing application. Data bits "8", parity "None" and Stop Bits "1" are a standard configuration and should be changed only if required to match those of the interfacing application. In general make sure that all flow control options are checked.

ViewPoint does not by default, monopolize the serial port, so it is necessary to connect to the serial port by selecting menu item Interface > Serial Port > Connection Settings. This will also open the Serial Receiver window which will display information sent from another ViewPoint application. After you have finished with it you should disconnect so that other applications can use the serial port. If the selected port is in use by another device, an error box will be displayed.

12.2 Sending Real and Test Data

To transfer real-time eye data, select Interface > Serial Port > Send Streaming Data.

The menu item Interface > Serial Port > Send Test Pattern will send artificial position-of-gaze information, and other information, that forms a geometric pattern, which can help in testing and demonstrating the serial communication feature.

Menu Item Interface > Serial Port > Send Events Only if toggled ON will send serial port data only when there is a significant event. Significant events are specified as:

1. a saccade or fixation
2. an entry or exit from any of the first 10 ROI.
3. Drift

Use the CLP command `EventFilterOptions` to control what constitutes an event.

```
eventFilterOptions  +saccade +roi -drift
```

Menu Item Interface > Serial Port > Send Single Packet if toggled ON will send a single packet of serial data.

Note: These can be controlled from the remote computer if eye data is only needed occasionally.

12.3 Transfer to Intel and Macintosh Machines

ViewPoint uses **Big Endian** data storage (also called **Network-Endian** because it is the standard for the internet). A Big Endian machine stores the hexadecimal value 0x1234 as (0x12 0x34), while a Little Endian machine stores the same value as (0x34 0x12).

You are all set if you are receiving the data packets on an Apple™ Macintosh™ computer, , because Big Endian is the native data storage format for this host. This is true for both the traditional Motorola™ and the newer IBM™ processor machines.

If you are receiving the data packets on a Windows™ PC using an Intel™ processor, then you will need to swap the two bytes composing the unsigned short integers (UINT16), because Intel machines use Little Endian data storage.

12.4 Connections

Newer Macintosh models (eg. G4 and PowerBook) do not have external serial ports, but instead have USB ports and FireWire ports. Serial data can nevertheless still be sent by using a 3rd party USB-to-Serial adapter (e.g. *KeySpan*™, *Belkin* Model Number F5U103-MAC) or by using an add-on PCI card with a serial port.

12.5 Serial Protocol

It is necessary to match the serial port settings of the received program to those of the sender program.

Table 10: **ViewPoint Default Serial Port Settings**

Setting	Value
Baud rate	56K (57,600)
Data bits	8
Parity bits	0 (no parity)
Stop bits	1 (one stop bit)

12.6 Serial Packet Header Structure

Note carefully that V uses a **packet** scheme to transfer data. This means that the bytes are

not ascii data and **should not be displayed using a terminal emulator program**.

The serial information is sent in bytes without any intrinsic word alignment. A delayed, dropped or corrupted byte can cause misalignment of multi-byte information, such as integers. Consequently, it is desirable to verify that a byte sequence starts with a valid Packet Header before reading in what is assumed to be data. The Packet Header consists of four bytes as follows:

Table 11: **Serial Packet Header Contents**

Setting	Type	Value
1	byte	Synchronization Byte-1, corresponds to ascii char 'V', decimal 86 (hex 0x56)
2	byte	Synchronization Byte-2, corresponds to ascii char 'P', decimal 80 (hex 0x50)
3	byte	SerialTag Byte, numerical value indicates the type of packet that follows.
4	byte	PacketSize Byte, numerical value is the number of bytes in the packet body.

The receiver program should verify that the first byte is the character 'V' and that the second byte is the character 'P', indicating that the data is from the *ViewPoint*™ program.

12.7 Serial Packet Data Structures

There are several types of packets that contain different types of information.

Table 12: **Packet Types**

Direction	Packet Data Structure, Header SerialTag Name	Header SerialTag Value	Information Description
OUT	Calibration_PacketType CALIBRATION_SerialTag	4	Info. For remote presentation of calibration points. Generated by: *Various stages of calibration.
OUT	EyeData_PacketType EYEDATA_29_SerialTag	10	Eye data
IN	ASCII string data COMMAND_ SerialTag	11	An ASCII string that is sent to the Settings Command Line Parser
IN	ASCII string data DATAFILE_INSERT_ SerialTag	12	Immediately inserts the packet string into the data
IN / OUT	Variable length timeStamp data PING_SerialTag	13	IN: immediately returns identical copy of the timeStamp data packet in a PONG packet. Generated during the serial send

			test pattern.
IN / OUT	Variable length timeStamp data PONG_PacketType	14	IN: reports the round trip time in EventHistory. Generated in response to a PING packet with an exact copy of the timeStamp data.

IN Packet Types are received by *ViewPoint*

OUT Packet Types are generated by *ViewPoint*

12.8 Data Value Encoding

All location information, for position of gaze, calibration point locations, etc., is normalized and multiplied by 10,000 before being sent as a two byte integer (i.e., an unsigned short) that we will denote as **UINT16**. Thus all locations are stored in the range of 0 to 10,000.

```
#define Fract2Int 10000.0

#define Int2Fract ( 1.0 / Fract2Int )
```

To reclaim the normalized floating point location value simply divide the value by 10000.0, For example:

```
EyeData_PacketType dat ;
dat.gx = (UINT16)( normalXpos * Fract2Int ) ;
…
if (MotorolaMachine) {
    normalxpos = dat.gx * Int2Fract;
    normalypos = dat.gy * Int2Fract;
}
elseif (IntelMachine) {
    normalxpos = BigToLittleEndian (dat.gx) * Int2Fract;
    normalypos = BigToLittleEndian (dat.gy) * Int2Fract;
}
windowXpos = normalXpos * windowWidth ;
```

12.9 Packet Data Structures

```
typedef enum
{
    HEAD_CalEpoch, // Never sent
    START_CalEpoch,// open full screen calibration window
    SHOW_CalEpoch, // show calibration stimulus point
    CLICK_CalEpoch, // show that point is registered, e.g. change color
    HIDE_CalEpoch,// hide calibration point
    STOP_CalEpoch,// close full screen calibration window
    TAIL_CalEpoch // Never sent
} CalibrationEpochType ;

typedef struct     //  CALIBRATION_SerialTag == 4
{
    UINT16 epochCode ;// type cast with (CalibrationEpochType)
    UINT16 pointIndex ;// calibration point index
    UINT16 cx ;// scaled X location of calibration point
```

```
    UINT16 cy ; // scaled Y location of calibration point
} Calibration_PacketType;

typedef struct     //  EYEDATA_29_SerialTag == 10
{
    UINT16 gx ;// scaled X position of gaze in range [0…10,000]
    UINT16 gy ;// scaled Y position of gaze in range [0…10,000]
    UINT16 dt ;// delta time in milliseconds since last eye data packet
    UINT16 bx ;// window discriminator box code
    UINT16 px ;// pupil width scaled 1 – 10000 normalized with respect to the EyeCamera
window
    UINT16 py ;// pupil height scaled 1 – 10000 normalized with respect to the EyeCamera
window
    UINT16 ct ;// cyclotorsion in minutes (degrees * 60)
    UINT16 ik ;// index of eye data packet
} EyeData_PacketType;
```

12.10 Example Serial Port Code

```
#define  DataFile_InsertMarker_SerialTag  2
#define  EventHistoryString_SerialTag     3
#define  COMMAND_LINE_SerialTag      11
#define  DataFile_InsertString_SerialTag 12


/*-------------------------------------------------------------------------------
/ serialSend_Command
/-------------------------------------------------------------------------------*/
void serialSend_CommandLine ( CSTR cstr )
{
    if ( haveSerialPort ) {
        serialOutputDataBytes( COMMAND_LINE_SerialTag, cstr, strlen(cstr) ) ;
    }
}


/*-------------------------------------------------------------------------------
/ serialSend_DataFileInsert
/-------------------------------------------------------------------------------*/
void serialSend_DataFileInsert ( CSTR cstr )
{
    if ( haveSerialPort ) {
        serialOutputDataBytes( DATAFILE_INSERT_SerialTag, cstr, strlen(cstr) );
    }
}



/*-------------------------------------------------------------------------------
/ serialOutputDataBytes
/-------------------------------------------------------------------------------*/
#define HeaderLength 4
void serialOutputDataBytes( SerialCodeType packetType, char data[], int packetBytes )
{
    char header[ HeaderLength ] = { 'V', 'P', '0', '0' };
    header[0] = 'V' ;
    header[1] = 'P' ;
    header[2] = (char)( packetType ) ;
    header[3] = (char)( packetBytes ) ;
    write( serialPort, (Ptr)&(header[0]), HeaderLength ); // Send HEADER information
    write( serialPort, (Ptr)&(data[0]), packetBytes ); // Send DATA information
    flush( serialPort );

}



/*-----------------------------------------------
/   SerialSend_DataFile_InsertMarker( 'K' );
```

```
/-------------------------------------------------*/
SerialSend_DataFile_InsertMarker( char theMarkerChar )
{
    BYTE buffer [ 5 ] ;
    BYTE markerPacketTag = 2 ;
    BYTE numberOfBytesInThePacketBody = 1 ;
    // Construct PACKET HEADER
    buffer[0] = (BYTE)( 'V' ) ; // the ascii capital character V
    buffer[1] = (BYTE)( 'P' ) ; // the ascii capital character P
    buffer[2] = markerPacketTag ;
    buffer[3] = numberOfBytesInThePacketBody ;
    // Construct PACKET BODY
    buffer[4] = (BYTE)( theMarkerChar ) ;
    // Send entire packet in one chunk for efficiency.
    write( serialPort, &buffer, sizeof(buffer) );
    flush( serialPort );
}


serialSend_CommandLine ( "velocityThreshold 0.8" );
serialSend_CommandLine ( "dataFile_NewUnique" );
serialSend_DataFileInsert ( "This is an insert string from remote computer " );
serialSend_DataFileInsert ( "Remote tab data:\t0.0\t9.1\t8.2\t7.3" );
serialSend_CommandLine ( "dataFile_Pause" )
```

Chapter 13 ViewPoint Interface: GUI, SDK, CLP

13.1 General

This Chapter provides a description of each GUI controls and the equivalent CLP commands and SDK functions.

There are several ways to interact with the *ViewPoint EyeTracker*®. The most apparent way is by using the graphical user interface (GUI) that consists of menu items, sliders, buttons, etc. Each of the GUI controls has a corresponding command line parser (CLP) string. The GUI control values can be saved in a Settings file that consistes of the CLP strings (keyTerms and parameters), so control values can be easily loaded at any time. The CLP strings can also be sent from other programs, either on the same machine, or from another computer. The software developer's kit (SDK) includes a routine that allows other programs to send the CLP strings as well as providing access to data and other information.

13.1.1 VPX_SendCommand(clpStr) replaces VPX_Set*

Previous versions of ViewPoint provided individual SDK functions to set contols (VPX_Set* commands), such that there were equivalent GUI, SDK, and CLP instructions. With the introduction of the SDK function VPX_SendCommand(string), the need for equivalent SDK functions was largely obviated. In general, no new SDK VPX_Set* functions are being added and the old ones are considered an unnecessary duplication and are therefore being deprecated. **Future versions of ViewPoint may not support the VPX_Set* functions if there is an equivalent CLP command string that can be sent.** The deprecated SDK functions are printed in light gray.

13.1.2 VPX_SendCommand & formatted strings

The VPX_SendCommand function includes a va_list mechanism to handle formatted text. This means that it accept both simple string arguments and also strings with formatting instructions followed by additional arguments, just like the C language printf and scanf functions. This is extremely convenient for C programming, however, some third party applications (such as Matlab) do not provide an interface that handles va_lists. To accommodate these we include the VPX_SendCommandString function that takes only simple string arguments.

With formatted strings we can simply write:

```
VPX_SendCommand( "stimulus_BackgroundColor %d %d %d", r, g, b ); // formatted
```

Without formatted strings we must write:

```
char str[255];
sprintf( str, "stimulus_BackgroundColor %d %d %d", r, g, b );
VPX_SendCommandString( str ); // formatted
```

The programmer should use a precompiler conditional found inside the header file VPX.h.

```
#ifdef _IMPORTING_INTO_MATLAB
   #define  VPX_SendCommand   VPX_SendCommandString
```

```
#else
    VPX_DECLSPEC int VPX_SendCommand( TCHAR * szFormat, ...);
#endif
```

13.1.3 Quoting strings with white spaces

File names that contain spaces (e.g.: “My New File .txt”) must be put inside double quotes. In a settings file this is very straight forward and readable:

```
dataFile_NewName “ C:\VP\Data Files\Exp 6\subj 2.wks\”
```

However when specified withing a formatted string, the programmer must remember to escape the quote characters inside the command string, that is, preceed the quote character with a back slash (e.g.: \”), as seen here:

```
VPX_SendCommand( “dataFile_NewName \”%s\”  “, dataFileName );
VPX_SendCommand( “dataFile_InsertString \“ Showing picture of a cat. \”  “);
```

File names cannot begin with a white space. All white spaces are gobbled up until either the beginning of a string is specified by either a non-white space character, or a beginning quote is encountered.

13.1.4 Case insensitive CLP strings

The CLP command strings are generally presented starting with lower case and then capitalizing the first letter of successive words, however the parser does not care about the case of the command strings, so you do not need to worry about this as a source of error.

13.1.5 Boolean Toggle

As of version 2.8.2 all CLP commands that accept BoolValue arguments (e.g.: True, False, On, Off) can now also accept the argument “Toggle”, e.g., “dataFile_Pause Toggle”, that changes from the current state to the opposite state.

13.1.6 SDK return values

All SDK functions return the integer value 1 unless otherwise specified. Check the SDK header file, VPX.h, for final authority; changes may appear there before the documentation can be updated.

13.2 Data Files

13.2.1 Open Data File with Randomly Generated Name

GUI:	**File > Data > Unique Data File**	**^U**
CLP Command:	**dataFile_NewUnique**	
SDK Function:	VPX_DataFile_NewUnique();	

Opens a new data file with a unique new name without going through the "Save As" window. The data line in the Status window shows the data file name (default is a random number).

By default data files are stored in the "Data" folder that is located in same folder as the ViewPoint application program. However this default can be overridden with the setPath command.

See also:
setPath
dataFile_NewUniqueExtension

See 9.3 Data File Format for a description of the format of the data file.

```
VPX_SendCommand( "dataFile_NewUnique" );
VPX_DataFile_NewUnique();
```

13.2.2 Specify Data File Extension

GUI:	**-none**
CLP Command:	**dataFile_NewUniqueExtension *fileExtensionString***
SDK Function:	-none-
Default:	.txt

Specifies the file type extension that is appended when performing the dataFile_NewUnique operation. This specification does *not* affect the format of the data inside the file. This specification does *not* affect the dataFile_NewName command.

A dot should be included for this to correctly specify a file type, e.g. ".wks", ".txt", ".doc". The file extension ".wks", will usually cause the data file to be opened directly by *Microsoft Excel* or *Microsoft Works* spreadsheet packages.

See section: 13.1.3 Quoting strings with white spaces

HINT: You can use the extension string to append a group name, e.g., "_drug_C_.wks" or "_MondayData.txt",

v.2.8.1.12 CLP added.

```
dataFile_NewUniqueExtension  " drug group X .xls"
VPX_SendCommand( "dataFile_NewUniqueExtension  .txt " );
VPX_SendCommand( "dataFile_NewUniqueExtension  \" patient_%d .txt\"  ", pid );
```

13.2.3 Open a Data File and Specify a File Name

GUI: **File > Data > New Data File ...** **^N**

CLP Command: **dataFile_NewName** ***fileNameString***

SDK Function: -none-

Opens a new data file with a specified name. The GUI Menu selection allows the user to specify the file name through the "New ViewPoint Data File" dialog.

Any file type extension must be included in the string.

The `dataFile_NewUniqueExtension specification` does *not* affect this command.

See section: 13.1.3 Quoting strings with white spaces

The Data line in the Status window reports the current state of data recording.

```
VPX_SendCommand( "dataFile_NewName  myData.txt" );
VPX_SendCommand( "dataFile_NewName \" C:\VP\Data Files\Exp 6\subj 2.wks\"  ");
VPX_SendCommand( "dataFile_NewName \"%s\"  ", dataFileName );
```

13.2.4 Insert a String into the Data File

GUI: **-none-**

CLP Command: **dataFile_InsertString** ***string***

SDK Function: -none-

Inserts the string into the data file. The string must be inside quotes if it contains white spaces; in C programs the quote characters inside the command string must be escaped with backslashes.

See section: 13.1.3 Quoting strings with white spaces

The string can either inserted synchronously, i.e., at the end of the next data line (record), or asynchronously, i.e., on a separate line, depending upon the specification of **dataFile_AsynchStringData**

When called more frequently than data is saved, and the data **File_AsynchStringData** is set to false, then the strings are concatenated. The string separator is the tab character.

See also:

dataFile_InsertMarker

dataFile_AsynchStringData

```
VPX_SendCommand( "dataFile_InsertString  showingPictureOfCat" );
VPX_SendCommand( "dataFile_InsertString \" Showing picture of a cat. \"  ");
VPX_SendCommand( "dataFile_InsertString  \"%s\"  ", userString );
```

13.2.5 Insert a Marker into the Data File

GUI: **-none-**

CLP Command: **dataFile_InsertMarker** ***DataMarker***

DataMarker: **Any single byte ascii character.**

SDK Function: **VPX_DataFile_InsertMarker (*DataMarker*);**

Insert the specified ASCII character into the data file. This can be used for data synchronization coding, or patient responses, etc.

The string can either inserted synchronously, i.e., at the end of the next data line (record), or asynchronously, i.e., on a separate line, depending upon the specification of "`dataFile_AsynchMarkerData Yes`"

Where exaxt timing of the markers is critical, you may achieve better performance using the specific SDK function directly, rather than sending the CLP command string that must first be processed by the parser.

Try the program **~/ViewPoint/ExtraApps/`DataMarker.exe`** provides an easy way to manually insert markers into the data file in real-time.

Note:

Currently, non-printable ascii characters are not filtered out, so be careful if you specify such characters as: tab, bell, backspace, line-feed, etc.

See also:

dataFile_InsertString

dataFile_AsynchMarkerData

```
dataFile_InsertMarker K
VPX_SendCommand (“dataFile_InsertMarker K “)
VPX_SendCommand (“dataFile_InsertMarker %c “, theMarker )
VPX_DataFile_InsertMarker(‘K’)
```

13.2.6 Insert a User Defined Data Tag into the Data File

GUI: -none-

CLP Command: **dataFile_InsertUserTag** ***UserTag***

SDK Function: -none-

This allows users to insert uniquely tagged data from their own sources into a data file. The insertion is done asynchronously with respect to the eye movement data records and the insertions are uniquely time stamped.

See: Section 9.3.1 Synchronous vs. Asynchronous data inserts on page 49.

See also:

dataFile_InsertString

```
dataFile_InsertUserTag 800 "MyUserData 1 A 0.888"
VPX_SendCommand("dataFile_InsertUserTag 800 \"MyUserData\t%d\t%d\" ", ix, ix*ix
)
```

13.2.7 Specify whether to asynchronously or synchronously insert string data

GUI:	**File > Data > Asynchronous String Data**
CLP Command:	**dataFile_AsynchStringData** ***BoolValue*** ***BoolValue:*** **Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	- none -
Default:	**Yes**

Specifies whether to insert strings data asynchronously or synchronously into the data file.

Synchronously means that this data is appended to the same line as the normal eye tracker data. This string data will be treated as muli-column data by using tab-characters as column separators. Synchronous data is usually easier to load into spread sheets or other analysis packages. If several Strings are inserted between eye tracker samples, the Strings will all be concatenated. If this control is set to Yes (i.e., Asynchronous), then each String is separately time stamped and inserted on a data line by itself.

See: Section 9.3.1 Synchronous vs. Asynchronous data inserts on page 49.

See also:
dataFile_InsertString

```
VPX_SendCommand( “datafile_ AsynchStringData No” );
```

13.2.8 Specify whether to asynchronously or synchronously insert markers

GUI:	**File > Data > Asynchronous Marker Data**
CLP Command:	**dataFile_AsynchMarkerData** ***BoolValue*** ***BoolValue:*** **Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	- none -
Default Setting:	**No**

Specifies whether to insert data markers asynchronously or synchronously into the data file.

Synchronously means that this data is on the same line as the normal eye tracker data, in a separate column, which is usually easier to load into spread sheets or other analysis packages. If several Markers are inserted between eye tracker samples, the Markers will all be displayed together and more precise Marker time information is lost. If this control is set to Yes (i.e., Asynchronous), then each Marker event is separately time stamped and inserted on a data line by itself.

See: Section 9.3.1 Synchronous vs. Asynchronous data inserts on page 49.

See also:
dataFile_InsertMarker

```
VPX_SendCommand( “datafile_AsynchMarkerData Yes” );
```

13.2.9 Specify whether to asynchronously or synchronously insert head tracker data

GUI: **File > Data > Asynchronous Head Tracker Data**

CLP Command: **dataFile_AsynchHeadData** ***BoolValue***
***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**

SDK Function: -none-

Default: **Yes**

Available only with head tracker option

Specifies whether to insert head tracker data asynchronously or synchronously into the data file.

See: Section 9.3.1 Synchronous vs. Asynchronous data inserts on page 49.

See also:
headTrackerConnect

```
VPX_SendCommand( “dataFile_AsynchHeadData yes" );
```

13.2.10 Specify data file start time

GUI: **File > Data > Start Data File Time at Zero**

CLP Command: **dataFile_startFileTimeAtZero** ***BoolValue***
***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**

SDK Function: -none-

Default Setting: **Yes**

Specifies whether to start each new data file at time=0. Otherwise, the data-file will use the time from the DLL, so the time values in each sequential data file will be increasing and represent actual elapsed time. The DLL time starts at zero when the DLL is launced, which is when the first program that accesses it is launched. Turning this off may be useful to keep track of fatigue factors or the duration of rest periods. It is may also be useful because other programs that use the DLL time will have the same time values, which can aid in post-hoc synchronization of events.

