

Eyetrack Collection Documentation

**Albert Einstein Healthcare Network
Moss Rehabilitation Research Institute**

Paul Nagelkerke

Amanda Dawson

September 21, 2010

INDEX

Introduction	5
Overview	5
Physical Component View.....	5
ASL MobileEye.....	5
Ascension Technology TrakSTAR	8
Data Collection Computer & Programs	10
Output Data Files	10
Output Data File Format	10
Output Data File Column Headers	11
Data Acquisition	12
Physical Connections.....	12
Configuring MobileEye System	12
Configuring TrakSTAR	13
Configuring Data Collection Computer	13
Testing Session - Video Onset Synchronization.....	15
Testing Session - Setting Study, Subject, and Block.....	15
Testing Session – Collecting a Trial	16
Testing Session – End of Session	16
Program and Data File Locations - MobileEye Laptop	17
Data Collection Computer - Program and Data Files	17
Program Compiler	17
Data Collection Program Locations	18
Collected Data File Locations	18
Data Backup	18

Sample Experiment Protocol.....	19
Example 1: Tea-Making Task	19
Example 2: Copy a Design Task	19
Experiment Design Considerations	19
Setting up the Scene	19
Calibration.....	19
Preview.....	19
Preparation for Coding.....	19
Data Analysis.....	20
Video Trimming.....	20
File Conversions	20
Step 1	21
Step 2	22
Step 3	24
Fixations and Saccades Analysis in iLab	26
Target Analysis in InqScribe.....	31
Timeline Chart of the Tracking Data	35
Position Chart of the Eyetracking Data	37
Programming Notes	39
Calibration Program	39
Compiler.....	39
Compiler – String Types	39
Data Acquisition Program Notes	40
MobileEye External Data Input – RS-232 Serial data	40
Compiler.....	40

Compiler – String Types	40
Parallel Port Digital I/O.....	40
Parallel Port Cable Wiring	40
Parallel Port Visual C++ Required Drivers	41
Parallel Port Compiler Settings.....	42
Parallel Port Motherboard BIOS Hardware settings:	42
High-Speed Timer	42
Serial Port Input (MobileEye)	43
Serial Port Null-Modem Cable.....	43
Serial Port on Laptop Docking Station.....	43
Serial Port Data Encryption	43
USB Input (TrakSTAR)	44
Automation File Format.....	44

Introduction

This project is an attempt to integrate the analysis of visual gaze with the kinematics of movement during everyday activities.

Overview

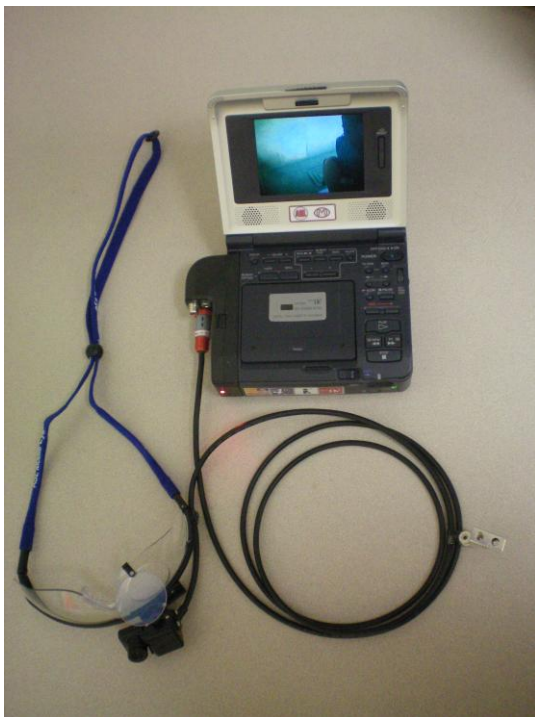
The Eyetrack integration project consists of the integration and interaction of three separate systems to capture and analyze video and kinematics of everyday movements such as making tea.

Physical Component View

Three separate physical systems are connected together to synchronize their data. One system generates a stream of data from the subject's visual gaze position, while a second system's data stream captures the subject's movement kinematics in space. The gaze and kinematic data streams are merged in a data collection computer and saved as digital numeric data, with redundant time-stamps and visual indicators to ensure future synchronization with the video images.

ASL MobileEye

Figure 1 - ASL Mobile Eye Head Mounted Optics and Digital Video Recorder (DVR)