See also:
VPX_GetPrecisionDeltaTime

```
VPX_SendCommand( “datafile_StartFileTimeAtzero No” );
```

13.2.11 Store smoothed or unsmoothed data

GUI:	**File > Data > Store Smoothed Data**
CLP Command:	**dataFile_StoreSmoothedData** ***BoolValue*** ***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	- none -
Default:	**No**

Specifies whether to store the trailing average smoothed data using the number of smoothing points specified by the Smoothing Points Slider on the Controls window. The eye trace lines displayed in the GazeSpace and Stimulus windows can be smoothed to reduce noise. The degree of smoothing of gaze calculation may be varied using the slider on the Controls window (see figure 9). When placed at the far left, no smoothing is performed. Incrementing the slider to the right increases the number of previous points included in the average calculation. A value of 4 makes attractive and useful real-time graphics. Smoothing effects the real time calculations. Because smoothing effects the velocity calculations the saccade velocity threshold must be adjusted proportionately. Smoothing will also affect which ROI boxes are triggered By default, smoothing does NOT influence the data values that are stored to file, because the real-time smoothing uses a trailing average technique, whereas post hoc data analysis should use a symmetrical smoothing technique.

See also:
smoothingPoints, smoothingMethod

```
VPX_SendCommand( “datafile_StoreSmoothedData Yes” );
```

13.2.12 Specify whether to use buffering (DEPRECATED)

GUI:	**-removed-**
CLP Command:	**dataFile_UseBuffering** ***BoolValue*** ***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	`VPX_DataFile_Buffering( bool tf );`
Default:	**Yes**

DEPRECATED

Allows selection between (Yes) buffer the data in RAM before saving to disk, or (NO) immediately write to disk each data record. Because previous versions MSWindows were quite unstable, many users preferred to turn buffering off, so that data was not lost in the event of a system or program crash; this did however sometimes incur a slower sampling rate. In general this is neither required nor recommended with most newer operating systems.

```
VPX_SendCommand( “dataFile_UseBuffering  No” );
VPX_DataFile_Buffering( false );
```

13.2.13 Pause writing of data to file

GUI: **File > Data > Pause Data Capture (toggle)** **^P**

CLP Command: **dataFile_Pause**
dataFile_Resume
No arguments.

SDK Function: `VPX_DataFile_Pause( bool tf );`

Pauses the writing of data to an open data file. Inserts a "+" marker into the data file when paused and inserts a "=" marker at time resumed. Because of the MSWindows overhead for opening and closing files, the user may prefer pausing and resuming to opening and closing. Also, pause may be set before the file is opened, such that the overhead delays for opening the file are finished before the start of the experiment. The Data line in the Status window reports the current state of data recording.

```
VPX_SendCommand("dataFile_Pause" );
VPX_SendCommand("dataFile_Resume" );
VPX_DataFile_Pause(TRUE);
```

13.2.14 Close Data File

GUI: **File > Data > Close Data File** **^W**

CLP Command: **dataFile_Close**

SDK Function: `VPX_DataFile_Close();`

Closes a data file if one is open, regardless of Pause state.

The Data line in the Status window reports the current state of data recording.

See also:
dataFile_CloseAndAnalyze

```
VPX_SendCommand("dataFile_Close" );
VPX_DataFile_Close();
```

13.2.15 Close Data File and Open in Post-Hoc Analysis tool

GUI: **File > Data > Close & Analyze Data File** **Alt-Shift-W**

CLP Command: **dataFile_CloseAndAnalyze**

SDK Function: -none-

Closes a data file if one is open, regardless of Pause state, and automatically launches the ***ViewPoint DataAnalysis ™*** with the data file loaded in.

The Data line in the Status window reports the current state of data recording.

```
VPX_SendCommand("dataFile_CloseAndAnalyze" );
VPX_closeAndAnalyzeDataFile();
```

13.3 Stimulus Images

13.3.1 Load Stimulus Image into the Stimulus window

GUI: **File > Images > Load Image** **^I**

CLP Command: **stimulus_LoadImageFile** ***filename***

SDK Function: -none-

Loads the selected image into the Stimulus window

See section: 13.1.3 Quoting strings with white spaces

See also:
stimulusGraphicsOptions +Image

```
VPX_SendCommand( “stimulus_LoadImageFile  catPicture.bmp” );
VPX_SendCommand( “stimulus_LoadImageFile  \”second cat picture .bmp\” ” );
VPX_SendCommand( “stimulus_LoadImageFile %s”, bitmapFileName );
```

13.3.2 Specifies how to display the currently loaded stimulus image

GUI **Stimuli > Image Shape > shape type**

CLP Command: **stimulus_ImageShape** ***ShapeType***
ShapeType: **Actual, Centered, Fit, Isotropic**

SDK Function: -none-

Default: **Fit**

Specifies how the bitmap image is to be displayed in the Stimulus windows.

A = Actual : Displays the in the two windows at actual size.

C = Centered : Displays the image actual size and centered in the windows.

F = Fit : Displays the image stretched un-equally to fit the window.

I = Isotropic: Displays the image stretched equally in all directions, so as to maintain the original proportions, i.e., the original aspect ratio of the image. This may leave window background ("matting") color between edges of the picture and the edges of the window. The color of this area can be specified with the command: stimulus_BackgroundColor. Note: the gazeSpace window may automatically resize to accommodate.

See also:
stimulus_BackgroundColor
VPX_STATUS_StimulusImageShape

```
VPX_SendCommand( “stimulus_ImageShape Isotropic” );
```

13.3.3 Specify a background “matting” color for the stimulus window

GUI: **Stimuli > Background Color**

CLP Command: **stimulus_BackgroundColor** ***ColorValue***
ColorValue: **Red 0-255, Green 0-255, Blue 0-255**

SDK Function: -none-

Added the ability to set the background ("matting") color for use when ImageShape is not set to Fit and there is space at the sides or at the bottom of the image.

Workarounds: The window may need to be minimized and reopened to show the color changes.

See also:
stimulus_ImageShape

```
Eg.set to BRIGHT RED use:  stimulus_BackgroundColor  255 0 0
VPX_sendCommand ( “stimulus_BackgroundColor 255 135 075” );
```

13.3.4 Play specified Sound file

GUI: **-none-**

CLP Command: **stimulus_PlaySoundFile** ***soundFileName***

SDK Function: -none-

Plays the specified sound file. May be used as an auditory cue. If the string contains spaces it must be in quotes. e.g stimulus_PlaySoundFile "Yes.wav".

See section: 13.1.3 Quoting strings with white spaces

This feature may cause a media/audio player to open, if this happens, check your computer settings.

```
stimulus_PlaySoundFile ”a very loud meow .wav”
VPX_SendCommand( “stimulus_PlaySoundFile meow.wav” );
VPX_SendCommand( “stimulus_PlaySoundFile \”a very loud meow .wav\” ” );
VPX_SendCommand( “stimulus_PlaySoundFile \”%s\” ”, soundFileName );
```

13.4 PictureList

13.4.1 Initialize Picture List

GUI: **-none-**

CLP Command: **pictureList_Init**

SDK Function: -none-

Initializes the list for stimulus images, making it ready for new names to be entered.

```
pictureList_Init
VPX_SendCommand( “pictureList_Init” );
```

13.4.2 Add List of Image Names to PictureList

GUI: **-none-**

CLP Command: **pictureList_AddName** ***imageFileName***

SDK Function: -none-

Adds an image file name to the picture list.

```
pictureList_AddName ”picture of cat .bmp”
VPX_SendCommand ( “pictureList_AddName picture2.bmp” );
VPX_SendCommand ( “pictureList_AddName \”picture of cat .bmp\” ” );
VPX_SendCommand ( “pictureList_AddName \”%s\” ”, imageFileName );
```

13.4.3 Randomize List of Images in the PictureList

GUI: **File > Images > Picture List > Randomize PictureList**

CLP Command: **pictureList_Randomize**

SDK Function: -none-

Randomizes the pointers in the picture list. Repeat this to re-randomize.

```
VPX_SendCommand( “pictureList_Randomize”);
```

13.4.4 Move to Next Image in the PictureList

GUI: **File > Images >PictureList>Next PictureList Image** **^F12 (default)**

CLP Command: **pictureList_ShowNext**

SDK Function: -none-

Moves to the next file pointer in the picture list.

```
VPX_SendCommand ( “pictureList_ShowNext” );
```

13.4.5 Move to Start of Images in Picture List

GUI:	**File > Images > PictureList > Restart PictureList**
CLP Command:	**pictureList_Restart**
SDK Function:	-none-

Re-sets the pointer to the first image in the list. Does not un-randomize if the list has been randomized.

```
VPX_SendCommand ( “pictureList_Restart” );
```

13.5 Controls window: VideoImage

13.5.1 Specify Mapping Feature

GUI:	**Controls Window, Video Image tab, Mapping featurepull down menu**
CLP Command:	**mappingFeature *Method*** ***Methods*: Pupil, Glint, Vector, Manual, SlipComp**
SDK Function:	**int VPX_SetFeatureMethod (int *featureMethod*)** **int VPX_SetFeatureMethod2(VPX_EyeType eyn, int *featureMethod*)** ***featureMethod* :** **PUPIL_ONLY_Method, GLINT_ONLY_Method, VECTOR_DIF_Method**
Default:	**Pupil**

Controls what type of mapping will be done from EyeSpace to GazeSpace

Return value: 0=false, 1=true, otherwise -1 if invalid value for eye

```
VPX_SendCommand ( “mappingFeature Glint” );
VPX_SendCommand ( “mappingFeature Vector” );
VPX_SendCommand ( “mappingFeature Pupil” );
VPX_SendCommand ( “mappingFeature Manual” );
VPX_SendCommand ( “mappingFeature SlipComp” );
```

13.5.2 AutoThreshold

GUI:	**Controls window , VideoImage tab, Threshold: Autothreshold button**
CLP Command:	**autoThreshold** autoThreshold_Start
SDK Function:	**int VPX_AutoThreshold();** **int VPX_AutoThreshold2(*VPX_EyeType* eye);** ***VPX_EyeType* : Eye_A, Eye_B**

Automatically sets desirable glint and pupil threshold levels.

```
VPX_SendCommand ( “autoThreshold” );
VPX_AutoThreshold2( EYE_A );
```

13.5.3 Positive Lock Tracking

GUI:	**Controls Window, Video Image Tab, Threshold Group, Positive-Lock Threshold-Tracking**
CLP Command:	**positiveLock** ***BoolValue*** ***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	**int set_positiveLockThresholdTracking(*int boolValue*);** **int VPX_SetPositiveLockThresholdTracking2(VPX_EyeType, *int tf*)** Return value: 0=false, 1=true, otherwise -1 if invalid value for eye
Default:	**Off**

Continuous automatic feature threshold adjustment.

```
VPX_SendCommand ( “positiveLock on” );
```

13.5.4 Adjust Pupil Threshold Slider

GUI:	**Controls window, VideoImage tab, Pupil / Threshold slider**
CLP Command:	**pupilThreshold** ***NormalizedValue*** **pupilThreshold** ***EyeType*** ***NormalizedValue*** ***NormalizedValue*: a floating point number in range 0.0 to 1.0** ***EyeType*: *Eye_A*, *Eye_B***
SDK Function:	**int VPX_SetPupilThreshold (*EyeType normalizedValue*)** **int VPX_SetPupilThreshold2(VPX_EyeType eyn, float value)** Return value: 0=false, 1=true, otherwise -1 if invalid value for eye
Default:	**0.25**, but autothreshold at startup may reset this

Sets the image intensity threshold such that the pupil can be segmented from the rest of the image. The assumption is that the pupil is darker than the rest of the image within the PupilScanArea. For binocular systems, the user may specify this value separately for eye.

The value zero represents black, the lowest pixel intensity possible, and the value one represents white, the highest pixel intensity possible.

See also:
autoThreshold

```
VPX_SendCommand ( “pupilThreshold 0.7” );
```

13.5.5 Adjust Glint Threshold Slider

GUI:	**Controls window, VideoImage tab, Glint / Threshold slider**
CLP Command:	**`glintThreshold`** ***`NormalizedValue`*** ***`NormalizedValue`*****: a floating point number in range 0.0 to 1.0**
SDK Function:	**`int VPX_SetGlintThreshold ( float normalizedValue );`** **`int VPX_SetGlintThreshold2( VPX_EyeType eyn, float value );`**
Default:	**`0.88`**, but autothreshold at startup may reset this

Sets the level pixel intensity used for segmenting the image when searching for the glint (aka, corneal reflection, corneal reflex, or 1st Purkinje image). All pixels with intensity greater than this value are candidates for being classified as the glint.

The value zero represents black, the lowest pixel intensity possible, and the value one represents white, the highest pixel intensity possible.

See also:
`autoThreshold`

```
VPX_SendCommand ( “glintThreshold 0.6” );
```

13.5.6 Adjust Video Image Brightness

GUI:	**Controls window, VideoImage tab, Brightness slider**
CLP Command:	**`videoImageBrightness`** ***`NormalizedValue`*** ***`NormalizedValue`*****: a floating point number in range 0.0 to 1.0**
SDK Function:	**`int VPX_SetImageBrightness ( float normalValue )`** **`int VPX_SetImageBrightness2( VPX_EyeType eyn, float normalVal)`** ***`normalValue`*****: a floating point number in range 0.0 to 1.0**
Default:	`- varies -`

Sets the video image brightness levels normalized from 0.0 to 1.0.

```
VPX_SendCommand( “videoImageBrightness 0.5” );
```

13.5.7 Adjust Video Image Contrast

GUI:	**Controls window, VideoImage tab, Contrast slider**
CLP Command:	**`videoImageContrast`** ***`normalValue`*** ***`normalValue`*****: a floating point number in range 0.0 to 1.0**
SDK Function:	**`int VPX_SetImageContrast ( float normalValue );`** **`int VPX_SetImageContrast2( VPX_EyeType eyn, float normalVal );`** ***`normalValue`*****: a floating point number in range 0.0 to 1.0**
Default:	`- varies -`

Sets the video image contrast levels normalized from 0.0 to 1.0.

```
VPX_SendCommand( “videoImageContrast 0.7” );
```

13.5.8 Dynamically Optimize Brightness and Contrast Settings

GUI:	**Controls window, VideoImage tab, AutoImage checkbox**
CLP Command:	**videoAutoImage** ***BoolValue***
SDK Function:	-none-
Default:	**Off**

Continuously attempts to set the video image brightness and contrast levels to optimal values.

Note 1 : Only the region within the pupil scan area is examined, the pupil scan area rectangle must be of sufficient size for the algorithm to sample a range of gray levels, otherwise the algorithm will fail.

Note 2 : The algorithm is under development and may change without notice.

```
VPX_SendCommand( "videoAutoImage  On" );
```

13.5.9 Adjust Pupil Scan Density

GUI:	**Controls window, VideoImage tab, Pupil / Scan Density slider**
CLP Command:	**pupilScanDensity** ***FloatValue*** ***FloatValue*** **: integer in range 1 to 20**
SDK Function:	**VPX_SetPupilResolution (float** ***resolution*** **);** **VPX_SetPupilResolution2 (** ***VPX_EyeType*** **eye, float** ***resolution*** **);** ***VPX_EyeType*** **: Eye_A, Eye_B** ***resolution*** **: use only whole value in range 1 to 20**
Default:	**7**

The value specifies the pixel sampling interval for the threshold segmentation operation. The value 1 indicates to sample every pixel. The value 2 indicates to sample every other pixel in both x and y directions, so one fourth as many pixels are sampled with a setting of 2 as with a setting of 1. Etc.

Caution: normally there is no need to sample very densely and doing so will greatly burden the cpu. For the GUI interface the slider has a default minimal value greater than 1 to avoid cpu overload. This default minimum may be change with the CLP command: **minimumPupilScanDensity**.

Note: previous versions provided for either a normalized floating point value in the range (0.0 – 1.0), or an integer in the range 1 – 20, however the normalized floating point values are no longer supported. There is no confusion with the value 1, because the minimal sampling interval of integer 1 and the maximum normalized density (1.0) are opposite ways of looking at the same thing.

See also:
minimumPupilScanDensity

```
VPX_SendCommand ( "pupilScanDensity 5" );
```

13.5.10 Override Pupil Scan Density Minimum

GUI:	**-none-**
CLP Command:	**minimumPupilScanDensity** ***DensityIndex*** ***DensityIndex: Integer in range 3 to 20, depending upon max density chosen.***
SDK Function:	-none-
Default:	**7**

Overrides the minimum pupil scan density on the Controls window slider.

Fine sampling is rarely required and not generally recommended.

WARNING: Setting the scan density too fine can create a huge burden on the CPU and possibley lock-out use of the GUI.

```
VPX_SendCommand ( "minimumPupilScanDensity 12" );
```

13.5.11 Adjust Glint Scan Density

GUI:	**Controls window, VideoImage tab, Glint / Scan Density slider**
CLP Command:	**glintScanDensity** ***IntValue*** ***IntValue*****: integer in range 1 to 20**
SDK Function:	**VPX_SetGlintResolution (*float resolution*);** **VPX_SetGlintResolution2 (*VPX_EyeType* eye, float *resolution*);** ***VPX_EyeType* : Eye_A, Eye_B** ***resolution* : use only whole value in range 1 to 20**
Default:	**2 or 3**, depending on glintSegmentationMethod

The argument specifies the pixel sampling interval for the glint threshold segmentation operation. The value 1 indicates to smple every pixel. The value 2 indicates to sample every other pixel in both the x and y directions, so one fourth as many pixels are sampled as with a setting of 1. Etc.

The glint is usually much smallter than the pupil, so finer sampling is expected.

Caution: normally there is no need to sample very densely and doing so will greatly burden the cpu. For the GUI interface the slider has a default minimal value greater than 1 to avoid cpu overload. This default minimum may be change with the CLP command: **minimumGlintScanDensity**.

Note: previous versions provided for either a normalized floating point value in the range (0.0 – 1.0), or an integer in the range 1 – 20, however the normalized floating point values are no longer supported. There is no confusion with the value 1, because the minimal sampling interval of integer 1 and the maximum normalized density (1.0) are opposite ways of looking at the same thing.

See also:

minimumGlintScanDensity

glintSegmentationMethod

```
VPX_SendCommand ( "glintScanDensity 5" );
```

13.5.12 Override Glint Scan Density Minimum

GUI:	**-none-**
CLP Command:	**minimumGlintScanDensity** ***DensityIndex*** ***DensityIndex: Integer in range 7 to 20, depending upon max density chosen.***
SDK Function:	-none-
Default:	**1 or 3**, depending on glintSegmentationMethod

Overrides the minimum glint scan density avaliable on the Controls window slider.

Note: this is not normally required and small scan density values can over burden the cpu.

See also:
glintScanDensity
glintSegmentationMethod

```
VPX_SendCommand ( “minimumGlintScanDensity 3” );
```

13.6 EyeCamera Window

13.6.1 Adjust Pupil Sacn Area

GUI:	**EyeCamera window , EyeCamera toolbar , Top Button**
CLP Command:	**pupilScanArea** ***L T R B*** ***L T R B: Normalized floating point values for the corners.***
SDK Function:	**VPX_SetPupilScanArea (VPX_*RealRect rr*);**
Default:	**0.200 0.200 0.800 0.800**

Defines scan area for the pupil. The four values are the floating point coordinates (0.0 – 1.0) of the bounding rectangle, listed in the order: Left, Top, Right, Bottom.

```
VPX_SendCommand ( “pupilScanArea 0.3 0.2 1.0 0.4” );
```

13.6.2 Specify Pupil Scan Area Shape

GUI:	**-none-**
CLP Command:	**pupilScanShape** ***ScanShapeType*** ***ScanShapeType:*** **Rectangle, Ellipse.**
SDK Function:	-none-
Default:	**Elliptical**

Specifies whether to change the scan area for the pupil to either rectangular or elliptical . Elliptical scan area is effective at eliminating dark spots that the software interprets as a pupil. Elliptical Scan

```
VPX_SendCommand( “pupilScanShape Ellipse” );
```

13.6.3 Pupil and Glint oval fit constraints

GUI:	**-none-**
CLP Command:	**pupilConstrained** ***BoolValue*** **glintConstrained** ***BoolValue***
SDK Function:	-none-

Controls whether or not the pupil (glint) oval fit is allowed to extend beyond the scan area rectangle in the EyeSpace window.

```
VPX_SendCommand( “pupilConstrained True” );
```

13.6.4 Define Glint Scan Area

GUI:	**EyeCamera window , EyeCamera toolbar , Third Button to enable** **Drag mouse in window to define the glint scan area rectangle.**
CLP Command:	**glintScanSize** ***X Y***
SDK Function:	**VPX_SetGlintScanSize (VPX_*RealPoint rp*);**
Default:	**0.400 0.200**

Defines scan area for the glint.

The two values are the normalized floating point X,Y size values of the scan rectangle.

```
VPX_SendCommand ( “glintScanSize –0.4 1.3” );
```

13.6.5 Define Offset of Glint Sacn Area Relative to the Pupil

GUI: **-none-**

CLP Command: **glintScanOffset** ***X Y***
X Y : Normalized floating point coordinates.

SDK Function: **VPX_SetGlintScanOffset (VPX_*RealPoint rp*);**

Default: **0.010 0.080**

Defines offset of the glint scan area relative to the center of the pupil.

The two values are the normalized coordinates of the offset vector from the center of the pupil.

See also:
video_yokedGlint NO
glintScanUnYokedOffset

```
VPX_SendCommand ( “glintScanOffset  0.4 0.3” );
```

13.6.6 Unyoke Glint Scan Area from the Pupil

GUI: -none-

CLP Command: **video_yokedGlint** ***BoolValue***
***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**

SDK Function: -none-

Allows the glint scan area to be unyoked from the pupil. i.e. the glint scan area does not move with the pupil. Special applications only.

See also:
glintScanUnYokedOffset
glintScanOffset

```
VPX_SendCommand( “video_yokedGlint On” );
```

13.6.7 Define offset of Unyoked Glint Scan Area

GUI: **-none-**

CLPCommand: **glintScanUnYokedOffset** ***X Y***
X Y : Normalized floating point coordinates.

SDK Function: **VPX_SetGlintScanUnyokedOffset(VPX_*RealPoint rp*);**

Defines offset of the glint scan area relative to the upper left hand corner of the EyeCamera window.

The two values are the normalized coordinates of the offset vector.

See also:
video_yokedGlint

```
VPX_SendCommand ( “glintScanUnYokedOffset 0.1 –3.0” );
```

13.6.8 Toggle Show Treshold Dots On / Off

GUI:	**Video > Show Threshold Dots (toggle)** **^D** **Button on EyeCamera window**
CLP Command:	**showThresholdDots** ***BoolValue*** ***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	`VPX_Video_ShowThresholdDots ( bool tf );`
Default:	**Yes**

Specifies whether the image segmentation dots are displayed in the EyeCamera window.

```
VPX_SendCommand ( “showThresholdDots No” );
VPX_SendCommand ( “showThresholdDots %s”, boolVal?”Yes”:”No” );
```

13.6.9 Specify EyeImage Overlay Graphics sent to layered application (EXPERIMENTAL)

Control or Menu:	-none-
CLP Command:	**vpx_EyeCameraImageOverlays** ***StringArg*** ***StringArg* : +Eye_A –Eye_A +Eye_B –Eye_B**
SDK Function:	**VPX_SetEyeImageOverlays(VPX_EyeType eye, bool tf);** ***VPX_EyeType* : Eye_A, Eye_B**

EXPERIMENTAL : This functionality is under development and may not be stable over future versions.

This only affects the overlay graphics in the **remote** eye image that is sent to a layered SDK application with the SDK function VPX_SetEyeImageWindow. It does not affect the EyeCamera window within the *ViewPoint*. Also, this does not effect the display of the segmentation dots; to remove these dots from both *ViewPoint* and the layered SDK application, use the command: *”showThresholdDots”*

Note carefully: the CLP and the SDK names are spelled differently.

See also:

VPX_SetEyeImageWindow

showThresholdDots

```
VPX_SendCommand ( “vpx_EyeCameraImageOverlays off” );
VPX_SetEyeImageOverlays( Eye_A, 1 );
```

13.6.10 EyeCamera Tool Bar Display

GUI:	**Video > Show Toolbar on EyeCamera window**
CLP Command:	**videoToolBar** ***BoolValue*** ***BoolValue*****: Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	**VPX_Video_ShowEyeCameraToolBar (*bool tf*);**
Default:	**Yes**

Specifies whether to display eye camera tool bar.

```
VPX_SendCommand( “videoToolBar off”);
```

13.7 Video related controls

13.7.1 Specify Video Input Standard

GUI:	**Video > Video Standard > NTSC, PAL, SECAM**
CLP Command:	**videoStandard** ***Option*** ***Option*****: any one of: NTSC, PAL, SECAM**
SDK Function:	-none-
Default:	**NTSC upon first run, but saved in preferences file thereafter.**

Specifies which video mode to use.

ViewPoint tryes to ensure that it starts up in a friendly way each time, to facilitate this the videoStandard selection is saved in a special Preferences file that is evaluated each time it ViewPoint is launched.

```
VPX_SendCommand( “videoStandard PAL”);
VPX_SendCommand( “videoStandard SECAM”);
VPX_SendCommand( “videoStandard NTSC”);
```

13.7.2 Specify Tracking Operation Mode

GUI:	**Video > Mode > Setup, Precision, Speed**
CLP Command:	**videoMode** ***ProcessingMode*** ***ProcessingMode*****: Setup, Precision, Speed**
SDK Function:	**VPX_Video_Mode (*VideoProcessingMode mode*);** **SetUp_Mode, HighPrecision_Mode, HighSpeed_Mode**
Default:	**Setup**

Specifies which operation mode to use.

```
VPX_SendCommand( “videoMode Precision”);
VPX_SendCommand( “videoMode Speed”);
VPX_SendCommand( “videoMode Setup”);
```

13.7.3 Specify Dark or Bright Pupil Tracking

GUI: **Video > Pupil Type > Dark Pupil, Bright Pupil**

CLP Command:
```
pupilType    PupilType
   PupilType:  Dark, Bright
```

SDK Function:
```
int VPX_SetPupilType ( PupilMethod );
int VPX_SetPupilType2( VPX_EyeType eyn, int method );
  DARK_PUPIL_Method, BRIGHT_PUPIL_Method
```

Specifies dark or bright pupil tracking.

```
VPX_SendCommand( "pupilType dark");
```

13.7.4 Specify Pupil Segmentation Method

GUI: **Video > Pupil Segmentation Method > Centroid, Oval Fit**

CLP Command:
```
pupilSegmentationMethod Method
   Method: Centroid, OvalFit
```

SDK Function: -none-

Default: **OvalFit**

Specifies which pupil segmentation method to use, either oval fit or centroid. Actually the centroid is obtained in either case, but OvalFit performs addititional image processing and fitting.

Note: the pupil width and pupil aspect ratio will not be available unless OvalFit is selected.

```
VPX_SendCommand( "pupilsegmentationMethod  Centroid" );
```

13.7.5 Specify Glint Segmentation Method

GUI: **Video > Glint Segmentation Method > Centroid, Oval Fit**

CLP Command:
```
glintSegmentationMethod  Method
   Method: Centroid, OvalFit
```

SDK Function: -none-

Default: **OvalFit**

Specifies which glint segmentation method to use, either ovalFit or centroid. Actually the centroid is obtained in either case, but OvalFit performs addititional image processing and fitting.

Note: changing this may also change the values of **`minimumGlintScanDensity`** and **glintScanDensity**.

```
VPX_SendCommand( "glintSegmentationMethod OvalFit" );
```

13.7.6 Changes default setting for Freeze Feature

GUI:	**-none-**
CLP Command:	**freezeStops** *Option* *Option*: **all, ImageDisplay**
SDK Function:	-none-
Default	**All**

Changes the default setting of stopping all video capture to just stopping the image display preview.

```
VPX_SendCommand( “freezeStops ImageDisplay”);
VPX_sendCommand( “freezeSops all” );
```

13.7.7 Toggle Freeze Video Imge Preview On / Off

GUI:	**Video > Freeze Video** **^F** **EyeCamera window, SnowFlake button**
CLP Command:	**videoFreeze** *BoolValue* *BoolValue*: **Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	`VPX_Video_Freeze ( bool tf );`
Default:	**No**

Allows freezing the video image preview, Status window display and data collection. (c.f. freezeStops).

```
VPX_SendCommand( “videofreeze Yes” );
```

13.7.8 Reset Video Capture Device

GUI:	**Video > Reset Video**
CLP Command:	**videoReset**
SDK Function:	`VPX_Video_Reset ( void );`

Currently under considered for extension to accept a video stream identifier.

Resets video capture device.

```
VPX_SendCommand( “videoReset” );
```

13.8 Calibration controls

13.8.1 Start Auto-Calibration

GUI:	**EyeSpace window, Auto-Calibrate / START Calibration button (toggle) ^A**
CLP Command:	**calibrationStart**
SDK Function:	**VPX_AutoCalibrate();**

Starts the calibration process.

```
VPX_SendCommand ( “calibrationStart” );
```

13.8.2 Stop Auto-Calibration

GUI:	**EyeSpace window, Auto-Calibrate / STOP Calibration button (toggle) ^K**
CLP Command:	**calibrationStop**
SDK Function:	**VPX_StopCalibration ();**

Stops the calibration process before its normal completion.

```
VPX_SendCommand ( “calibrationStop” );
```

13.8.3 Specify Calibration Stimulus Presentation Speed

GUI:	**EyeSpace window, Advanced button, Duration slider**
CLP Command:	**calibration_StimulusDuration *milliseconds*** ***milliseconds* : integer between 1 and 400**
SDK Function:	**VPX_SetCalibrationSpeed (int *milliseconds*);** ***milliseconds*: integer between 1 and 400**
Default:	**80 for Windows XP (depends upon the OS)**

Specifies the delay in milliseconds between calibration stimulus changes (zoom rectamgle decrements). *ViewPoint* attempts to set an optimal default value according to the operating system version. The “milliseconds” secification is only approximate and unfortunately varies between Microsoft operating system versions. This value also affects the warning time and the inter-stimulus interval (isi) that specify durations in units of stimulus duration milliseconds.

The maximum duration is 200 ms, and the minimum is 1 ms.

```
VPX_SendCommand ( “Calibration_StimulusDuration  145” );
```

13.8.4 Specify the duration of presentation of calibration warning notice

GUI:	**EyeSpace window, Advanced button, Warning slider**
CLP Command:	**`calibration_WarningTime`** ***`durationUnits`*** ***`durationUnits`*****: integer between 0 and 100**
SDK Function:	-none-
Default:	**20**

Specifies the delay for posting a waring that calibration is about to start. *ViewPoint* attempts to set an optimal default value according to the operating system version. The time is only approximate. The delay is in units of the stimulus duration specified by the command: `calibration_StimulusDuration`

The value 0 specifies no warning is to be given.

See also:
`Calibration_StimulusDuration`

```
VPX_SendCommand ( “Calibration_WarningTime 15” );
```

13.8.5 Specifies Interval Between Presentation of Calibration Stimulus Points

GUI:	**-none-**
CLP Command:	**`calibration_ISI`** ***`intervalUnits`*** ***`intervalUnits`*****: integer between 1 and 9**
SDK Function:	-none-
Default:	**2**

Specifies the inter-stimulus interval between calibration points. *ViewPoint* attempts to set an optimal default value according to the operating system version. The time is only approximate. The delay is in units of the stimulus duration specified by the command: `calibration_StimulusDuration`.

The value 0 specifies no ISI time.

See also:
`calibration_StimulusDuration`

```
VPX_SendCommand ( “Calibration_ISI 2” );
```

13.8.6 Calibration Snap Mode

GUI:	**EyeSpace window, Advanced button, Snap Mode checkbox**
CLP Command:	**calibration_SnapMode *BoolValue*** ***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	`VPX_set_snapCalibrationMode( bool tf );`
Default:	**No**

Snap mode means that the calibration stimulus images (the zooming concentric rectangles) are not presented, and the calibration of the currently selected point is immediately performed based on the current eye position. This is useful for remote or manual calibration as when using the sceen camera option and when controlling calibration with stimulus points are controlled and generated on a remote computer; and also for use with a scene camera.

This command affects the behavior of the "Re-Present" and the "Slip-Correction" buttons/commands and is indicated by the appearance of an asterisk (*) on these buttons when in this special mode.

It is not necessary to enter this mode if using the command: calibration_Snap.

See also:

calibration_Snap
calibration_AutoIncrement
calibrationRedoPoint

```
VPX_SendCommand ( “calibration_SnapMode ON” );
```

13.8.7 RePresent in Snap Calibration Mode

GUI:	**EyeSpace window, Re-Present * (when asterisk is showing)**
CLP Command:	**calibration_Snap**
SDK Function:	- none -
Default:	

Snap mode means that the calibration stimulus images (the zooming concentric rectangles) are not presented, and the calibration of the currently selected point is immediately performed based on the current eye position.

This is useful for remote or manual calibration as when using the scene camera option and when controlling calibration with stimulus points are controlled and generated on a remote computer; and also for use with a scene camera.

Use of this command does not require, and in may situations obviates the need for, changing the calibration_SnapMode.

```
VPX_SendCommand ( “calibration_Snap” );
```

13.8.8 AutoIncrement Calibration Mode

GUI:	**EyeSpace window, Advanced button, Auot-Increment checkbox**
CLP Command:	**Calibration_AutoIncrement** ***BoolValue*** ***BoolValue*****: Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	-none-

It affects the behavior of the "Re-Present" button/command and is indicated by a double plus (**++**) on this button when in this special mode.

This mode is useful for manual calibration as with a scene camera.

```
VPX_SendCommand ( “calibration_AutoIncrement TRUE ” );
```

13.8.9 Calibration Stimulus Point Presentation Order

GUI:	**EyeSpace window, Advanced button, Presentation Order pulldown menu**
CLP Command:	**calibration_PresentationOrder** ***orderChoice*** ***orderChoice*****: Sequential, Random, Custom**
SDK Function:	-none-

This affects both auto-callibration and manual calibration that sequence through the index values. If the user has set: calibration_PresentationOrder Sequential then the index value and the calibration stimulus point number are the same.

```
VPX_SendCommand ( “calibration_PresentationOrder  Random” );
```

13.8.10 Specify Number of Calibration Stimulus Points

GUI:	**EyeSpace window, drop-down menu: 6 … 72**
CLP Command:	**calibration_Points** ***numberOfPoints*** ***numberOfPoints*** **: integer from the following set:** **{ 6, 9, 12, 16, 20, 25, 30, 36, 42, 49, 56, 64, 72 }**
SDK Function:	**VPX_SetCalibrationPoints (*int numberOfPoints*);** ***numberOfPoints*** **: integer from the following set:** **{ 6, 9, 12, 16, 20, 25, 30, 36, 42, 49, 56, 64, 72 }**
Default:	**16**

Sets the number of calibration points to be presented.

Note that the valid values are either N x N or N x (N-1)

```
VPX_SendCommand ( “calibration_Points 12” );
```

13.8.11 Specify Calibration Stimulus Point Color

GUI: **EyeSpace window, Advanced button, Set Stimulus Color button**

CLP Command: **calibration_StimulusColor** ***ColorValue***
ColorValue: **Red 0-255, Green 0-255, Blue 0-255**

SDK Function: -none-

Specifies the red, green and blue components (0 to 255) of the calibration stimulus points E.g. , 255 255 255 is white and 100 100 255 is a sky blue.

```
VPX_SendCommand ( “calibration_StimulusColor 255 255 025” );
```

13.8.12 Specify Calibration Stimulus Window Background Color

GUI: **EyeSpace window, Advanced button, Set Background Color button**

CLP Command: **calibration_BackgroundColor** ***ColorValue***
ColorValue: **Red 0-255, Green 0-255, Blue 0-255**

SDK Function: -none-

Specifies the red, green and blue components (0 to 255) of the calibration Stimulus window background E.g. , 255 255 255 is white and 100 100 255 is a sky blue.

```
VPX_SendCommand ( “calibration_BackgroundColor 050 100 255” );
```

13.8.13 Randomize Calibration Stimulus Points Check Box (DEPRECATED)

GUI: **EyeSpace window, Advanced button, Randomize Calibration checkbox**

CLP Command: **calibration_randomize** ***BoolValue***
BoolValue: **Yes, No, True, False, On, Off, 1, 0, Toggle**

SDK Function: -none-

Default: **Yes**

DEPRECATED

calibration_Randomize ON → calibration_PresentationOrder Random

calibration_Randomize OFF → calibration_PresentationOrder Sequential

See also:
calibration_PresentationOrder

```
VPX_SendCommand ( “calibration_randomize ON” );
```

13.8.14 Specify Calibration Stimulus Point Presentation Order

GUI:	**-none-**
CLP Command:	**calibration_CustomOrderList n1 n2 n3 n4 n5 n6 ...**
SDK Function:	-none-
Default:	**6 5 4 3 2 1 9 8 7 12 11 10 16 15 14 13 20 19 18 17 21 22 23 …**

Allow specification of up to 72 calibration point in the desired order of presentation.

Caution: An error will occur if the user has provided a point number in the list, which is larger than the selected number of calibration Points (i.e., the quantity of calibration points). For example, if the user specified: **customOrderList 6 72 4 69 2 1** and also specified: **calibrationPoints 6**, the points 72 and 69 would cause errors, because they are greater than 6.

See also:
calibration_SelectIndex
calibration_SelectPoint
calibrationPoints

```
VPX_SendCommand ( “calibration_ CustomOrderList 6 1 5 2 4 3” );
```

13.8.15 Specify Individual Custom Calibration Stimulus Points

GUI:	**-none-**
CLP Command:	**calibration_CustomOrderEntry *index calStimPoint*** ***index : integer in { 1 to N }*** ***calStimPoint : integer in { 1 to N }***
SDK Function:	-none-
Default:	See calibration_CustomOrderList, just above.

Used to specify individual custom calibration point entries.

Caution: see the Caution section in **calibration_CustomOrderList**, above.

See also:
calibration_SelectIndex
calibration_SelectPoint

```
VPX_SendCommand ( “calibration_CustomOrderEntry 1 6” );
```

13.8.16 Display Custom Calibration Stimulus Point Order

GUI:	**-none-**
CLP Command:	**calibration_CustomOrderDump**
SDK Function:	-none-
Default:	

Prints the customOrder of calibration points to the History window.

```
VPX_SendCommand ( “calibration_CustomOrderDump” );
```

13.8.17 Select the Specified Calibration Data Point

GUI:	**EyeSpace window, Data Point slider** **or/ Click mouse in EyeSpace window, *calibration graphics well***
CLP Command:	**calibration_SelectPoint** ***pointSelection*** ***pointSelection:*** ***LAST, NEXT, or*** **int { 1 .. N }**
SDK Function:	**VPX_EyeSpace_SelectPoint (*int SelectPoint*);**

Selects the specified calibration data point. The point will be highlighted in the EyeSpace window.

See also:
calibration_SelectIndex

```
VPX_SendCommand ( “calibrationSelectPoint 7” );
```

13.8.18 Select the Index Number that Maps to the Specified Calibration Data Point

GUI: **-none**

CLP Command: **calibration_SelectIndex** ***indexSelection***
indexSelection: ***LAST, NEXT, or*** **int { 1 .. N }**

SDK Function: -none-

Selects the index number that maps to a calibration stimulus point. The corresponding stimulus point will be highlighted in the EyeSpace window and the calibration data point slider will be adjusted.

When the calibration_PresentationOrder is Sequential the selected index and the selected point are the same. When calibration_PresentationOrder is Random or Custom, the index is incremented and the selected point is taken from the random, or custom, table.

Note: if the user has set: **calibration_PresentationOrder Random** then the series is re-randomized every time the set finishes, so that there is an new set for the next loop.

See also:
calibration_SelectPoint
calibration_PresentationOrder
calibration_CustomList
calibration_CustomOrderEntry ***index calStimPoint***

```
VPX_SendCommand ( “calibration_SelectIndex 7” ); // look up Pt# in CustomList
```

13.8.19 Undo the last operation on a Calibration Data Point

GUI: **EyeSpace window, Undo button**

CLP Command: **calibrationUndo**

SDK Function: **VPX_calibUndo**

Re-centers the selected calibration point.

```
VPX_SendCommand ( “calibrationUndo” );
```

13.8.20 Re-Present the Specified Calibration Data Point

GUI: **EyeSpace window, Re-present button**

CLP Command: **calibrationRedoPoint *CalibrationPoint***
***CalibrationPoint:* Numbered point to select.**

SDK Function: `VPX_ReCalibratePoint ( int SelectPoint );`

Re-presents the specified calibration data point.

The behavior is determined by the calibration_SnapMode and calibration_AutoIncrement specifications.

The *CalibrationPoint* parameter is optional, if omitted, the currently selected calibration point will be re-presented.

Note: the point number corresponds to the slider values in the EyeSpace window and does not depend on the calibration method chosen.

See also:
calibration_SnapMode
calibration_AutoIncrement

```
VPX_SendCommand ( “calibrationRedoPoint 7” );
VPX_SendCommand ( “calibrationRedoPoint” ); // defaults to current point
```

13.8.21 Specify Custom Calibration Stimulus Point Locations

GUI: **-none-**

CLP Command: **calibration_CustomPoint 2 0.95 0.95**

SDK Function: `VPX_SendCommand( “calibration_CustomPoint %d %g %g”, pointIndex, loc.x, loc.y );`

Specifies custom locations of the calibration stimulus points. Note: the nearest-neighbor grid-lines in the EyeSpace are not automatically draw when this option is used, because the points could be in any configuration.

See also:
calibration_CustomPointsUsed
calibration_CustomPointDump

```
VPX_SendCommand ( “calibration_CustomPoint  2  0.95  0.95” );
```

13.8.22 Turn Custom Calibration Stimulus Point Location ON / OFF

GUI: **-none-**

CLP Command: **calibration_CustomPointsUsed YES / NO / TOGGLE**

SDK Function: VPX_SendCommand("calibration_CustomPoint %d %g %g", pointIndex, loc.x, loc.y);

Turns custom calibration stimulus point location on or off.

See also:
calibration_CustomPoint
calibration_CustomPointDump

```
VPX_SendCommand ( "calibration_CustomPointsUsed YES" );
```

13.8.23 Print Locations of custom calibration stimulus points in EventHistory window

GUI: **-none-**

CLP Command: **calibration_CustomPointDump**

SDK Function: VPX_SendCommand("calibration_CustomPointDump");

Turns custom calibration stimulus point location on or off.

See also:
calibration_CustomPoint
calibration_CustomPointsUsed

```
VPX_SendCommand ( "calibration_CustomPointDump" );
```

13.8.24 Compensate for Slip

GUI: **EyeSpace window, Slip-Correction button**

CLP Command: **calibrationSlipCorrection** ***CalibrationPoint***
CalibrationPoint: **Numbered point to select.**

SDK Function: **VPX_SlipCorrection (*int SelectPoint*);**

Re-presents the specified calibration data point and re-aligns calibration to compensate for slip. Normally a point near the center of the display should be chosen.