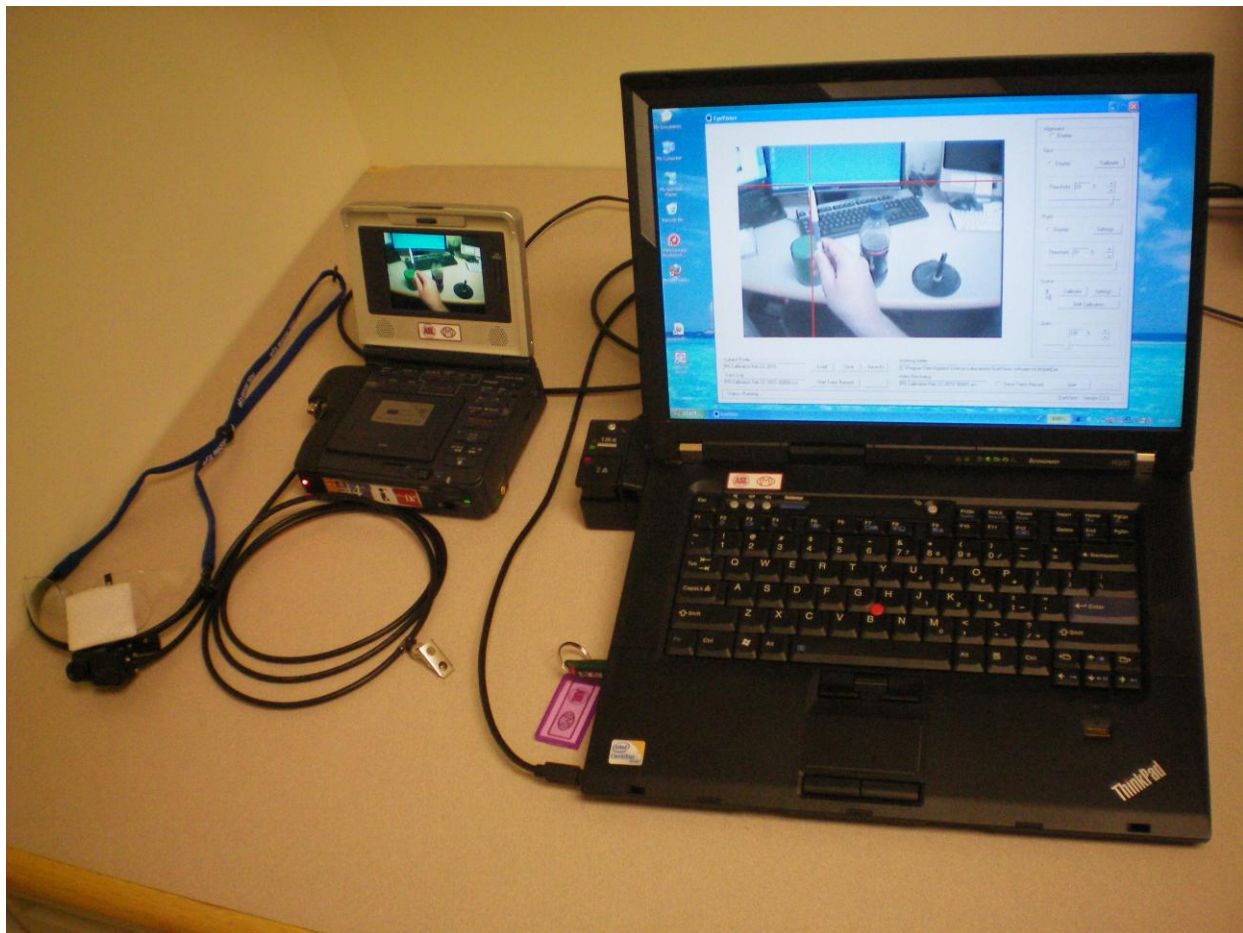


The Applied Science Lab (ASL) MobileEye vision gaze capture system consists of a lightweight head mounted optics connected to a portable digital video tape recorder (DVR). The video head-mounted optics has been specially modified to encode the images from two video cameras into one video stream

for recording on video tape. One image is from the headset point of view (POV) indicating what the participant can see, while the second video image is of the participant's eye.

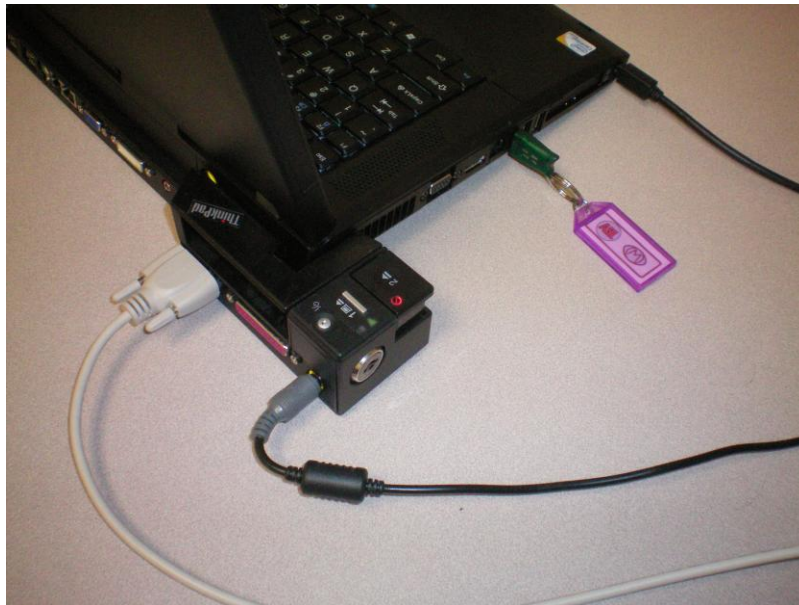
The combined eye/scene video images are transmitted either live or during playback to a video analysis laptop computer via a FireWire® serial data cable. The resulting video image is analyzed by ASL software on the video analysis laptop computer to yield the participant's X-Y gaze position. A stream of XY position data is transmitted out of the video analysis computer through an RS-232 serial port for capture by the data collection computer for later analysis.