See also:
calibration_SnapMode

```
VPX_SendCommand ( "calibrationSlipCorrection 7" );
```

13.8.25 Adjust Calibration Area

GUI:	**Controls window, Regions Tab, Calibration Region radio button**
CLP Command:	**calibrationRealRect** ***L T R B*** ***L T R B: Normalized floating point values for the corners.***
SDK Function:	-none-
Default:	0.1 0.1 0.9 0.9

Allows the user to adjust the calibration area (size and position) within which the calibration stimulus points are presented. The four values are the floating point coordinates (0.0 – 1.0) of the bounding rectangle, listed in the order: Left, Top, Right, Bottom.

```
VPX_SendCommand ( “calibrationRealRect 0.2 0.2 0.8 0.8” );
```

13.8.26 Save Image of Eye at each Calibration Data Point

GUI:	-none-
CLP Command:	**calibration_SaveEyeImages** ***BoolValue*** ***BoolValue:*** **Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	-none-
Default:	**Off**

When enabled this command will take a snapshot of the eye during calibration stimulus presentation at each calibration point. This feature is useful to examine the position of the eye when presented the stimulus. This allows users to determine any problems with subjects eyes or loss of a direct image of the pupil at a certain calibration point.

```
VPX_SendCommand ( “calibration_SaveEyeImages yes” );
```

13.9 Controls: Criteria Controls

13.9.1 Specify amount of Smoothing

GUI: **Controls window, DataCriteria tab, Smoothing Points slider**

CLP Command: **smoothingPoints** ***IntValue***

SDK Function: **VPX_SetSmoothing (*IntValue*);**

Default: **4**

The amount of smoothing to apply to the gaze position. The number specifies the number of previous sample point to use in the trailing average. A value of 4 makes attractive and useful real-time graphics. The value 1 indicates to use only the current point, i.e., no smoothing.

See also:
smoothingMethod, velocityCriterion

Modified: 2.8.2.44

```
VPX_SendCommand ( “smoothingPoints 3” );
```

13.9.2 Specify Smoothing Algorithm to Apply

Control or Menu: **-none-**

CLP Command: **smoothingMethod** ***method***
***method*: SMA, EMA**

SDK Function: -none-

Default: **SMA**

The user may choose between two smoothing algorithms: Simple Moving Average (SMA) and Exponential Moving Average (EMA).

The SMA method uniformly averages N pointsBack, i.e., all points having equal weight.

SMA(t) = [x(t) + x(t-1) + ... + x(t-n)] / N ; where n = (N-1)

The EMA method uses the following algorithm:

EMA(t) = (currentValue - EMA(t-1)) * K + EMA(t-1) ; where K = 2 / (pointsBack + 1).

The number of pointsBack is adjusted by the Smoothing slider or the CLP command smoothingPoints N.

Note: The successfully set method is currently reported in the Event History window.

See also:
smoothingPoints

Added: 2.8.2.44

```
VPX_SendCommand ( “smoothingMethod EMA” );
```

13.9.3 Specify Velocity Threshold

Control or Menu:	**Controls window, DataCriteria tab, Saccade Velocity slider**
CLP Command:	**velocityCriterion** ***NormalizedValue*** **velocityThreshold** ***NormalizedValue*** ***NormalizedValue*****: floating point number in range 0.0 to 1.0**
SDK Function:	-none-
Default:	**0.10**

The velocity level that is used to distinguish between saccades and fixations. This criterion threshold value is displayed in the penplot window plot for total velocity.

Note that the velocity magnitude, and consequently the required threshold, will be affected by the amount of smoothing applied.

See also:

smoothingPoints
driftCriterion

```
VPX_SendCommand ( “velocityCriterion 0.8” );  // Prefered
VPX_SendCommand ( “velocityThreshold 0.45” ); // OlderForm
```

13.9.4 Specify amount of Drift Allowed

Control or Menu:	**Controls window, DataCriteria tab, Fixation Drift Allowed slider**
CLP Command:	**driftCriterion** ***NormalizedValue*** ***NormalizedValue*****: floating point number in range 0.0 to 1.0**
SDK Function:	-none-
Default:	**0.03**

Specifies the absolute drift away from the fixation start point, or the last drift start point, that is tolerated before a Drift classification is made. The units are in normalized stimulus window coordinates, just like gaze point.

Without a Drift Criterion, the eyes can slowly change position and still be classified as a Fixation, because the velocity never exceeded the Saccade Velocity Criterion.

This criterion threshold value is displayed in the penplot window plot for for Drift.

See also:

velocityCriterion
penPlot +DRIFT

Changes:

Default value changed in version 2.8.3 from 0.1 to 0.03

```
VPX_SendCommand ( “driftCriterion  0.025” );
```

13.9.5 Specify Pupil Aspect Ratio Failure Criterion

GUI:	**Controls window, DataCriteria tab, Pupil Aspect Criterion**
CLP Command:	**pupilAspectCriterion** ***NormalizedValue*** ***NormalizedValue*: a floating point number in range 0.0 to 1.0**
SDK Function:	`VPX_SetPupilOvalCriteria ( NormalizedValue );`
Default:	**0.05**

Specifies the aspect ratio at which the data quality marker indicates that there s a problem. The default value is 0.05 , so that any aspect ratio is accepted. Typically a useful value is about 0.8 Adjust the pupil oval ratio criteria for classification as the pupil. Range 0.0 – 1.0. The pupil oval fit changes color from yellow to orange when criterion is violated.

```
VPX_SendCommand (“pupilAspectCriterion 0.8” );
```

13.9.6 Specify Pupil Width Failure Criterion

GUI:	**Controls window, DataCriteria tab, Maximum Pupil Width slider**
CLP Command:	**pupilMaxWidthCriterion** ***NormalizedValue*** ***NormalizedValue*: a floating point number in range 0.0 to 1.0**
SDK Function:	-none-
Default:	**0.75**

Specifies the pupil width at which the data quality marker indicates that there is a problem.

```
VPX_SendCommand ( “pupilMaxWidthCriterion 0.35” );
```

13.10 Region of Interest (ROI)

13.10.1 Define an ROI Box

GUI:	**-none-**
CLP Command:	**setROI_RealRect** ***Index L T R B*** ***Index:*** ***Integer value indicating the ROI to specify.*** ***L T R B:*** ***Normalized floating point values for the corners.***
SDK Function:	**int VPX_SetROI_RealRect (*int n, RealRect rr*)**
Default:	One box the center and eight iso-eccentric boxes.

Defines a Region of Interest (ROI) (aka window discriminator box) The first value <n> specifies which ROI to adjust. The next four values are the normalized (0.0 to 1.0) coordinates of the bounding rectangle.

See also:

setROI_AllOff
setROI_isoEccentric
VPX_GetROI_RealRect(n,rr);
VPX_drawROI(HWND hWnd, int activeRegion);

```
VPX_SendCommand ( “setROI_RealRect 5 0.1 0.1 0.9 0.9” );
// Sets ROI #5 with 10% margins
```

13.10.2 Specify Number of ROI to be drawn in a circle around center of window

GUI:	**-none-**
CLP Command:	**setROI_isoEccentric** ***NumberOfBoxes*** ***NumberOfBoxes:*** **integer number of ROI in a circle.**
SDK Function:	**VPX_SetROI_isoEccentric (int *numberOfBoxes*);**

Specifies the number of ROI boxes to be drawn in an isoeccentric distribution, i.e., in a circle around the center of the window. This also clears previous ROI box settings and refreshes the displays.

```
VPX_SendCommand( “setROI_isoEccentric 15” );
```

13.10.3 Remove all ROI Boxes

GUI:	**Controls window, DataDisplay tab, ROI Regions checkbox**
CLP Command:	**setROI_AllOff**
SDK Function:	-none-

Removes all ROI boxes.

```
VPX_SendCommand( “setROI_AllOff” );
```

13.10.4 Select a Specific ROI

GUI:	**Controls window, Regions tab, Region: slider**
CLP Command:	**setROI_Selection** ***ROIbox***
	ROIbox **: integer number of the box to be selected. i.e. 1 or 2 or 3 ect. Up to the max number of ROI boxes enabled.**
SDK Function:	-none-
Default:	-none-

Select ROI number N. The selected ROI is shown in red when the ROI overlay graphics is shown.

This can be used to highlight one particular ROI.

See also: "setROI_Lock"

```
VPX_SendCommand( "setROI_Selection 9" );
```

13.10.5 Select the next ROI Box

GUI:	**Controls window, Regions tab, Region: slider**	**F8**
CLP Command:	**setROI_selectNext**	
SDK Function:	-none-	

Select the next ROI number. This can be used to highlight an area.. (current + 1). The selected ROI is drawn in red when the ROI overlay graphics is shown. This can be used to highlight an area.

HINT: A mouse wheel is extremely helpful for moving between selections of the region slider.

```
VPX_SendCommand( "setROI_selectNext" );
```

13.10.6 Lock ROI Settings

GUI:	**Controls window, Regions tab, Region: slider, None**
CLP Command:	**setROI_Lock**
SDK Function:	-none-

Deselects all ROI, i.e. no ROI is selected.

See also: " setROI_Selection N"

```
VPX_SendCommand( "setROI_Lock" );
```

13.11 PenPlot controls

13.11.1 Specify Which PenPlot Traces to Display

GUI: **Menu : PenPlots >**

CLP Command: **penPlot +*chartItemName* - *chartItemName***

***chartItemName* : any of the following:**

All, Tming, Vergence, Xvelocity, Yvelocity, Tvelocity, Width, Aspect, Xgaze, Ygaze, Xangle, Yangle, Torsion, Seconds, HeadPosition, HeadAngle, Xpupil, Ypupil, Xglint, Yglint, Drift, Events, fixationTime, Timing, ROI, Quality

SDK Function: -none-

Default: +Xgaze +Ygaze +Velocity +Aspect +Drift

Specifies which penPlots to display in the PenPlot window. To include a plot preceed its name stiring with a "+", to exclude it preceed its name with "-". Be carefule that there is no white space between + or - and the string. Separate multiple strings arguments on the same line with a space, as in the exaple below.

+Velocity +Width +Aspect +Timing

+Vergence (data available with binocular option only)

+HeadPosition (data available with head track option only)

+HeadAngle (data available with head track option only)

+xPupilPoint +yPupilPoint (raw eyespace pupil position data as a function of time)

+XAngle +YAngle (data valid only when accurate GeometryGrid measurements are set)

```
VPX_SendCommand( "penPlot +Xgaze +Ygaze –Tvelocity +Width +Aspect –Timing" );
```

13.11.2 BackGround Color of PenPlot Traces

GUI: **-none-**

CLP Command: **penPlot_BackgroundColor *ColorValue***

***ColorValue:* Red 0-255, Green 0-255, Blue 0-255**

SDK Function: -none-

Default: 160, 160, 160

Controls of background color for penPlot stripChart windows.

See also:

penPlot_LimenFillColor

```
VPX_SendCommand( "penplot_BackgroundColor  115 100 235" );
```

13.11.3 PenPlot Back Ground Color

GUI: **-none-**

CLP Command: **penPlot_LimenFillColor** ***ColorValue***
ColorValue: **Red 0-255, Green 0-255, Blue 0-255**

SDK Function: -none-

Default: 144, 144, 144

Specifies the color that fills the rectangle within the criterion lines (threshold, limen) in the penPlots. The default value is slightly darker gray than the default penPlot_BackgroundColor.

See also:
penPlot_BackgroundColor

```
VPX_SendCommand( “penplot_ LimenFillColor  115 100 235” );
```

13.11.4 Specify Speed ot PenPlot Scrolling

GUI: **Menu : PenPlots > Speed > { ¼ x, ½ x, 1x, 2x, 4x, 8x, 16x }**

CLP Command: **penPlot_Speed** ***xInc***
xInc: **float**

SDK Function: -none-

Default: 2

Specifies the number of pixels to increment the the penPlot along the x (time) axis.

Sometimes it is desirable to increase the speed of the penPlot scrolling, so that details, markers, and classifications can be more easily distinguished.

Modified: 2.8.2.51

```
VPX_SendCommand( “penPlot_speed 6” );
```

13.11.5 Specify Range of PenPlot Values

GUI: **-none-**

CLP Command: **penPlot_Range *plotName lowerValue upperValue***

plotName: **any of:**

XGaze, YGaze, Drift, Fix, Vergence, Xvelocity, Yvelocity, Tvelocity, Width, Aspect, XAngle, YAngle, Torsion, HeadPosition, HeadAngle, XPUPIL, YPUPIL, XGLINT, YGLINT, Vergence

lowerValue, upperVAlue: **float**

SDK Function: -none-

Default: varies depending on plotName

Specifies the lower and upper plot range values for a particular penPlot graph.

Added: 2.8.2.51

```
VPX_SendCommand( “penPlot_Range xgaze 0.2 0.6” );
```

13.11.6 Specify the behavior of the penpot after a video freeze

GUI: **-none-**

CLP Command: **penPlot_restartAfterFreeze *BoolValue***

BoolValue: **Yes, No, True, False, On, Off, 1, 0, Toggle**

SDK Function: -none-

Default: **No**

Specifies the behavior of the penpot after a video freeze. Specifies whether or not the pen will continue going from where it is, or if the penplot window will be erased and the pen will reset and start afresh from the left.

```
VPX_SendCommand( “penplot_restartafterfreeze Yes” );
```

13.12 Graphics controls

13.12.1 Specify the color of the GazeSpace and PenPlot Lines

GUI:	**Controls window, DataDisplay tab, Eye A button or , Eye B button**
CLP Command:	**penColorA** ***ColorValue*** **penColorB** ***ColorValue*** ***ColorValue:*** **Red 0-255, Green 0-255, Blue 0-255**
SDK Function:	-none-
Default:	penColorA: 100 255 0 (limeGreen); penColorB : 0 255 255 (cyan)

Specifies the red, green and blue components (0 to 255) of the gazespace and penPlot lines. E.g. , 255 255 255 is white and 100 100 255 is a sky blue.

```
VPX_SendCommand( “pencolorA 115 100 235” );
VPX_SendCommand( “pencolorB   0 255   0” ); // Green
```

13.12.2 Specify which Overlay Graphics to Display in the GazeSpace Window

GUI:	**Controls window, DataDisplay tab, Gaze option checkbox matrix**
CLP Command:	**gazeGraphicsOptions** ***+graphicsOptions -graphicsOptions*** ***graphicsOptions*** **: +ROI +POG +Path +Fix +Size +Grid +Cal +Raw**
SDK Function:	-none-
Default:	+ROI +Path +Image

Specifies which overlay graphics to display in the GazeSpace window.

Use -graphicsOption to exclude an option, or use +graphicsOption to include an option.

Note: The +/- must be next to the key work, i.e., NOT separated from it by a space.

Separate multiple arguments by spaces, as in the example here below.

See also: **stimulusGraphicsOptions**

```
VPX_SendCommand( “gazeGraphicsOptions +POG –Raw –ROI” );
```

13.12.3 Specify which Overlay Graphics to Display in the Stimulus Window

GUI:	**Controls window, DataDisplay tab, checkbox matrix**
CLP Command:	**stimulusGraphicsOptions** ***+graphicsOptions -graphicsOptions*** ***graphicsOptions*** **:** **+ROI +POG +Path +Fix +Size +Grid +Cal +Raw +Image**
SDK Function:	-none-
Default:	+POG +Image

Specifies which overlay graphics to display in the Stimulus window.

Use -graphicsOption to exclude an option, or use +graphicsOption to include an option.

Note: The +/- must be next to the key work, i.e., NOT separated from it by a space.

Separate multiple arguments by spaces, as in the example here below.

See also: **gazeGraphicsOptions**

```
VPX_SendCommand( “stimulusGraphicsOptions +POG –Raw –ROI” );
```

13.12.4 Erase Data Displays in the GazeSpace and Stimulus windows

GUI:	**Controls window, DataDisplay tab, Erase Display button**
CLP Command:	**eraseDisplays**
SDK Function:	-none-

Clears the previous drawn data from the GazeSpace and Stimulus windows.

See also:

timedErase_autoErase

timedErase_delaySeconds

```
VPX_SendCommand( “eraseDisplays” );
```

13.12.5 Automatically erase display windows

GUI: **-none-**

CLP Command: **timedErase_autoErase** ***BoolValue***
***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**

SDK Function: -none-

Default: **Off**

Automatically erase display windows.

See also:
timedErase_delaySeconds
eraseDisplays

```
VPX_SendCommand( “timedErase_autoErase On” );
VPX_SendCommand( “timedErase_ delaySeconds 6.5” );
```

13.12.6 Specify time delay for auto erase

GUI: **-none-**

CLP Command: **timedErase_delaySeconds** ***seconds***
***seconds* : floating point number**

SDK Function: -none-

Default: **Off**

Automatically erase display windows.

See also:
timedErase_autoErase
eraseDisplays

```
VPX_SendCommand( “timedErase_autoErase On” );
VPX_SendCommand( “timedErase_ delaySeconds 6.5” );
```

13.13 Stimulus Window controls

13.13.1 Specify Stimulus Source	
GUI:	**Stimuli > View Source > { StimulusWindow, SceneCamera, Interactive Computer Display ... }**
CLP Command:	**viewSource options** **options: StimulusWindow, SceneCamera, 1, 2, 3**
SDK Function:	- none -
Default:	**Yes**
Specify the type of stimulus the subject will be viewing.	
`VPX_SendCommand( "viewSource  SceneCamera" );`	

13.13.2 Specify Custom Stimulus window Size and Position

GUI:	**1st) select style Stimuli> Stimulus Window Properties > Normal Adjustable Window** **2nd) resize the window by dragging its border** **3rd) change style: Stimuli> Stimulus Window Properties > Custom Static Position**
CLP Command:	**stimWind_CustomStatic *L T R B*** ***L T R B: Normalized floating point values for the physical dimensions.***
SDK Function:	~~VPX_StimWind_CustomStatic (“int x1, int y1, int x2, int y2”);~~

Specifies a custom position and size of the Stimulus window. Where L,T,R,B correspond to the left, top, right and bottom physical dimensions in the display space. The following example assumes that we have a secondary display placed in the virtual desktop with the tops of the two displays at the same level, namely zero. Further, the primary monitor is 1280 x 1024 and the secondary is 1024 x 768, such that the top left origin of the primary monitor is at (0,0), the top left origin of the seconday monitor is at (1280,0), and the extreme diagonal bottom right point is at (1280+1024,768) or (2304,768) **stimWind_CustomStatic 1280 0 2304 768**.

Sets the custom static Stimulus window in the position specified. Displays the Stimulus window as a static window (no borders or title bar). The window will be always in front. This is useful if the graphics card does not show a second display.

This neither (i) switches the display selection to Custom Static, nor (ii) causes the stimulus window to be shown.

Note: obsolete term ‘customStimulusWindow’ would raise the window.

See also:

stimWind_FullDisplay Custom
setWindow Stimulus Show
stimulus_ImageHidden

```
VPX_SendCommand( “stimWind_CustomStatic 1280 0 2304 768” );
VPX_SendCommand( “setWindow  Stimulus  Show” );
```

13.13.3 Automatically Show the Stimulus Window on the Primary Monitor

GUI:	**Stimuli> Stimulus Window Properties > AutoShow on Calibrate**
CLP Command:	**stimwind_AutoShowOnCalibrate** ***BoolValue*** ***BoolValue:*** **Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	**VPX_StimWind_AutoShowOnCalibrate (*bool tf*);**
Default:	**Yes**

ViewPoint has been designed to make calibration easy and fast, even when there is only one computer display, and when the experimenter wants to do self-testing.

If (i) the *AutoShowOnCalibrate* feature is active, (ii) the stimulus window is set to display full screen on the primary monitor, and (iii) the stimulus window is hidden, then ViewPoint will automatially show (unhide) the stimulus window, whenever a calibration start procedure starts.

See also:
stimWind_FullDisplay 1

```
VPX_SendCommand( “stimwind_autoshowoncalibrate No” );
```

13.13.4 Specify How and where to show Stimulus window

GUI:
Stimuli> Stimulus Window Properties > Normal Adjustable
Stimuli> Stimulus Window Properties > Custom Static
Stimuli> Stimulus Window Properties > Full Screen Monitor 1 (Primary)
Stimuli> Stimulus Window Properties > Full Screen Monitor 2
Stimuli> Stimulus Window Properties > Full Screen Monitor 3
etc.

CLP Command:
```
stimWind_FullDisplay  OptionString
  MonitorNumber: integer
  OptionString : Adjustable, Custom, 1, Primary, 2, Secondary
```

SDK Function:
```
VPX_StimWind_FullDisplay ( int monitor )
VPX_StimWind_Adjustable(void )
```

Default: **1**

Specifies where and how to display the stimulus window. Arguments **Primary**, **1**, **Seconday**, **2**, etc.specify that the stimulus window will be displayed full screen on these monitors. Adjustable indicates that the stimulus window is to be displayed as a regular adjustable-size floating window. **Custom** was primarily developed to help users who have dual monitor display card that do not correcly tell the Windows OS that there are two devices; these are now rare.

Note 1 :

This command ONLY specifies the selection of the device on which the stimulus window will be displayed (or is displayed, if the stimulus window is currently showing), it does NOT cause the stimulus window to be shown. There are advantages to separating these instructions for (i) selecting the device and for (ii) showing / hiding the window, not the least of which is isomorphism to the conceptual layout of the GUI menu item groupings.

Note 2:

In previous versions, prior to 2.8.3, the argument 0 corresponded to the instruction to Hide the stimulus window, or in some previous versions, to toggle Show / Hide. Argument 0 should no long be used and its effect may be unpredictable.

See also:

setWindow STIMULUS SHOW
setWindow STIMULUS HIDE
stimWind_CustomStatic
stimWind_AutoShowOnCalibrate

Modified: 2.8.2.52

```
VPX_SendCommand( “stimWind_FullDisplay Seconday” );
```

13.13.5 Calibrate to a third party application window

GUI: -none-

CLP Command: -none-

SDK Function: **VPX_SetExternalStimulusWindow(HWND hMyWndow);**

This provides a mechanism for *ViewPoint* to draw the calibration stimuli directly into a window created by another application. The argument to this function is the handle of the created window.

CAUTION: When finished, the programmer must make certain to call this function again with a NULL HWND argument (or the handle of yet another window), before destroying the created window.

The calibration stimuli are still drawn in the *ViewPoint* Stimulus and GazeSpace windows, as usual.

See sampe code in:
VPX_ MFC_Demo.cpp

Contrast to:
HWND VPX_GetViewPointStimulusWindow();

```
CWnd* pWnd = GetDlgItem(IDC_StimulusPicture) ;
HWND hWnd = pWnd->GetSafeHwnd() ;
VPX_SetExternalStimulusWindow( hWnd );
```

13.14 Window related controls

13.14.1 Print ViewPoint windows

GUI: **File > Print > * window**

CLP Command: **printWindow *windowNameString***
windowNameString: Main, EyeCamera, EyeSpace, Controls, Status, GazeSpace, PenPlot

SDK Function: -none-

Using this command, windows can be sent to a printer. Note: you may want to select Freeze before Print to prevent pull down menu occlusion.

See also:
printDateTimeStamp

```
VPX_SendCommand( “printWindow EyeCamera” );
```

13.14.2 Include Date and Time Stamp on Printed windows

GUI: **File > Print > Date Timestamp printouts (toggle)**

CLP Command: **printDateTimeStamp** ***BoolValue***

***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**

SDK Function: -none-

Default: **On**

It is often useful to have the current date and time stamp included on printouts. Use this command to turn this feature on or off.

See:

printWindow

```
VPX_SendCommand( “printDateTimeStamp Off” );
```

13.14.3 Move and Resize Window

GUI: **Drag window with mouse, resize window with mouse.**

CLP Command: **moveWindow** ***windowNameString L T R B***

***windowNameString:* Main, EyeCamera, EyeSpace, Controls, Status, GazeSpace, PenPlot**

***L T R B:* four integers describing the left, top, right and bottom corners of the window rectangle.**

SDK Function: -none-

Both moves and resizes a particular window to the defined cordinates.

See also:

setWindow

```
RECT r = { 0, 0, 500, 800 };
VPX_SendCommand(“moveWindow PenPlot %d %d %d %d”,r.left,r.top,r.right,r.bottom)
VPX_SendCommand( “moveWindow GazeSpace 15 38 25 73” );
```

13.14.4 Specify ViewPoint Window Layout

GUI: **Windows > { *WindowName* } (Toggle)**

Windows > Arrange > { Starup Layout, Cascade }

CLP Command: **setWindow *windowNameString* *windowState***

setWindow *windowLayout*

***windowNameString*:**

Main, EyeCamera, EyeSpace, Controls, Status, GazeSpace, PenPlot, Stimulus

***windowState*: Show, Hide, Maximize, Minimize**

***windowLayout*: Startup, Cascade**

SDK Function:

```
int VPX_Video_WindowVisible ( BOOL tf );
int VPX_StimWind_Hide( void );
```

Allows the user to easily control the state of all ViewPoint EyeTracker windows.

setWindow Startup: equivalent to: Windows > Arrange > Startup layout

setWindow Cascade: equivalent to: Windows > Arrange > Cascade

Note: "**setWindow Stimulus Hide**" is different from the command "**stimulusGraphicsOptions –Image**", the latter suppresses showing the bitmap image inside the stimulus window.

See also:

moveWindow

stimWind_FullDisplay

stimWind_AutoShowOnCalibrate

Deprecated:

stimWind_Hide

```
VPX_Send Command( "setWindow Stimulus Show");
VPX_Send Command( "setWindow GazeSpace Minimize");
VPX_Send Command( "setWindow PenPlot Maximize");
```

13.14.5 Clear Event History window

GUI: **Windows > Clear History**

CLP Command: **eventHistory_Clear**

No arguments.

SDK Function: -none-

Clears the EventHistory window.

```
VPX_SendCommand( "eventHistory_Clear" );
```

13.14.6 Save window layout settings

GUI: **File > Settings > Save Window Layout**

CLP Command: **settingsFile_SaveWindowLayout No arguments.**

SDK Function: -none-

The window layout information can be saved in a Settings file. It is not saved as part of the standard Save Settings operation.

See also:
settingsFile_Save
settingsFile_Load

```
VPX_SendCommand( “settingsFile_SaveWindowLayout” );
```

13.15 Settings File commands

13.15.1 Load Settings File

GUI: **File > Settings > Load Settings ...** **^L**

CLP Command: **settingsFile_Load** ***filename***
***filename*: Name of the settings file to be loaded.**

SDK Function: -none-

Loads a settings file of the specified file name. Recursion is not allowed. Nesting depth is limited to 9.

See also:
settingsFile_SaveWindowLayout

```
VPX_SendCommand( “settingsFile_Load researchsettings” );
```

13.15.2 Edit Settings File

GUI: **File > Settings > Edit Settings File ...**

CLP Command: **settingsFile_EditDialog**

SDK Function: -none-

Enables user to quickly access and edit Settings files.

```
VPX_SendCommand( “settingsFile_EditDialog” );
```

13.15.3 Show Verbose Settings File Loading Details in Event History

GUI: **File > Settings > Verbose Loading**

CLP Command: **settingsFile_Verbose** ***BoolValue***
***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**

SDK Function: - none -

Default: **No**

Specifies whether to report verbose loading details.

```
VPX_SendCommand( “setingsFile_verbose  Yes” );
```

13.15.4 Save Settings e.g. calibrations etc.

GUI: **File > Settings > Save Settings…** **Alt-Shift-S**

CLP Command: **settingsFile_Save** ***Filename***
***Filename*: Name of the settings file to be saved.**

SDK Function: - none -

Saves a settings file with the specified file name.

See also:
settingsFile_SaveWindowLayout

```
VPX_SendComand( “settingsFile_save researchsettings” );
```

13.16 SettingsFileList commands

13.16.1 Initialize Settings File List

GUI: -none-

CLP Command: **settingsFileList_Init**

SDK Function: - none -

Initializes the list for settings file, making it ready for new settings to be entered.

```
VPX_SendCommand( “settingsFileList_Init” );
```

13.16.2 Next Settings File in List

GUI: **File > settings > SettingsFileList > Next Settings File** **F9 (default)**

CLP Command: **settingsFileList_Next**

SDK Function: - none -

Executes the settings for the next settings file in the settings file list.

```
VPX_SendCommand( “settingsFileList_Next” );
```

13.16.3 Add Settings File to the List

GUI: **-none-**

CLP Command: **settingsFileList_AddName *FileName***

FileName: **Name of the settings file to be added to the settings file list.**

SDK Function: -none-

Adds a settings file name to the settings file list.

```
VPX_SendCommand ( “settingsFileList_AddName  subject1.txt” );
```

13.16.4 Restart Settings File List

GUI: **File > Settings > SettingsFileList > Restart SettingsFileList**

CLP Command: **settingsFileList_Restart**

SDK Function: -none-

Reopens the settings file list and re-applys the settings listed in the setting files.

```
VPX_SendComand( “settingsFileList_Restart” );
```

13.16.5 Toggle Autosequencer ON / OFF

GUI: **File > settings > settingsfilelist > Auto Sequencer** **F10 (default)**

CLP Command: **settingsFileList_AutoSequence *BoolValue***

BoolValue: **Yes, No, True, False, On, Off, 1, 0, Toggle**

SDK Function: -none-

Enables or disables settings file list sequencer.

```
VPX_SendCommand( “settingsFileList_AutoSequence on” );
```

13.16.6 Specify delay between Settings Files in List

GUI: **-none-**

CLP Command: **settingsFileList_SequenceSeconds *TimeValue***
TimeValue: **Amount of sequence seconds.**

SDK Function: -none-

Creates a delay between loading settings-files from the settings-file-*list.* Users may also specify sequence-seconds within the settings files themselves rather then in a settings-file-list.

Will create a delay in the execution of settings files from the list for as long as specified. Also note that the sequence seconds can be set within a settings file itself

```
VPX_SendCommand("settingsFileList_SequenceSeconds 4.5");
```

13.17 Torsion commands

13.17.1 Start / Stop Torsion Calculations

GUI: **Torsion window, Start / Stop button** **^T**

CLP Command: **torsion_Calculation** ***BoolValue***
BoolValue: **Yes, No, True, False, On, Off, 1, 0, Toggle**

SDK Function: -none-

Default: **off**

Starts and stops the torsion calculations. As a side effect this also adds or removes the torsion stripChart from from the penPlot window.

Note 1: In previous PC versions this command would open and close the torsion window as well, because in those previous versions, torsion would be calculated if and only if the torsion window were open.

See also:
VPX_GetTorsion2

```
VPX_SendCommand( "torsion_Calculation On" );
```

13.17.2 Adjust Start Point of Torsion Sampling Arc

GUI:	**Torsion window, Angle slider**
CLP Command:	**torsion_SampleAngle *FloatDegrees*** ***FloatDegrees:* floating point value 0.0 to 360.0 degrees**
SDK Function:	-none-
Default:	**180**

Adjusts the start point of the torsion sampling arc in degrees.

Range from 0 - 360.

Zero degrees is at the 3 o'clock position, 90 degrees is at the 6 o'clock position.

An interesting demonstration and validation can be obtained on a static image by first unchecking the **Auto-set after adjust** check box and then moving the **Angle** slider a few degrees. This moves the start point of the sample vector and so the autocorrelation shows a "torsional" rotation of the same number of degrees.

```
VPX_SendCommand( "torsion_SampleAngle 166" );
```

13.17.3 Adjust Radius of Torsion Sampling Arc

GUI:	**Torsion window, Radius slider**
CLP Command:	**torsion_SampleRadius *FloatValue*** ***FloatValue:* normalized floating point number 0.01 - 0.99**
SDK Function:	-none-
Default:	**0.50**

Adjust the radius (the distance out from the center of the pupil) of the torsion sampling arc. The arc should be adjusted such that: (a) ther is good variation in the striations and marks of the iris, (b) the arc does not include any reflections, such as the glint, that do not move with the iris, (c) the arc does not extend beyond the EyeCamera window.

```
VPX_SendCommand( "torsion_SampleRadius 0.75" );
```

13.17.4 Autoset Torsion Template after Adjustments

GUI:	**Torsion window, Auto-Set after adjust checkbox**
CLP Command:	**torsion_AutoSetAfterAdjust** ***BoolValue*** ***BoolValue:*** **Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	-none-
Default:	**On**

If ON, a new autocorrelation template is set whenever adjustments are made to the radius and angle.

```
VPX_SendCommand( “torsion_autosetafteradjust On” );
```

13.17.5 Display Real-Time Torsion Data

GUI:	**Torsion window, Real-time graphics checkbox**
CLP Command:	**torsion_RealTimeGraphics** ***BoolValue*** ***BoolValue:*** **Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	-none-
Default:	**Off**

Specifies whether to display real-time torsion data in the torsion window. If ON the window is updated every new field. If OFF, the window is updated every 30th field. This does not affect the real-time data stored in the data file, but does effect the CPU load.

```
VPX_SendCommand( “torsion_RealTimeGraphics On” );
```

13.17.6 Adjust Torsion Measurement Range

GUI:	-none-
CLP Command:	**torsion_MeasureDegrees** ***FloatDegrees***
SDK Function:	-none-
Default:	+/- 9.0

Adjusts the torsion measurement range.

Default is +/- 9 degrees.

Since the eye does not normaly rotate about the line of sight more then about 9 degrees there is usually no need to perform the auto-corralation past this range, because increasing the range increases the cpu load uneccesaraly. There are some situations in wich this range needs to be increased, such as when the entire head is rotated. Depending upon the power of your computer, you may need to reduce the resolution of the auto-corrlation via: torsion_ResolutionDegrees**.**

See also:
torsion_ResolutionDegrees

```
VPX_SendCommand( “torsion_MeasureDegrees  9.0” );
```

13.17.7 Adjust Torsion Measurement Resolution

GUI:	-none-
CLP Command:	**torsion_ResolutionDegrees** ***FloatDegrees***
	FloatDegrees**: floating point value between: 0.20 to 360.0**
SDK Function:	-none-
Default	0.5

Adjusts the default torsion measurement resolution.

The default is 0.5.

This minimum value is 0.20.

To limit CPU load, vary this inversely with Torsion_MeasureDegrees.

See for further discussion:
torsion_MeasureDegrees

```
VPX_SendCommand( “torsion_ResolutionDegrees 0.80” );
```

13.17.8 Set Autocorrelation Template

GUI:	**Torsion window, Set Template button**
CLP Command:	**torsion_SetTemplate**
SDK Function:	-none-

Sets a new autocorrelation template.

```
VPX_SendCommand( "torsion_SetTemplate" );
```

13.18 Interface settings commands

13.18.1 Turn Cursor Control On / Off

GUI:	**Interface > CursorControl > Eye Moves Mouse ^E**
CLP Command:	**cursor_Control** ***BoolValue*** ***BoolValue:*** **Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	**VPX_CursorControl (*bool tf*);**
Default:	**Off**

Turns Cursor Control feature on or off.

```
VPX_SendCommand( "Cursor_Control On" );
```

13.18.2 Use Fixation to Issue Button Click

GUI:	**Interface > CursorControl > Fixation Clicks Buttons ^C**
CLP Command:	**cursor_DwellClick** ***BoolValue*** ***BoolValue:*** **Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	-none-
Default:	**Off**

Turns on or off dwell time issues mouse click.

```
VPX_SendCommand( "cursor_DwellClick On" );
```

13.18.3 Specify Fixation Time to Issue Button Click

GUI:	**Controls window, DataCriteria tab, Mouse Click if Fixated slider**
CLP Command:	**cursor_DwellSeconds** ***FloatValue*** ***FloatValue:*** **From 0.00 to 9.00. Sets the amount of time until mouse click is issued due to fixation.**
SDK Function:	-none-

Specifies the dwell time in seconds before a mouse click is issued.

```
VPX_SendCommand( "cursor_DwellSeconds 2.5" );
```

13.18.4 Use Blinks to Issue Button Click	
GUI:	**Interface > Cursor Control > Blinks Click Buttons (toggle)**
CLP Command:	**cursorBlinkClick** ***BoolValue*** ***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	-none-
Default:	**Off**
Blinks will stimulate mouse clicks with this option enabled.	
`VPX_SendCommand( "cursorBlinkClick On" );`	

13.19 RemoteLink & SerialPort controls

13.19.1 Connect / Disconnect Serial Port	
GUI:	**Interface > Serial Port > Connect**
CLP Command:	**serialPortConnect** ***BoolValue*** ***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	-none-
Default:	**Off**
Connects and disconnects to the serial port. If disconnected, *ViewPoint* will not be able to receive a subsequent connect instruction via the serial port.	
`VPX_SendCommand( "serialPortConnect On" );`	

13.19.2 Specify Serial Data to Send	
GUI:	**Interface > Serial Port > Nothing, Stream, Test, Events**
CLP Command:	**serialPortSend Nothing, Stream, Test, Events, SinglePacket**
SDK Function:	-none-
Specifies what type of serial data to send.	
`VPX_SendCommand( "serialPortSend Events" );`	

13.19.3 Send Serial Port Ping

GUI:	**Interface > Serial Port > Send Ping**	**alt + shift + P**
CLP Command:	**serialPortPing**	
SDK Function:	-none-	

Sends a PING packet out over the serial connection. The RemoteLink program (or your program) is expected to reply with a PONG packet. When a PONG packet is received, the round trip time is reported.

```
VPX_SendCommand( “serialPortPing” );
```

13.20 HeadTracking commands

13.20.1 Connect / Disconnect Head Tracker Interface

GUI:	**HeadTrack > Connect**
CLP Command:	**headTrackerConnect** *BoolValue* *BoolValue*: **Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	-none-
Default:	**Off**

Connects or disconnects the head tracker interface.

See also:
dataFile_AsynchHeadData

```
VPX_SendCommand( “headTrackerConnect On” );
```

13.20.2 Specify What the Position and Angle Data Origin is Relative to

GUI:	**HeadTrack > Use Local Origin**
CLP Command:	**headTracker_useLocalOrigin** *BoolValue* *BoolValue*: **Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	-none-
Default:	**Off**

Specifies whether the position and angle data should be relative to the transmitter, or relative to the local origin as set by headTracker_resetLocalOrigin

See also:
headTracker_resetLocalOrigin

```
VPX_SendCommand( “headTracker_useLocalOrigin On” );
```

13.20.3 Set Position and Angle Origins

Control or Menu: -none-

CLP Command: **headTracker_setLocalOrigin *coordinatesAndAngleValues***
***coordinatesAndAngleValues* : x y z roll pitch yaw**

SDK Function: - none -

Sets the position and angle origins to the desired position and angle.

```
VPX_headtracker_setLocalOrigin
```

13.20.4 Set Position and Angle Data to the Center of Rotation of the Eye

Control or Menu: -none-

CLP Command: **headTracker_eyeOffset *Coordinates***
***Coordinates:* x y z**

SDK Function: - none -

Specifies the position and angle data to the center of rotation of eye. This information aids the ViewPoint program in displaying the intercept point of the primary axis of the eye when the headspace window is enabled.

```
VPX_SendCommand( “headTracker_eyeOffset 0.7 0.5 0.3” );
```

13.20.5 Reset Position and Angle Relative to the Current Position and Angle

GUI: **HeadTrack > Reset Local Origin**

CLP Command: **headTracker_resetLocalOrigin**

SDK Function: **- none -**

Sets the position and angle origins to the current position and angle. All position and angle data then begin relative to this new origin.

```
VPX_SendCommand( “headTracker_resetLocalOrigin” );
```

13.20.6 Set Position and Angle Data to the Center of Rotation of the Eye

GUI: **HeadTrack > CRT Sync > * Off, 50-72 Hz, 73-144 Hz**

CLP Command: **headTracker_CRT_sync Off, Low, High**

SDK Function: **- none -**

You can synchronize the FOB to the monitor using the CRT SYNC Pickup. Low 50- 72 Hz and high is 73-144 Hz.

```
VPX_SendCommand( “headTracker_CRT_sync Low” );
```

13.21 Binocular commands

13.21.1 Turn Binocular Mode On / Off

GUI:	**Binocular > Binocular mode (toggle)**
CLP Command:	**binocular_Mode** ***BoolValue*** ***BoolValue*****: Yes, No, True, False, On, Off, 1, 0, Toggle**
SDK Function:	- none -
Default:	**Off**

Turns binocular operation mode on or off.

```
VPX_SendCommand( “Binocular_Mode On” );
```

13.21.2 Specifies Binocular Averaging

GUI:	**Binocular >** **Show both eye positions** **Show average Y-gaze positions** **Show average of eye positions**
CLP Command:	**binocular_Averaging** ***averageOption*** ***averageOption*** **: Off, only_Y, both_XY**
SDK Function:	- none -

Specifies whether to use binocular averaging and which type.

```
VPX_SendCommand( “binocular_Averaging  both_XY ” );
```

13.22 File Related

13.22.1 Launch ViewPoint with Command Line Options

GUI: **-none-**

CLP Command: **launchApp** ***applicationName argumentsToApp***

applicationName: ***The name of the application to launch***

argumentsToApp: ***command line arguments may be flags, input/output file names, etx.***

SDK Function: **VPX_LaunchApp(** ***applicationName, argsToApp*** **);**

A general purpose command to launch an application and to provide it with optional command line arguments.

Note: Must use full path for file names if they are not in the default location for the application.

Special: This command will enable playing stimulus movies.

WARNING: The CLP strings are parsed by the ViewPoint application, therefore you cannot use this CLP string to launch the ViewPoint application itself, instead use: VPX_LaunchApp("ViewPoint.exe","");

See also:

VPX_QuitViewPoint();

```
launchApp  DataMarker.exe
launchApp  "VP_MoviePlayer.exe"  "C:/ARI/Movies/m 1.mov"
VPX_SendCommand ("launchApp VP_MoviePlayer.exe  \"C:/ARI/Movies/m 6.mov\" ");
VPX_LaunchApp("ViewPoint.exe", " "); // see
VPX_SendCommand ("launchApp ViewPoint.exe" ); // PARSE ERROR IF VP NOT RUNNING
```

13.22.2 Specify Default ViewPoint Folder path

GUI: -none-

CLP Command: **setPath** ***pathID pathString***

pathID**: IMAGES: DATA: SETTINGS: SOUNDS: DOCUMENTATION:**

pathString **: full path string or keyterm: DEFAULT_PATH**

SDK Function: -none-

Specifies the current default folder path for important ViewPoint directories.

CAUTION: the current version requires that (a) only forward slashes (/) be used, and (b) a final forward slash be used; otherwise bad things may happen.

The special keyTerm DEFAULT_PATH may be used to reset the path to the original ViewPoint default path string.

The key term IMAGES: must include the colon at the end.

See also:

PTCHAR VPX_GetViewPointHomeFolder(PTCHAR pathString);

```
setPath IMAGES: DEFAULT_PATH
setPath IMAGES: "C:/ARI/Global/Images/"
```

13.23 FKey

13.23.1 Associate CLP Commands with FKeys

GUI: **-none-**

CLP Command: **Fkey_cmd *fKeyNumber commandString***
***fKeyNumber* : integer in { 1 to 12 }**
***commandString* : any valid command**

SDK Function: -none-

Allows CLP commands to be associated with FKeys. It is a very useful to customize the Fkeys for your needs.

These fKey associations can be viewed in the Info panel: menu Help > Info > **ShortCuts** tab.

Note: do not put the command string in quotes; all text after the number is included in the command string including leading spaces and tabs, UNLESS the string contains a semicolon, which has higher priority than the `Fkey_cmd` command does, so anything after the semicolon will be processed independently after the `Fkey_cmd` command is processed. *Important*: this is subject to change.

Restore defaults with: **`fkey_default`**

```
VPX_SendCommand( “fkey_cmd 12  dataFile_NewUnique” );
VPX_SendCommand( “fkey_cmd 11  stimulus_playSoundFile \"No Way .wav\" ” );
```

13.24 TTL

13.24.1 Associate CLP Commands with TTL Voltage Changes

GUI: **-none-**

CLP Command: **`ttl_cmd` *signedChannel commandString***
***signedChannel* : +/- just before an integer in { 0 to 7 }**
***commandString* : any valid command**

SDK Function: -none-

Allows CLP commands to be associated with TTL voltage changes, high or low.

These associations can be viewed in the Info panel: menu Help > Info > **TTL CMDS** tab.

Restore defaults with: **`ttl_default`**

Requires the TTL option.

```
VPX_SendCommand( “ttl_cmd +0 dataFile_Pause” );
VPX_SendCommand( “ttl_cmd -0 dataFile_Resume” );
VPX_SendCommand( “ttl_cmd +1 dataFile_NewUnique” );
VPX_SendCommand( “ttl_cmd -1 historyReport \"TTL ch#1 LO\" ” );
VPX_SendCommand( “ttl_cmd +2 dataFile_InsertMarker 2” );
```

13.24.2 Set TTL Output Voltages

GUI: **-none-**

CLP Command: **`ttl_out signedChannel`**
`signedChannel : +/- just before an integer in { 0 to 7 }`

SDK Function: -none-

Provides a mechanism to easily set the TTL output voltages.

There must be no space between the sign and the number.

Requires the TTL option.

```
VPX_SendCommand( “ttl_out -0” ); // set TTL channel 0 LO
VPX_SendCommand( “ttl_out +7” ); // set TTL channel 7 HI
```

13.24.3 Simulate Change in TTL Input

GUI: **-none-**

CLP Command: **`ttl_simulate signedChannel`**
`signedChannel : +/- just before an integer in { 0 to 7 }`

SDK Function: -none-

A change in TTL input can be simulated to the software to aid in development and debugging.

Does not require the TTL option.

```
VPX_SendCommand( “ttl_simulate +0” ); // simulate TTL channel 0 HI event
```

13.24.4 Set TTL Output to Indicate Data Quality Codes

GUI: **-none-**

CLP Command: **ttl_out_quality** ***channel levelString***

channel **: integer in { 0 to 7 }**

levelString **: OFF, or any of VPX_QUALITY_***

VPX_QUALITY_PupilScanFailed
VPX_QUALITY_PupilFitFailed
VPX_QUALITY_PupilCriteriaFailed
VPX_QUALITY_PupilFallBack
VPX_QUALITY_PupilOnlyIsGood
VPX_QUALITY_GlintIsGood

SDK Function: -none-

A ttl output channel can be specified to indicate when the data quality value is **greater than or equal to** (>=) the quality critereon level.

The level strings are identical to the VPX_QUALITY_* constants defined in the VPX.h file. The best quality is level == QUALITY_GlintIsGood, poorer quality raises the quality level. Setting the quality criterion to x will cause the TTL channel to always be high, because the data quality value is always greater than or equal to this.

See also:

VPX_GetQuality
verbose +ttl_out

```
VPX_SendCommand( “ttl_out_quality 0 VPX_QUALITY_PupilFallBack” );
```

13.25 Misc

13.25.1 Specify Verbose Information to Send to Event History Window

GUI: **-none-**

CLP Command: **verbose +/-*activityType***
activityType : **ttl_out ttl_cmd calibration settings**

SDK Function: -none-

CURRENTLY BEING EXPANDED

Allows fine control over the type of verbose information sent to the History window.

The reports are turned on or off by preceding the keyTerm with a plus (+) or minus(-), respectively. There can be no space between the sign and the keyTerm.

This is used for debugging and the details of what is reported may change without notice.

The following arguments can be used to turn reporting on or off.

```
+setting
+parsing
+ttl_out
+ttl_cmd
+frameGrabber
+videoTiming
+serialSend
+serialReceive;
+insertMark
+insertString
+insertUserTag
+calibration
+headTracker
+nameList
```

```
VPX_SendCommand ( “verbose +ttl_cmd +ttl_out –calibration -settings” );
```

13.25.2 Update Eye Data on Request

GUI: **Alt-Shift-U**

CLP Command: **updateData**

SDK Function: -none-

Some programs want as much CPU time as they can get, so they would like to have ViewPoint video image processing turned off until fresh data is needed. We have now added the capability to update eye data based on the most recent video image in memory (this memory is constantly being updated via direct memory access, DMA, by the video capture board).

Note: sending an **updateData** command while NOT frozen may cause a glitch in the data timing.

```
VPX_SendCommand ( “updateData” );
```

13.25.3 Set Status Window Update Rate for FPS Field

GUI: **-none-**

CLP Command: **fpsUpdate** ***nth_Interupt***
nth_Interupt : integer

SDK Function: -none-

Added control for rate of update of the FPS (frames per second) value in the Status window. The argument may be any positive number. An argument of 1 would cause the fps calculation to be updated every video interupt (frame or field), 2 would be every 2nd, etc.

```
VPX_SendCommand ( “fpsUpdate 3” );
```

13.25.4 SDK Debug Mode

GUI: **-none-**

CLP Command: **debugSDK**

SDK Function: **VPX_DebugSDK(int onOff)**

This command will add debuging capability for the dll based sdk.

```
VPX_DebugSDK(1);
```

13.25.5 Specify ViewPoint Generated Events

GUI: **-none-**

CLP Command: **vpx_event *+option -option***
***option* : videoSynch**

SDK Function: **-none-**

This provides a mechanism to control (thin) the number of events that *ViewPoint* generates. The command format the keyword vpx_event followed by one or more options that are immediately preceeded (no spaces) by a + or - character.

Note: unnecessary messages will unnecessarily consume system resources.

See:
VPX_VIDEO_SyncSignal

```
VPX_DebugSDK(1);
```

13.25.6 Turn Accelerator Key Functionality On / Off

GUI: **-none-**

CLP Command: **acceleratorKeys *BoolValue***
***BoolValue*: Yes, No, True, False, On, Off, 1, 0, Toggle**

SDK Function: `VPX_AcceleratorKeys ( bool tf );`

Default: **On**

RARE

Specifies whether accelerator keys may be used.

```
VPX_SendCommand( “acceleratorKeys Off” );
```

13.26 Parser Instructions

13.26.1 Settings File Comment

GUI: **-none-**

CLP Command: **COMMENT**
//

SDK Function: -none-

For use in a settings file. Use either the key word COMMENT or the double forward slashes (//) to tell the parser to ignore this line.

```
//
```

13.26.2 End of Settings File Command

GUI: **-none-**

CLP Command: **END**

SDK Function: -none-

The command END should be placed by itself on the final line of a settings file. This provides a way to verify that all the settings command lines were read. *ViewPoint* reports "Settings read successfully" when the END command is reached.

```
END
```

Chapter 14 Software Developers Kits (SDK)

14.1 General

A third party application (for example, your application) may interact with the *ViewPoint EyeTracker®* by compiling with the `VPX_InterApp.lib` file, a library file. At run time your program will dynamically link to the `VPX_InterApp.DLL`, a dynamically linked library file. All of the ViewPoint inter-application communications constants, data types, and functions begin with the prefix `VPX_` and are specified in the `VPX.h` file.

Your application may call the VPX_ routines `VPX_LaunchApp("ViewPoint.ext", " ")` and `VPX_QuitViewPoint()` to control when the *ViewPoint EyeTracker®*, application is running. If the remote application will provide its own control settings to *ViewPoint*, then it may be desirable to launch only the EyeCamera window, by calling:

```
VPX_LaunchApp("ViewPoint.ext", " ")
VPX_LaunchApp("ViewPoint.ext", " -hideMain –freeEyeCamera ")
```

The command line argument `–minimized` allows access to the main *ViewPoint* program window via the minimized icon, `-hideMain` makes the main window of *ViewPoint* completely inaccessible. `–freeEyeCamera` launches *ViewPoint* with the eye camera window as a free floating window.

Note: currently, if launched minimized, the splash window is not presented.

Your application may access *ViewPoint* data at any time. It should be noted that employing a tight polling loop is a poor programming practice, because it unnecessarily consumes computer CPU time. If only occasional updates are required, a timer would probably be the preferred method (see MSWindows SetTimer function). If your application needs to know immediately every time the data values are updated, then it should register to receive notifications of fresh data.

14.2 Registering to Receive Notifications

Registering to receive notifications of fresh data is a multi-step process:

1. Obtain the unique message identifier used by ViewPoint for inter-process communication:

```
const static UINT wm_VPX_message = RegisterWindowMessage(VPX_MESSAGE).
```

2. The window(s) that wish to receive notification must register to receive it by calling:

```
VPX_InsertMessageRequest( m_hWnd, wm_VPX_message ).
```

More than one window in an application may request notifications, however no window should make more than one request.

3. Your program must listen for the notifications. This may be done in several ways. If you are using MFC message maps, then you should add a mapping, e.g.:

```
ON_REGISTERED_MESSAGE( wm_VPX_message, OnVPX_message ).
```

If you are using Win32, then you will want to listen for the `wm_VPX_message` notification just as you would listen for a `WM_PAINT` message.

4. When a `wm_VPX_message` is received, your message handling routine should determine the type of the notification, as follows:

```
WORD notificationCode = HIWORD (wParam).
```

5. This `notificationCode` may then be used in a switch statement that uses case constants defined in the `VPX.h` file. Among others, these include: `VPX_DAT_FRESH`, `VPX_ROI_CHANGE`, and notifications relating to the presentation of calibration point stimuli. Refer to Table 40 for a complete list.

IMPORTANT: A finite number of message windows may register a `VPX_InsertMessageRequest` at one time (currently ten), after which notification requests will be refused. You application should always make sure that each requesting window successfully removes its request for notification before the window is destroyed or before the program terminates, by calling: `VPX_RemoveMessageRequest(m_hWnd).`

The *ViewPoint EyeTracker*® Status window contains the field **DLL sharing**. This shows the number of windows that are currently registered to receive notifications. You may monitor this value during program development to make sure that terminating your application also decrements this value. If you find that all requests are used up, the only way to reset this list is to terminate every application that dynamically links to the `VPX_InterApp.DLL`.

Note 1: The `VPX_Set_x` routines work by directly sending values to the *ViewPoint EyeTracker*®. Any commands sent before *ViewPoint* is launched, will have no effect on the initial startup values of *ViewPoint*.

Note 2: *ViewPoint* does not send out notifications when control values are changed, so unless the remote application explicitly sets the *ViewPoint* values, the remote applications control values (e.g. of sliders) will not accurately reflect the *ViewPoint EyeTracker*® application control values.

We encourage users and third party developers to work with us in developing this interface. We take suggestions and usability reports very seriously.

14.3 Example SDK Code

Your application must first register with the `VPX_InterApp.lib` by doing the following for each window procedure (WinProc) that desires notification:

```
if ( uniqueMessageId == 0 ) {
  uniqueMessageId = RegisterWindowMessage( VPX_MESSAGE );
  VPX_InsertMessageRequest( hWnd, uniqueMessageId );
}
```

After registering, the WinProc should listen for notifications:

```
LRESULT CALLBACK WndProc ( HWND hWnd, UINT message, WPARAM wParam, LPARAM lParam )
{
    WORD notificationCode = HIWORD(wParam) ;
    if ( message == uniqueMessageId ) {
        switch ( notificationCode )
        {
            case VPX_DAT_FRESH :
                {
                    EyeType eye = LOWORD ( wParam );
                    showFreshData( eye graphicsWindow );

                } break;
```

14.4 Data Quality Codes

Because the data can now be from multiple sources, and because in data files it is often desirable to store all data on a single record line, the concept of a data reject record is obsolete. Instead, data quality codes are provided for each source.

A VPX_DAT_FRESH is sent and the SDK application is responsible for obtaining the quality code and making a decision as to what levels of quality are appropriate for various situations. We highly recommend that you use the constants provided, rather than testing the integer value, as these are not guaranteed to remain unchanged. Nevertheless, the hierarchical relationships are expected to remain intact. For example:

```
VPX_GetDataQuality2( eye, &quality );
switch (quality)
{
    case VPX_QUALITY_PupilScanFailed: showGaze(false); break;
    case VPX_QUALITY_PupilFitFailed: showGaze(false); break;
    case VPX_QUALITY_PupilCriteriaFailed: showGaze(false); break;
    case VPX_QUALITY_PupilFallBack: showGaze(true ); break;
    case VPX_QUALITY_PupilOnlyIsGood: showGaze(true ); break;
    case VPX_QUALITY_GlintIsGood: showGaze(true ); break;
}
```

Data records are constantly stored, because the data quality may vary with different sources. For example, data may be good from one eye, and a wink occurred in the other eye, or both eyes are closed, but the head tracker data is still good. Data sections now contain individual quality columns, as needed.

14.5 Sending CLP Commands with the SDK

The *ViewPoint EyeTracker*® software developers kit (SDK) provides a routine that allows sending Command Line Parser (CLP) strings directly to the *ViewPoint EyeTracker*®. This means that the same command strings that are loaded from Settings Files or that are sent in serial port packets, can be issued via the DLL. An important benefit is that this allows passing textStrings and fileNames.

```
result = VPX_SendCommand( TCHAR *cmd );
VPX_SendCommand("dataFile_NewName rabbitPictureData");
VPX_SendCommand("dataFile_InsertString Showing Picture of a Rabbit");
VPX_SendCommand("settingsFile_Load  RabbitPictureROI.txt");
```

The function returns an integer result value that provides feedback about the success or problems encountered. See **VPX.h** for a list of return codes.

For a matrix comparing CLP commands, SDK functions, window buttons, and menu items, refer to the Command and Control Matrix contained in the SDK folder.

14.6 High Precision Timing

High Precision timing (HPT) with resolution in the order of 0.0000025, i.e., 2.5E-6 or 2.5 microseconds, is available via the SDK function call:

```
#define SINCE_PRECISE_INIT_TIME ((double*)NULL)
#define RESET_PRECISE_HOLD_TIME 1
#define LEAVE_PRECISE_HOLD_TIME 0

double seconds = VPX_GetPrecisionDeltaTime(double *holdTime, BOOL resetHoldTime);
```

The function returns the difference between the holdTime and the current time. When NULL is passed to VPX_GetPrecisionDeltaTime it returns the time since the DLL was first initialized, which is when it was first called. If resetHoldTime is true, the variable holdTime will be set to the current time when the function returns.

14.7 DLL Version Checking

All applications using the ViewPoint SDK should include the following check for a possible mismatch between the DLL version that is being linked at run time and the version of the SDK library (prototypes and constants) that was compiled into the application.

```
BOOL versionMismatch = VPX_VersionMismatch (VPX_SDK_VERSION);

double  dllVersion = VPX_GetDLLVersion();
if ( VPX_SDK_VERSION != dllVersion ) doSomething();
```

14.8 SDK Access Functions

There are many functions provided to access ViewPoint data and the current state of the ViewPoint Program. These are generally referred to as the ***Get*** commands and ***Set*** commands.

14.8.1 Get Eye Data Access

```
int ok = VPX_GetGazePoint ( VPX_RealPoint* gazePoint )
int ok = VPX_GetGazePoint2 ( VPX_EyeType eye, VPX_RealPoint* gazePoint )
int ok = VPX_GetGazePointSmoothed2( VPX_EyeType eye, VPX_RealPoint* gazePnt );
```

Retrieves the calculated position of gaze, for either Eye_A or Eye_B if binocular mode is on.

Monocular ViewPoint uses Eye_A by default.

Returns 1 if valid VPX_EyeType, 0 otherwise.

See also:

VPX_GetPupilPoint2

VPX_GetGlintPoint2

```
VPX_RealPoint rp ;
VPX_GetGazePoint2( EYE_A, &rp );
printf( " X: %g , Y: %g ", rp.x, rp.y );
```

```
int VPX_GetGazeAngle2( VPX_EyeType eye, VPX_RealPoint *gp )
int VPX_GetGazeAngleSmoothed2( VPX_EyeType eye, VPX_RealPoint *gp )
```

Retrieves the calculated angle of gaze, for either Eye_A, or Eye_B if binocular mode is on. Monocular ViewPoint uses Eye_A by default.

Note: The angles are from trigonometric calculations based on the values that the user has measured and set for the window size (horizontal & vertical) and the viewing distance. This is **NOT** for use with the head tracker option.

See also:

VPX_GetMeasuredScreenSize

VPX_GetMeasuredViewingDistance

VPX_GetHeadPositionAngle

```
VPX_RealPoint rp ;
VPX_GetGazeAngleSmoothed2( EYE_A, &rp );
printf( " X: %g , Y: %g ", rp.x, rp.y );
```

int ok = VPX_GetFixationSeconds (double* seconds)

int ok = VPX_GetFixationSeconds2 (VPX_EyeType eye, double* seconds)

Retrieves the number of seconds that the total velocity has been below the VelocityCriteria for either Eye_A or Eye_B if binocular mode is on. Monocular ViewPoint uses Eye_A by default. .

A zero value indicates a saccade is occurring.

Returns 1 if valid VPX_EyeType, 0 otherwise.

This function replaces the less precise function: VPX_GetFixationDuration(DWORD);

See also:

VPX_GetTotalVelocity

```
double seconds, milliseconds, microseconds ;
VPX_GetFixationSeconds2 ( EYE_A, &seconds );
milliseconds = 1000.0 * seconds ;
microseconds = 1000.0 * milliseconds ;
```

VPX_GetTotalVelocity (double *velocity);

VPX_GetTotalVelocity2 (VPX_EyeType eye, double* velocity);

Retrieves the total velocity of movement in the (x,y) plane. That is, the first derivative of the (smoothed) position of gaze for either Eye_A, or Eye_B if binocular mode is on. Monocular ViewPoint uses Eye_A by default.

Returns 1 if valid VPX_EyeType, 0 otherwise.

See also:

VPX_GetComponentVelocity

VPX_GetFixationSeconds

```
VPX_RealType velocity ;
VPX_ VPX_GetTotalVelocity2 ( EYE_A, &velocity );
printf( “ Velocity: %g “, velocity );
```

VPX_GetComponentVelocity(VPX_RealPoint *velocityComponents);
VPX_GetComponentVelocity2(VPX_EyeType eye, VPX_RealPoint *velocityComponents);

Retrieves the x- and y-components of the eye movement velocity for either Eye_A, or Eye_B if binocular mode is on. Monocular ViewPoint uses Eye_A by default.

Returns 1 if valid VPX_EyeType, 0 otherwise.

See also:
VPX_ GetTotalVelocity

```
VPX_RealPoint cv ;
VPX_GetComponentVelocity2( Eye_A, &cv );
printf( " dx/dt: %g , dy/dt: %g ", cv.x, cv.y );
```

VPX_GetPupilSize (VPX_RealPoint *dims)
VPX_GetPupilSize2 (VPX_EyeType eye, VPX_RealPoint *dims)

Retrieves the raw size of the oval fit to the pupil for either Eye_A or Eye_B if binocular mode is on. Monocular ViewPoint uses Eye_A by default.

The x- y-size values are normalized with respect to the EyeSpace dimensions that have a 4:3 aspect, so the x- and y-values are anisotropic. To obtain the aspect ratio of the pupil, rescale: (aspect = ps.x / (ps.y * 0.75)

Returns 1 if valid VPX_EyeType, 0 otherwise.

See also:
VPX_GetPupilAspectRatio
VPX_GetPupilOvalRect

```
VPX_RealPoint  pupilDimensions ;
double  pupilAspectRatioCalculated, pupilAspectRatioRetrieved ;
VPX_GetPupilSize( &pupilDimensions );
// NOTE: dimensions are normalized but incommensurate
pupilAspectRatioCalculated = pupilDimensions.x / (pupilDimensions.y * 0.75 );
VPX_GetPupilAspectRatio( &pupilAspectRatioRetrieved );
difference = pupilAspectRatioCalculated - pupilAspectRatioRetrieved ;
printf( "pupilAspectRatio %g - %g = %g",
  pupilAspectRatioCalculated, pupilAspectRatioRetrieved, difference );
```

```
int VPX_GetPupilAspectRatio( double *ar );
int VPX_GetPupilAspectRatio2( VPX_EyeType eye, double *ar );
```

The ratio is independent of the EyeCamera window shape. Aspect ratio, so a circular pupil will always produce a value of 1.0

Retrieves the pupil aspect ratio.

See also:

VPX_GetPupilSize
VPX_GetPupilOvalRect

See example under: **VPX_GetPupilSize**

```
VPX_GetPupilOvalRect ( VPX_RealRect *ovalRect )
VPX_GetPupilOvalRect2 ( VPX_EyeType eye, VPX_RealRect *ovalRect )
```

Retrieves the rectangle in **RAW** EyeSpace coordinates (normalized with respect to the EyeCamera window) that specifies the oval (ellipse) fit to the pupil.

Separate rectangles are available for Eye_A, or Eye_B if binocular mode is on. Monocular ViewPoint uses Eye_A by default.

See also:

VPX_GetPupilSize
VPX_RealRect2WindowRECT
VPX_GetPupilAspectRatio
VPX_RealRect2WindowRECT

```
// Remote painting of the pupil size and location.
HDC hDC = GetDC( hWnd );
RECT wr, scaledPupilRECT ;
VPX_RealRect pr ;
VPX_GetPupilOvalRect( &pr );
GetClientRect( hWnd, &cr );
VPX_RealRect2WindowRECT( pr, cr, &scaledPupilRECT );
Rectangle( hDC, scaledPupilRECT );
ReleaseDC( hWnd, hDC );
```

VPX_GetPupilPoint (VPX_RealPoint *rawPupilLoc)
VPX_GetPupilPoint2 (VPX_EyeType eye, VPX_RealPoint *rawPupilLoc

Retrieves the **raw** normalized (x,y) location of the center of the pupil (center of the oval fit to the pupil) in the EyeSpace, for either Eye_A or Eye_B if binocular mode is on. Monocular ViewPoint uses Eye_A by default. (c.f. `VPX_GetPupilCentroid2`)

```
VPX_GetPupilPoint2( EYE_A, &rawPupilLocation );
```

VPX_GetGlintPoint (VPX_RealPoint *rawGlintLoc)
VPX_GetGlintPoint2 (VPX_EyeType eye, VPX_RealPoint *rawGlintLoc)

Retrieves the **raw** normalized (x,y) location of the center of the glint (center of the oval fit to the glint) in the EyeSpace, for either Eye_A or Eye_B if binocular mode is on. Monocular ViewPoint uses Eye_A by default. (c.f. `VPX_GetGlintCentroid2`)

```
VPX_GetGlintPoint2( EYE_A, &rawGlintLocation );
```

int VPX_GetDiffVector(VPX_RealPoint *dv)
int VPX_GetDiffVector2 (VPX_EyeType eye, VPX_RealPoint *dv)

Retrieves the **raw** normalized vector difference between the centers of the pupil and the glint in the EyeSpace, for either Eye_A or Eye_B if binocular mode is on.

Monocular ViewPoint uses Eye_A by default.

```
VPX_GetDiffVector2( EYE_A, &differenceVector );
```

VPX_GetPupilCentroid2 (VPX_EyeType eye, VPX_RealPoint *centroid

Provides **raw** data access to the normalized centroid of the pupil threshold scan in the EyeSpace window, regardless of what subsequent processing options are selected. (c.f. `VPX_GetPupilPoint2 )`

```
VPX_GetPupilCentroid2( EYE_A, &centroid );
```

VPX_GetGlintCentroid2 (VPX_EyeType eye, VPX_RealPoint *gc)

Provides raw data access to the normalized centroid of the glint threshold scan in the EyeSpace window, regardless of what subsequent processing options are selected. (c.f. `VPX_GetGlintPoint2`)

```
VPX_GetGlintCentroid2 ( EYE_A, &gc );
```

VPX_GetTorsion(double *degrees)
VPX_GetTorsion2 (VPX_EyeType eye, double *degrees)

Retrieves torsion in degrees for either Eye_A or Eye_B if binocularmode is on. Monocular ViewPoint uses Eye_A by default.

```
VPX_GetTorsion2 ( EYE_A, &degrees );
```

VPX_GetDataQuality2 (VPX_EyeType eye, int *quality)

Retrieves the quality code for the eye data.
See `VPX.h` for a list of data quality constants.

```
VPX_GetDataQuality2 ( EYE_A, &quality );
```

14.8.2 Get Time Information

VPX_GetDataTime2 (VPX_EyeType eye, double *dataTime)

Retrieves the time that the video frame became available for the current data point, before video image processing and other calculations were done. This was modified in version 2.8.2.36, Previously this obtained the time that the data was stored to the DLL and a VPX_DAT_FRESH event was issued. Now this function obtains the video sych time that better reflects the actual time that the image of the eye became available, and is not affected by variance in image processing time. The data storage time can now be obtained via **VPX_GetStoreTime2**.

Note: this modification effects VPX_GetDataDeltaTime2 such that its variance should significantly reduced.

See also:
VPX_GetStoreTime2

```
VPX_GetDataTime2 ( EYE_A, &dataTime );
```

VPX_GetDataDeltaTime2 (VPX_EyeType eye, double* deltaTime)

Retrieves the time since the last GetDataTime2 value.

```
VPX_GetDataDeltaTime2 ( EYE_A, &deltaTime );
```

VPX_GetStoreTime2 (VPX_EyeType eye, double* storeTime)

This is the last time that the data was stored to the DLL and a VPX_DAT_FRESH event was issued. Use VPX_GetDataTime for eye movement times; use this to find out when the data was available in the DLL, e.g., to calculate the delay in inter-application notification event handling.

```
VPX_ GetStoreTime2 ( EYE_A, &deltaTime );
```

14.8.3 Get Motor Data

VPX_GetHeadPositionAngle (VPX_PositionAngle *hpa)

Retrieves head position and angle data. The PositionAngle structure is defined in VPX.h.

** available with head tracker option only **

NOTE: Subject to change.

```
VPX_PositionAngle hpa;
VPX_GetHeadPositionAngle ( &headTrackerSixDOF );
```

POINT VPX_GetCursorPosition();

Returns the integer screen coordinates of the mouse cursor.

See also:

cursor_Control

VPX_GetMeasuredScreenSize

```
//Convert from pixel position to normalized screen position.
POINT pixelCursorPosition = VPX_GetCursorPosition();
VPX_RealPoint screenSize, normalizeCursorPosition;
VPX_GetMeasuredScreenSize ( &screenSize );
normalizeCursorPosition.x = (float) pixelCursorPosition.x / screenSize.x ;
normalizeCursorPosition.y = (float) pixelCursorPosition.y / screenSize.y ;
```

14.8.4 Get ViewPoint Status

```
int VPX_GetStatus( VPX_StatusItem );
```

This provides a simple way to determine the current status or state of various ViewPoint operations.

Note: The return value may need to be type cast for correct interpretation.

See also:

status_Dump

VPX_STATUS_CHANGE

```
int running = VPX_GetStatus( VPX_STATUS_ViewPointIsRunning );
// regardless of whether ViewPoint or RemoteLink is the local distributor.
int frozen  = VPX_GetStatus( VPX_STATUS_VideoIsFrozen );
int open    = VPX_GetStatus( VPX_STATUS_DataFileIsOpen );
int paused  = VPX_GetStatus( VPX_STATUS_DataFileIsPaused );
int thresh  = VPX_GetStatus( VPX_STATUS_AutoThresholdInProgress );
int calib   = VPX_GetStatus( VPX_STATUS_CalibrationInProgress );
int binoc   = VPX_GetStatus( VPX_STATUS_BinocularModeActive);
int scene   = VPX_GetStatus( VPX_STATUS_SceneVideoActive);
char shape  = (char)VPX_GetStatus( VPX_STATUS_StimulusImageShape );
// returns 'I'=isotropic stretch, 'C'=centered, 'F'=fit to window, 'A'=actual
Int dllDataSource = VPX_GetStatus( VPX_STATUS_DistributorAttached );
// returns: 0=VPX_Distributor_None, 1=VPX_Distributor_IsViewPoint, or
//     2=VPX_Distributor_IsRemoteLink
```

```
PTCHAR VPX_GetViewPointHomeFolder( PTCHAR pathString );
```

Concatenates the full path to the ViewPoint folder onto the end of the provided string.

Note: this is not a copy operation, i.e., it does not clear any existing contents of the provided string. To effectively obtain a copy operation, make sure an empty string is provided.

```
TCSTR pictureFile = TEXT("") ;             // clear VERY IMPORTANT TO DO
VPX_GetViewPointHomeFolder( pictureFile ); // adds:  ...ViewPoint/"
lstrcat( pictureFile, IMAGE_FOLDER );      // adds   "/Images/"
lstrcat( pictureFile, myPicture.bmp );     // adds   "myPicture.bmp"
```

14.8.5 Get ViewPoint Stimulus Window

```
HWND VPX_GetViewPointStimulusWindow(void);
HWND VPX_GetViewPointGazeSpaceWindow(void);
```

Allows a layered program to access to ViewPoint's Stimulus_Window by way of the window handle.

Note: this will work only if the the local data distributor application is *ViewPoint*; it will not work if the local distributor application is *RemoteLink*.

See also:

VPX_SetEyeImageWindow
VPX_SetExternalStimulusWindow
VPX_GetStatus(VPX_STATUS_DistributorAttached);

```
int dllSource = VPX_GetStatus( VPX_STATUS_DistributorAttached );
if ( VPX_Distributor_IsViewPoint == dllSource ) {
 for ( int ix=0; ix<2; ix++ )
 {
  HWND hWnd ;
  if ( ix == 0 ) hWnd = VPX_GetViewPointStimulusWindow();
  else hWnd = VPX_GetViewPointGazeSpaceWindow();
  if (!hWnd) continue ;
  CWnd* w = FromHandle( hWnd );
  CDC*  d = w->GetDC();
  RECT  r ;
  w->GetClientRect(&r);
  d->Rectangle( r.left+10, r.top+10, r.right-10, r.bottom-10 );
  d->MoveTo( r.left, r.bottom ); d->LineTo( r.right, r.top );
  r.left = r.top = 25 ;
  d->DrawText("Drawing from\nVPX_mfc_demo",&r,0);
  ReleaseDC(d);
 }
}
```

14.8.6 Get Stimulus Display Geometry

VPX_GetMeasuredViewingDistance(VPX_RealType *vd);

Provides the physical distance (Millimeters) of the subject's eye to the display screen, as specified by the user in the ViewPoint GeometryGrid dialog.

When the head is free move and a head tracker is used, this value may not be accurate.

See also:
VPX_GetHeadPositionAngle
VPX_GetMeasuredScreenSize

```
VPX_RealPoint rsc;
VPX_GetMeasuedViewingDistance( &rcs );
```

int VPX_GetMeasuredScreenSize(VPX_RealPoint *displaySize);

Provides the physical size of the display screen (Millimeters), as calculated from the ViewPoint GeometryGrid dialog specifications.

See also:
VPX_ GetMeasuredViewingDistance

```
VPX_RealPoint rp ;
VPX_GetMeasuredScreenSize( &rp );
printf("Stimulus Display Screen Size is %d X %d", rp.x, rp.y );
```

14.8.7 Get ROI

VPX_GetROI_RealRect (int roiN, VPX_RealRect *rr)
where roiN is in { 0 to 99 }

Retrieves the normalized floating point coordinates for the specified region of interest (ROI).

```
VPX_RealRect rr;
RECT cr;
INT w, h;
GetClientRect( hwnd, &cr ); w = cr.right; h=cr.bottom;
for ( ix=0; ix<MAX_ROI_BOXES; ix++) {
  VPX_GetROI_RealRect( ix, &rr );
  printf("ROI %d = (%d,%d)(%d,%d)",
    (int)(w*rr.left), (int)(h*rr.top), (int)(w*rr.right), (int)(h*rr.bottom) );
  }
```

int VPX_ROI_GetHitListLength (VPX_EyeType eye)

The ROI may be overlapped, so a gaze point may be in more than osne ROI. This function returns a count of the number of ROI the gaze point is in. This is calculated for each eye since the gaze point may be different for the left and right eyes. If the gaze point is not in any ROI, a zero value is returned. If the gaze point was in three overlapping ROI, the value three is returned, etc.

Monocular *ViewPoint* users should specify Eye_A.

See sample code under: VPX_ROI_GetHitListItem

```
int numberOfRegionsHit = VPX_ROI_GetHitListLength( EYE_A );
```

int VPX_ROI_GetHitListItem (EyeType eye , int NthHit)

The ROI may be overlapped, so a gaze point may be in more than one ROI. This function returns the ROI index number of the Nth ROI that the gaze point is in for either Eye_A, or Eye_B if binocular mode is on; monocular ViewPoint should specify Eye_A. The NthHit argument starts at zero. The functions may be called repeatedly to obtain successive ROI index values until no more ROI are in the hit list. If the *NthHit* argument is greater than the hit count, then the function returns the value ROI_NOT_HIT. The test is for values inside the ROI box values, not resting on the box lines.

Monocular *ViewPoint* users should specify Eye_A.

See also: **VPX_ROI_GetHitListLength**

```
int ix = 0; // range is: 0 to (VPX_ROI_GetHitListLength(EYE_A) – 1 )
while( ROI_NOT_HIT != ( roiNumber = VPX_ROI_GetHitListItem( EYE_A, ix++ )))
   doSomethingWith( roiNumber );
```

14.8.8 Set Remote EyeImage

`int VPX_SetEyeImageWindow( VPX_EyeType eyn, HWND hWnd );`

Specifies the window within a layered application that should be used for display of the EyeCamera image.

See also:
`vpx_EyeCameraImageOverlays`
`VPX_SetEyeImageDisplayRect`

```
HWND hWnd = myEyeWindow ;
VPX_SetEyeImageWindow( EYE_A, hWnd );
```

`int VPX_SetEyeImageDisplayRect( VPX_EyeType eyn, RECT displayRect );`

Allows optional re-adjustment of the display image offset and size, from the default.NOTE: 320x240 provides optimal performance, other sizes may increase CPU usage.

See also:
`VPX_SetEyeImageWindow`

```
RECT displayArea = { 10, 10, 130, 250 } ;
VPX_SetEyeImageDisplayRect( EYE_A, displayArea );
```

14.9 DLL Interface

Table 13: **SDK API & Messaging Functions**

VPX_InsertMessageRequest (HWND hWnd, UINT msg)

Inserts the specified hWnd into the list of windows that are sent notification messages. E.g. when fresh data has been put in the DLL shared memory. Refer to Table 40

VPX_RemoveMessageRequest (HWND hWnd)

Removes your application's request for notification for the specified window.

VPX_GetMessageListLength (int * num)

Returns the number of windows that are registered to receive messages.

VPX_GetMessagePostCount (int * num)

Returns the total number of messages that have been distributed.

int VPX_GetViewPointAppCount(int *apps);

Sets applications to non-zero if ViewPoint is running.

BOOL VPX_VersionMismatch (VPX_SDK_VERSION)

Returns 0 if the program was compiled with the same version of the DLL lib as the DLL lib that is loaded at run time.

double VPX_GetDLLVersion()

You can obtain the version number of the loaded DLL using this function.

Example:

```
double dllVersion = VPX_GetDLLVersion();
if ( VPX_SDK_VERSION != dllVersion ) doSomething();
```

VPX_STATUS_DistributorAttached

The DLL based SDK gets data from, and sends command strings to, a "distributor" application. Normally the distributor application is the ViewPoint EyeTracker, but it could be the RemoteLink application. We now provide a mechanism for determining which, if any, it is.

```
#define VPX_Distributor_None              0
#define VPX_Distributor_IsViewPoint       1
#define VPX_Distributor_IsRemoteLink      2
#define VPX_DistributorType               int

VPX_DistributorType dllDataSource = VPX_GetStatus(
VPX_STATUS_DistributorAttached );
```

// Note: VPX_STATUS_ViewPointIsRunning returns true if ViewPoint is running either directly or via RemoteLink.

Table 14: SDK Utility Functions
VPX_GetPrecisionDeltaTime (double*, resetHoldTime) Retrieves the delta time between the holdTime and the current time.
BOOL VPX_IsPrecisionDeltaTimeAvailableQ() Use this command to determine if precision time is supported. Returns TRUE if the system supports precision time, otherwise returns false.
RectFrame (HDC hdc, int x1, int y1, int x2, int y2, int t) Draws two concentric hollow rectangles in the specified window. The inner rectangle is defined by the specified coordinates. The outer rectangle is larger by parameter **t** pixels.
EllipseFrame (HDC hdc, int x1, int y1, int x2, int y2, int t) Draws two concentric hollow ellipses in the specified window. The inner rectangle is defined by the specified coordinates. The outer rectangle is larger by parameter **t** pixels.
VPX_WindowRECT2RealRect(RECT nr, RECT clientRect, RealRect * rr); Takes in integer coordinates for a rectangle within a specified window and returns the normalized coordinates for that rectangle.
VPX_RealRect2WindowRECT(RealRect rr, RECT clientRect, RECT * scaledRect); Takes normalized coordinates of a rectangle and returns integer coordinates that have been scaled for the size of the specified window. For example: `RealRect rr = { 0.1, 0.1, 0.2, 0,2 }; RECT clientWindowRect = { 320, 240 }; RECT scaledRect ; VPX_RealRect2WindowRECT( rr, clientWindowRect, &scaledRect );` `scaledRect` will now contain { 32, 24, 64, 48 }
VPX_drawROI (HWND hWnd, int activeRegion) Draws the activeRegion ROI in red and all of the other ROI in blue, within the specified window.
int VPX_LParam2RectPoint (LPARAM codedLoc, RECT clientRect, POINT *pt); Used with VPX_CAL_* messages to obtain the location of the calibration point that is encoded in the message LPARAM. Takes LPARAM and returns integer coordinates of the calibration points that have been scaled for the size of the specified window. Previously defined in DLL but not listed in prototypes, because it was under evaluation. Added here in version 2.4.2.0

14.10 ViewPoint Events & Notification Messages

14.10.1 General Events

HIWORD(WPARAM)	**VPX_DAT_FRESH** The data has just been updated, real-time programs should now access the data that it needs by calling the accessor functions.

LOWORD(WPARAM)	The eye the command pertains to: EYE_A, EYE_B
	`VPX_EyeType eyn = (VPX_EyeType)LOWORD(wparam);`
	`VPX_RealRect gpt;`
	`VPX_GetGazePoint2( eyn, &gpt );`

LPARAM	**Do not use LPARAM.**

HIWORD(WPARAM)	**VPX_ROI_CHANGE** Indicates that a Region Of Interest (ROI) was changed.

LOWORD(WPARAM)	`RealRect rr ;`
	`RECT cr, dr ;`
	`GetClientRect( hwnd, &cr );`
	`WORD roiIndexNumber = LOWORD( wParam );`
	`VPX_GetROI_RealRect(roiIndexNumber, &rr );`
	`VPX_RealRect2WindowRECT( rr, cr, &dr );`
	`Rectangle( hdc, dr.left, dr.top, dr.right, dr.bottom );`

LPARAM	**Do not use LPARAM.**

HIWORD(WPARAM)	**VPX_STATUS_CHANGE** Indicates that a key ViewPoint status item was changed. For details, see Section: **14.8.4: Get ViewPoint Status**. **VPX_GetStatus**
LOWORD(WPARAM)	**Do not use WPARAM.**

LPARAM	`WORD statusItem = LOWORD( lParam );`
	`WORD statusValue = HIWORD( lParam );`
	`switch ( statusItem ) {`
	`  case VPX_STATUS_DataFileIsOpen :`
	`  printf("DataFile is %s", (statusValue==1)?"Open":"Closed" );`
	`  break;`
	`…`

HIWORD(WPARAM)	**VPX_VIDEO_FrameAvailable** Notifies external (layered) applications that a video frame is available in ViewPoint memory. See also: .
LOWORD(WPARAM)	**VPX_EyeType eye = LOWORD(wparam); // Usage: if (eye == EYE_A)**
LPARAM	**DWORD notUsed = lparam ; // NOTE: subject to change!**

HIWORD(WPARAM)	**VPX_VIDEO_SyncSignal** This message is sent as soon as the video capture board detects frame-ready (30 Hz) or field-ready (60 Hz) signal. The user can now tell when the image became available for processing, before any image processing has been performed. This better reflects the true time of the eye movement, and reduces noise in the timing calculation. See also: **vpx_event +videoSynch** **VPX_GetDataTime2**
LOWORD(WPARAM)	**VPX_EyeType eye = LOWORD(wparam); // Usage: if (eye == EYE_A)**
LPARAM	**DWORD deltaMicroSeconds = lparam; // NOTE: subject to change!**

14.10.2 Calibration Events

The flow of the calibration events in the autocalibration sequence is as follows:

```
VPX_CAL_BEGIN
VPX_CAL_WARN

    // each calibration point
    VPX_CAL_SHOW

        // for radius 15 down to 0
        VPX_CAL_ZOOM

    VPX_CAL_SNAP
    VPX_CAL_HIDE

VPX_CAL_END
```

HIWORD(WPARAM)	**VPX_CAL_BEGIN** Indicates that a calibration sequence is about to start. This is the first calibration message in the sequence. In general you would want to blank the stimulus display screen and disable other graphics drawing.
LOWORD(WPARAM)	The calibration point number, the actual point index number, not the random or custom sequence number.
LPARAM	The location of the upcoming stimulus point. **// Contains the location of the upcoming stimulus point.** **As below, use: VPX_LParam2RectPoint(lParam, cr, &calPt);**

HIWORD(WPARAM)	**VPX_CAL_WARN** Provides an opportunity to display a warning message to the subject, to make sure that they are paying attention. Follows VPX_CAL_BEGIN. The warmomg time, i.e., the delay between this event and the next event, can be specified in ViewPoint, EyeSpace window, Advanced button, WarningTime slider.
LOWORD(WPARAM)	The calibration point number, the actual point index number, not the random or custom sequence number.
LPARAM	Contains the location of the upcoming stimulus point. **POINT calPt; PTCHAR str = " PAY ATTENTION " ;** **RECT cr ;** **GetClientRect(hwnd, &cr);** **VPX_LParam2RectPoint(lParam, cr, &calPt);** **TextOut(hdc, calPt.x-80,calPt.y, str, strlen(str));**

HIWORD(WPARAM)	**VPX_CAL_SHOW** Indicates that the calibration stimulus point should be drawn. Follows VPX_CAL_WARN for the first stimulus point; loops back to here after VPX_CAL_HIDE for each additional stimulus point.
LOWORD(WPARAM)	The calibration point number, the actual point index number, not the random or custom sequence number.
LPARAM	Contains the location of the stimulus point. As above, use: VPX_LParam2RectPoint(lParam, cr, &calPt);

HIWORD(WPARAM)	**VPX_CAL_ZOOM** Indicates a radius change of the tunnel motion of the stimulus. Follows VPX_CAL_SHOW and is repeatedly sent until the radius shrinks to zero.
LOWORD(WPARAM)	The stimulus radius (shrinks from 15 to 2). `WORD zoomSize = LOWORD( wParam );`

LPARAM	Contains the location of the stimulus point.
	`POINT pt ;`
	`WORD r, zoomSize = LOWORD( wParam );`
	`RECT cr ; GetClientRect( hwnd, &cr ); VPX_LParam2RectPoint( lParam, cr, &pt );`
	`r = cr.right * zoomSize / 200 ;`
	`Rectangle ( hdc, pt.x - r, pt.y - r, pt.x + r, pt.y + r );`

HIWORD(WPARAM)	**VPX_CAL_SNAP** Indicates that the calibration image of the eye is being taken Follows the series of VPX_CAL_ZOOM events, after zoomSize has shrunk to zero; or if the calibration mode is in snapMode, this is called itself.

LOWORD(WPARAM)	The calibration point number, the actual point index number, not the random or custom sequence number, is in the lower 8 bits, flags for slipCorrection mode and snapMode are in the upper 8 bits.
	`WORD loWordw = LOWORD(wParam);`
	`BOOL slipMode = ( loWordw & 128 ) ? 1 : 0 ;  // bit 8`
	`BOOL snapMode = ( loWordw & 256 ) ? 1 : 0 ;  // bit 9`
	`int pointNumber = LOWORD(wParam) & 127 ;  // lower bits 0..7`

LPARAM	Contains the location of the stimulus point. `As above, use: VPX_LParam2RectPoint( lParam, cr, &calPt );`

HIWORD(WPARAM)	**VPX_CAL_HIDE** Indicates completion of the current calibration point. The program should clean up any remnants of this last calibration stimulus point display. Follows VPX_CAL_SNAP.
LOWORD(WPARAM)	The calibration point number, the actual point index number, not the random or custom sequence number. `int pointNumber = LOWORD( wparam )`
LPARAM	Contains the location of the stimulus point. `As above, use: VPX_LParam2RectPoint( lParam, cr, &calPt );`

HIWORD(WPARAM)	**VPX_CAL_END** Indicates that the entire calibration sequence has finished. The LOWORD indicates whether or not a slipFix was requested. A 1 indicates slipFix, zero indicates (re)calibration of a point. Follows the VPX_CAL_SNAP of the last calibration stimulus point.
LOWORD(WPARAM)	Indicates whether or not a slipFix was requested (rather than e.g. a recalibration) . A 1 indicates slipFix, zero indicates recalibration of a point. *Note*: this is **not** currently consistent with the wparam format used in VPX_CAL_SNAP, but it may be made consistent in the future. **BOOL doSlipFix = LOWORD(wParam) == 1 ;**
LPARAM	Contains the location of the stimulus point. **As above, use: VPX_LParam2RectPoint(lParam, cr, &calPt);**

Chapter 15 Legacy, Obsolete, & Deprecated

Do not use the following for new work. They are described here only for reference use with already existing code and to provide a migration path for new code development.

15.1.1 Old CLP

Old Name	New Name	Reason
`circularPupilCriteria`	`pupilAspectCriteria`	
`calibrationSpeed`	`calibration_StimulusDuration`	Clarity
`gazeGraphics`	`gazeGraphicsOptions`	Easier string parser
`stimulusGraphics`	`stimulusGraphicsOptions`	Easier string parser
`pupilMinWidthCriteria`	`pupilMinWidthCriterion`	Singular
`pupilAspectCriteria`	`pupilAspectCriterion`	Singular
`circularPupilCriteria`	`pupilAspectCriterion`	Clarity & Singular
`pupilMaxWidthCriteria`	`pupilMaxWidthCriterion`	Singular
`cursorControl`	`cursor_Control`	Consistency
`gazeColor`	`penColorA`	Clarity & binoc

15.1.2 Old VPX

Old	Change

VPX_GetGlintScanOffset **VPX_GetGlintScanUnyokedOffset** **VPX_CHANGE_GlintScanOffset** **VPX_CHANGE_PupilScanArea** **VPX_CHANGE_GlintScanSize**	Obsolete
VPX_SetCalibrationDensity	Obsolete
VPX_LaunchViewPoint **VPX_LaunchViewPointEx**	Use: **VPX_LaunchApp**
VPX_DataFile_StoreRejectData **VPX_DAT_FAILED**	In previous versions of ViewPoint, the default was to only store good data in the data file. This command was used to override that default behavior. In newer versions of ViewPoint all data is stored together with a QualityCode that indicates how good the data is. See: **VPX_GetQualityCode**.
VPX_GetROI_InCode **VPX_DisplayROI_InCode**	Old positional bit code was cumbersome. New string parser is easier and clearer

Chapter 16 Troubleshooting

This section discusses some of the common sources of error and problem areas. Once recognized, many of these can be avoided.

16.1 EventHistory Window

The EventHistory window can be a very useful tool for troubleshooting many problems including video and settings file problems. Use menu item Windows > EventHistory to view. For troubleshooting settings file commands menu item File > Settings > Verbose loading will display extra information from the CLP.

16.2 Improving Frame Rate

The video frame rate will be compromised when other demands are made on the computer. Ways to improve video frame rate include:

- Closing the Event History window will significantly improve performance.
- Turn off "Show Dots" in the EyeCamera window.
- Turn off the screen saver.
- Ensure that there are no other applications running that are not required.

16.3 EyeCamera Window Troubleshooting

If a video source was connected to the computer when *ViewPoint*™ was started, the EyeCamera window should display the captured video image. Otherwise, follow the following troubleshooting tips:

- If the EyeCamera window shows "*** FROZEN ***", then you should select the menu item: Video > Freeze Video, which will toggle the check mark next to this item and unfreeze the video processing.
- Ensure that the frame grabber board and drivers have been correctly installed. Check in the Windows Device Manager for conflicts.
- Reset the video: Video > Reset Video

Note: If a camera is disconnected and reconnected then ViewPoint will automatically reset the video pipe and start working again. If after eight reset tries the software cannot detect a camera then the message MaxVideoResetTries exceeded will appear in the Status window.

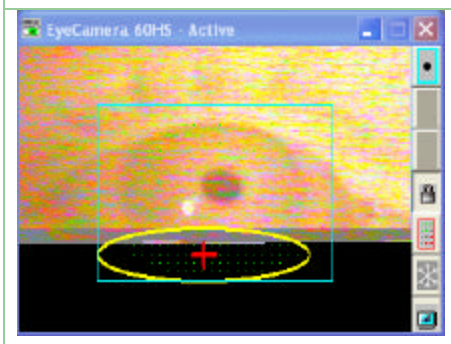
- If the EyeCamera window background is black, white or blue, then check the following:
- The camera is plugged into the computer properly.
- The camera is getting power that it needs, e.g., from a power supply.

- The camera is getting enough light.
- The camera iris adjustment is open.
- The lens cap has been removed!
- If the EyeCamera window video segmentation is not working, make sure the display monitor is set to True Color (32 bit).

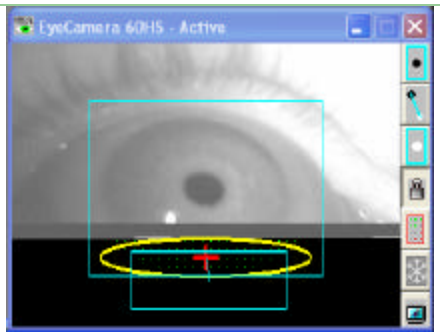
16.3.1 Bottom half of EyeCamera window is black

If the bottom of EyeCamera image is black as in Figure 19: Then the video standard has been set to PAL or SECAM, but the camera is NTSC. All ARI supplied cameras are NTSC. Select menu item: Video > Video Standard > NTSC. Also check any Settings file that may be loaded, e.g. StartUp.txt, that may specify a different video standard.

Figure 19: EyeCamera Window if Incorrect Video Mode Selected



Video Mode set to SECAM



Video Mode set to PAL

16.4 General Troubleshooting

If the color of the sliders and buttons are different than the window background, change the appearance settings in the **Windows Controls > Display > Appearance** to the Windows Standard scheme.

Chapter 17 History of Eye Tracking Methods

The quest to be able to determine where the eyes are looking has been long and elusive. Many talented individuals have invested many years to achieve this goal and many methods have been tried. It is useful to understand some of the methods available, so as to avoid repeating mistakes and to choose the best method for a particular purpose.

17.1 Electrical Methods

17.1.1 Surface Recordings

The most obvious solution suggested by most lay people is to record the eye muscle activity around the eye, but this electromyographic information is insufficient to determine the position of gaze. Interestingly however, there is an electrical potential between the front and the back of the eyeball. Measurement of this potential is called electro-oculography (EOG). It is relatively easy, but not very precise. One of the problems is the potential shows substantial diurnal variation, which necessitates that experiments be conducted at the same time of day. This method can also show substantial drift of the signal over time.

17.1.2 Induction Coils

With this method the head must be inside of a box frame that holds large magnetic induction coils, which bathe the head in alternating magnetic fields. The different dimensions of the box use different alternation frequencies. Electrical currents will be induced in a coil of wire that is moved inside box. Movements in different dimensions can be de-multiplexed by selectively filtering for the different alternation frequencies. Permanently implanting coils of wire in the eyes, so called *scleral search coils*, provides one of the most accurate methods of eye tracking available to date. Needless to say, this is usually possible only in animal experiments. Alternatively, tight fitting contact lenses can be used in humans, but the lead-wires hanging from the contact lenses interfere with normal eye blinks and they can not be tolerated for very long.

17.2 Optical Methods

17.2.1 Reflections, or Purkinje Images

Light is reflected from surfaces when there is a change in optical density. This occurs in the eye first at the corneal surface (air to cornea), second from the back of the cornea (cornea to aqueous humor), third at the front surface of the lens and fourth from the back surface of the lens. These reflections are referred to as the first to fourth Purkinje images, respectively. These reflections can be used for eye tracking.

Corneal Reflection Tracking

The first purkinje image, the reflection from the front of the cornea, is also referred to as glint. An infrared light source produces a specular reflection on the smooth cornea, which is recorded by an infrared light sensitive device. Used alone, this method is very sensitive to head movement when calculating direction of gaze.

Other Reflections

The other purkinje images can also be used for eye tracking and they can be used in combination with one another. One problem is that the higher numbered (deeper within the eye) Purkinje images tend to be quite dim compared to the first purkinje image.

17.2.2 Dark Pupil Tracking

An un-collimated infrared light source will make even the darkest iris appear light, so as to produce a high contrast with the dark pupil that acts as a sink for the infrared light. The pupil edges are located and the pupil center is calculated. Used alone, this method is sensitive to head movement when calculating direction of gaze.

17.2.3 Limbus Tracker

The limbus is the junction between the smooth clear cornea and the much rougher white sclera that surrounds it. This method takes advantage of there being a difference in the amount of light reflected from the cornea compared to the sclera. This reflectivity difference produces a contrast difference that can be monitored by photodetectors (e.g. phototransistors, or historically photodiodes); typically two photodetectors are placed on either side of the eyeball. Used alone this method is sensitive to head movement when calculating direction of gaze.

17.2.4 Bright Pupil Method

Collimated infrared light reflects off the retina, similar to the reflection we see from the eyes of a nocturnal animal, or in red-eye from flash photography. This also can be detected and located. Used alone, this method is sensitive to head movement when calculating direction of gaze.

17.2.5 Corneal Bulge Method

It is possible to calculate the location of the corneal bulge by using an array of detectors placed around the eye to sense variations in total infrared reflection. This system has the advantage of being able to locate the bulge even when the eye is closed, however it is typically confused by eye blinks. Used alone, this method is sensitive to head movement when calculating direction of gaze.

17.2.6 Vector Difference Method

When using only a single signal there is always confusion between eye movements and head movements. Most eye movements are relatively small compared to head movements, even when a person thinks that they are holding their head still. A solution is to use two signals that move together in a constant way when the head moves, but that vary from one another as the eye moves. By comparing only the difference between these two signals, eye movements can be disambiguated from head movements. This difference can be thought of as a floating vector. Only the magnitude and direction are important, not the absolute position. We will briefly discuss two of these *vector difference methods*., both of which usually employ video image processing.

One popular vector difference method compares the corneal reflection, i.e., the first Purkinje image, to the reflection from the back surface of the crystalline lens, i.e., the fourth Purkinje image, and is often referred to as a Purkinje eye tracker. The fourth purkinje image is however quite dim and care must be taken not to expose the subject to excessive amounts of infrared light in an attempt to image it.

The most easily observed vector difference method is sometimes called the Pupil-Corneal Complex Method, which is the method used by ViewPoint™. In this method it is the difference between the position of the corneal reflection and the position of the pupil.

Vector difference methods are not without problems of their own. (a) There are now two

sources of position noise instead of one. (b) Given a change in viewing direction, the magnitude of the vector signal is smaller than that of the individual signals; the result is a lower signal to noise ratio. (c) While the vector difference methods are robust against horizontal (sideways, x-axis) and vertical (up/down, y-axis) direction movements, they are more sensitive to in-and-out (closer or farther from the camera, z-axis) movement of the head. This is because the distance between the two points, i.e., the vector length, becomes shorter in video image, as the head is moved backward away from the camera.

Chapter 18 Binocular Eye Tracking Option

This section describes those features that are particular to the *ViewPoint EyeTracker*® binocular option only.

18.1 Installing Binocular FrameGrabber & Software

Refer to Chapter 3.

18.2 Operating in Binocular Mode

The main (monocular) ViewPoint window shows Eye-A. When in binocular mode, the second *ViewPoint* window shows Eye-B. To switch from monocular to binocular operation, select menu item: Binocular > Binocular Mode

Alternatively, use the command line parser (CLP) command:

```
binocular_Mode [ On , Off ]
```

This command may be placed in the settings file `startup.txt` to automatically set your binocular preference when ViewPoint is launched. Refer to **Chapter 10** and **Chapter 11.**

When in binocular mode, the Eye-B window contains only those controls and menu items necessary to adjust the EyeCamera image settings and calibration points for Eye-B. All other controls will be made through the Eye-A window.

18.3 Setup

For optimal performance in the binocular mode, follow these suggestions:

1. The video modes may be different between Eye-A and Eye-B during setup. However, when collecting data both Eye-A and Eye-B are collecting at the same speed.
2. Set the video modes to High Precision rather than High Speed, unless the higher speed is actually required.
3. Close EyeCamera windows in both Eye-A and Eye-B when running in High Speed mode.
4. Many controls are disabled in the Eye-B window. Do not try to bypass the inactivated menu items by loading settings files that contain commands to change these items.
5. When collecting data, avoid moving the mouse, especially to resize or move windows, which may cause video frame loss especially on slower computers.

18.4 Storing Data

The data file will automatically have data columns appended for binocular mode. Quality markers are recorded for each eye which will allows collection of data from one eye, even if the other eye data has been rejected for some reason. The data file record format is typically a sequence as follows:

```
Tag#, EyeA_data, EyeB_data, Count, Markers
```

Refer to Chapter 9 for details of data file format.

18.5 Real-Time Display of Binocular Data

The binocular data may be combined in a "cyclopean" average position during the display in the GazeSpace and Stimulus windows and in the PenPlot window:

See menu items:

Binocular > Show both eye positions

Both eye positions will be displayed as separate points in the GazeSpace and Stimulus windows.

Binocular > Show Averaged Y-Positions

Two positions of gaze will be displayed in the GazeSpace and Stimulus windows. These will reflect the average of the vertical (Y) positions of both eyes.

Binocular > Show Average of Eye Positions

One position of gaze will be displayed in the GazeSpace and Stimulus windows. This will take the average of the eye positions.

Note: Regions of Interest (ROI) hit lists are triggered by the (possibly smoothed) individual positions of gaze, but with no binocular averaging.

Alternatively, use the command line parser (CLP) command:

```
binocular_Averaging [Off, only_Y, both_XY ]
```

This command may be placed in the settings file `startup.txt` to automatically set your binocular preference when ViewPoint is launched. Refer to Chapter 10 and Chapter 11.

18.6 Interfacing to Other Applications

ViewPoint EyeTracker® provides for communication with other applications running on the same computer or a remote computer. The software developer kit (SDK) contains new or augmented functions for binocular data typically taking the following form:

New: VPX_SomeFunction2 (EyeType eye, VarType *var) ;

Old: VPX_SomeFunction (VarType *var)

#define EyeType int

#define Eye_A 0 // the first, or monocular eye

#define Eye_B 1 // the second, or binocular option eye

The SDK notification message VPX_DAT_FRESH is issued separately for each eye. The low word of the message contains the eye of origin information:

```
EyeType eye = LOWORD (wParam) ; // will be either Eye_A or Eye_B
```

Note: Serial port packets and the RemoteLink application currently do not contain information about the second eye. Updates will be sent to customers when this is included.

18.7 Settings Files

You will need to load and save separate settings files for each eye using menu items: File > Data > ….. Refer to Chapter 10.

Chapter 19 Head Tracker Option

This section describes those features that are particular to the *ViewPoint EyeTracker*® head tracker option only.

19.1 General

Currently the *ViewPoint EyeTracker*® works exclusively with the FlockOfBirds (FOB) magnetic tracker for its head tracking capability. *ViewPoint* connects to FOB via a serial port interface. We have designed the interface so that the user should not need to spend much time reading the FOB Installation and Operation Guide (IOG). In particular, you do not need to examine or change the internal jumpers inside the FOB electronics unit, you do not need to consider the low level commands that are described, and any dip switch changes that are pertinent to *ViewPoint* users are described below. Note: if you read only the sections of the IOG specified below, and SKIP the other sections, you should stay out of trouble.

Important: The sensor must be within +/- 4 feet of the transmitter; otherwise, data will not be accurate.

19.2 Unpacking

Please check the contents of the FOB box listed in section 2.0. Items 1 through 4 and 7 through 10 should be included. Items 5 and 6 are not part of this package and the optional extended range transmitter is not included.

19.3 Installation

Please read the following sections of the IOG:

- 2.1.1 ELECTRONICS UNIT LOCATION
- 2.2.2 TRANSMITTER LOCATION
- 2.1.3 SENSOR LOCATION
- 2.1.4 POWER SUPPLY LOCATION

Please SKIP sections 2.1.5, 2.1.6, and 2.1.7, as these are preset for *ViewPoint*.

19.4 Cable Attachment

Please connect the cables as described on p.15-16, in section 2.2:

- 2.2.1 RS-232C CABLE
- 2.2.4 SENSOR CABLE
- 2.2.5 TRANSMITTER CABLE
- 2.2.6 CRT SYNC CABLE (optional)

2.2.7 POWER CABLE

Sections 2.2.2 and 2.2.3 relating to FBB CABLE are not relevant.

19.5 Baud Rate and DipSwitch Settings

Currently the *ViewPoint EyeTracker*® works only with Position/Angles data records (this may be changed in the future to allow for additional capabilities). The Position/Angles data record type allows 113 records per second at 19.2K baud, and approximately 56 records per second at 9600 baud. The current default is 19.2K. In any case, the FOB settings and the ViewPoint settings must match. The baud rate for the FOB is set by adjusting the dipswitches on the back of the FOB box. Dipswitch changes must be made when the switch on the front of the FOB box is set to STBY.

The dipswitch settings are described on p.12 of the FOB-IOG, and are summarized here.

Table 15: **Head Tracker Dip Switch Settings**

DIPSWITCH #			BAUD RATE
1	2	3	
Off	On	On	9600
On	Off	Off	19.2K

All other dipswitches (4 through 8) should remain in the up (OFF) position.

The baud rate is specified via the dialog box: *ViewPoint* menu item: **HeadTrack > Connection Settings…**. Only the port and the baud rate should be modified; all other settings should remain the same. DataBits=8, Parity=None, StopBits=1, and all check boxes must be left unchecked.

Note: Depending on the type of computer you are using, when the eye tracker is running at 60Hz Binocular, the frame rate may be less noisy if the baud rate to the FOB is lowered from 19.2K baud to 9600 baud.

19.6 Connection to FOB

After all port and baud rate settings have been specified, the user may connect to the FOB.

1. First flip the FOB front panel switch to FLY, the red light on the front of the box should will start blinking as it is trying to find the small sensor, then the red light should be constantly ON.
2. Next, use the *ViewPoint* menu item: HeadTrack > Connect. The red light on the front of the box may or may not blink, but after a few seconds, it should be constantly ON. If it is not, there is a connection problem; check baud rate match, cables, etc.
3. After connecting the first time, the user may wish to select *ViewPoint* menu item: HeadTrack > Disconnect when not collecting data, because this will put

the FOB to sleep and turn off the strong magnetic field.

19.7 CRT Synchronization

ViewPoint has been designed to take advantage of the FOB CRT SYNC option. If working close to a CRT, the magnetic fields can interfere with the display. You can synchronize the FOB to the monitor using the CRT SYNC Pickup. First find a location where the signal is strong; the maximum voltage will be obtained on the top or side of the CRT housing near the deflection yoke, typically halfway between the front and the back of the cabinet.

Make sure the pickup is plugged into the FOB before starting. See p. 16, section 2.2.6 of IOG for details.

1. Select *ViewPoint* menu item: HeadTracker > Connect
2. Select *ViewPoint* menu item: HeadTracker > CRT Sync > Test Signal Strength
3. The voltages and the CRT refresh rate will be displayed in the Status window and in the EventHistory window. The FOB light should not be glowing when you are in this mode.

Important: This voltage and Hz data should be correct when connected at 19.2K baud, but may be incorrect when connected at 9600 baud.

4. Select *ViewPoint* menu item: HeadTracker > CRT Sync > Sync to 50-72 Hz Display, or select Sync to 73-144 Hz Display, depending on your CRT display refresh rate.

19.8 Location and Orientation of Transmitter & Receiver

The penPlot ranges assume that the transmitter is at approximately the left shoulder and (design side) facing right. The receiver should be on the head in the same orientation, with the wire leaving it to the left and the design side facing right. The bottoms of each should be downward.

In the above configuration the data file columns will be as follows:

Position Coordinates (cm):

- X-pos will indicate horizontal movement with positive to the right
- Y-pos will indicate vertical movement with positive upward
- Z-pos will indicate movement of the head toward or away from the CRT display

Orientation Angles (degrees):

- Yaw about the Y-axis. (The position where the nose points moves along the horizontal.)
- Pitch about the X-axis. (The position where the nose points moves along

the vertical.)

- Roll about the Z-axis.

19.9 Head Tracker Event Data

The FOB hardware always creates new data at exactly 100Hz; this cannot be modified. We can request that data be send to the computer at various rates, including rates that are faster than new data is being created, but this would be a waste of computer resources to process the incoming data. The timing of the eye tracker cameras is not synchronized with the timing of the head tracker, so fresh data is arriving from these various sources at different times.

Select the menu item: HeadTracker > Asynchronous Data Storage if you want the incoming FOB data to be inserted into the data file as soon as it is acquired, which will have it appear on a separate data line. Otherwise, uncheck this option to have the most current head tracker data appended to the each line of eye tracker data (i.e., in the same record). The asynchronous head tracker data is indicated by record tag number 14 in the first column of the data file.

Refer to Chapter 9 for data file format.

19.10 HeadSpace Window

The HeadSpace window provides real-time graphical display of head position and head angular orientation. The window also displays the stimulus display screen (x,y) intercept point of the (gaze forward) primary axis of the eye, based on the user specified distance from the headTracker sensor to the center of rotation of eye.

19.11 Troubleshooting

If there is no movement showing in the data, briefly switch to STBY and then back to FLY

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