Figure 2 - ASL MobileEye Optics, DVR, and Analysis Computer



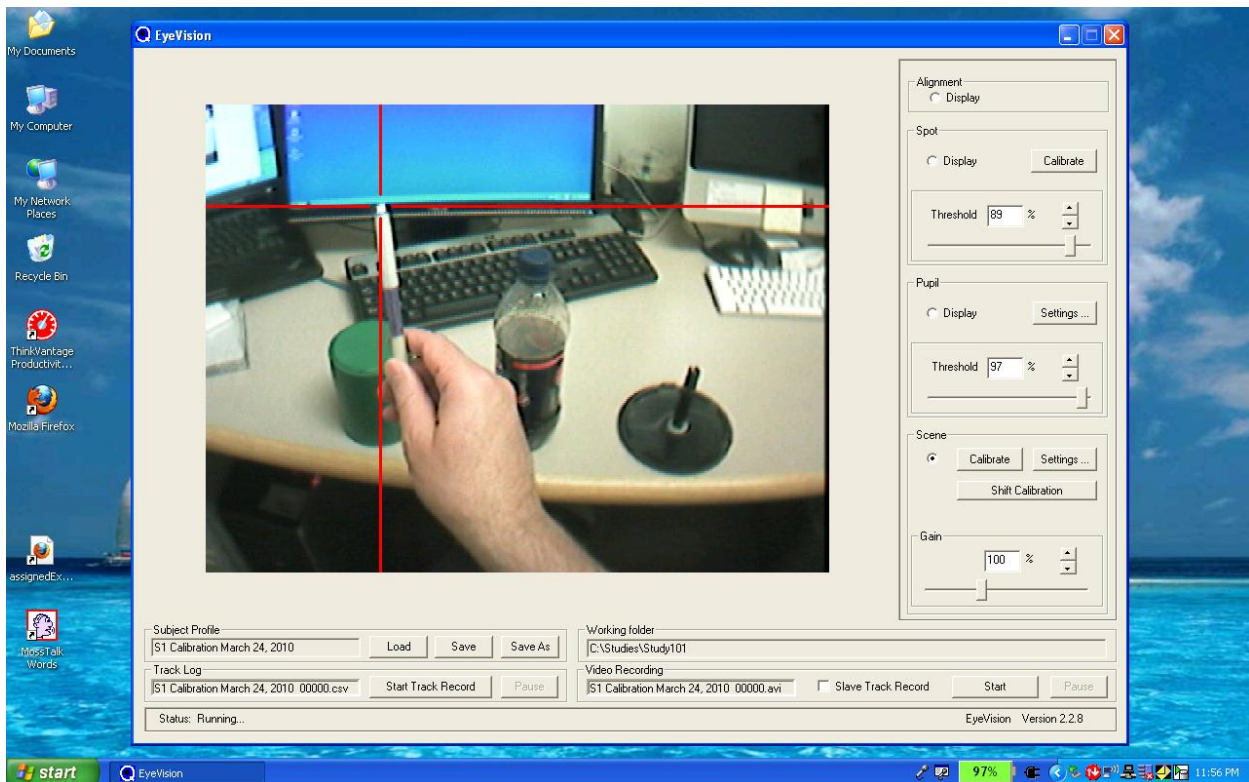
The combined head-mounted optics and video tape recorder system can capture and display video images live or record them for later playback and analysis. This project uses the live configuration to simultaneously videotape the participant's point of gaze and physical movements while capturing the XY gaze coordinates and movement kinematics in the data collection computer.

Figure 3 - MobileEye Video Analysis Computer - Rear View



The MobileEye Video Analysis laptop computer uses a docking station for a serial port connection. Shown in Figure 3 are (from left to right) the RS-232 Serial cable, power cable, ASL MobileEye USB key, and mini-FireWire cable from the MobileEye DVR.

Figure 4 - Screen image of MobileEye EyeVision Software on the Video Analysis Laptop



The Eyevision program screen image displayed in Figure 4 shows the Point of View (POV) image from the head-mounted optics and the red cross-hairs of calculated point of gaze.

Note the program settings in the above image:

- Subject calibration data is saved in the Subject Profile file, in this case file “S1 Calibration March 24, 2010”.
- All of the Eyetrack data is currently being saved in the Working Folder directory “C:\Studies\Study101”.
- Similarly a digital Video Recording of the trial will be saved in the same directory with the same name and as an “avi” video file.

Ascension Technology TrakSTAR

The Ascension Technology TrakSTAR motion capture system is 6 degree of freedom (DOF) motion capture system that uses magnetic fields to capture position and orientation of its sensors in space.

Figure 5 - ATC TrakStar Motion Capture- Front View with (from left to right) magnetic Transmitter, and two of four sensors (in black)

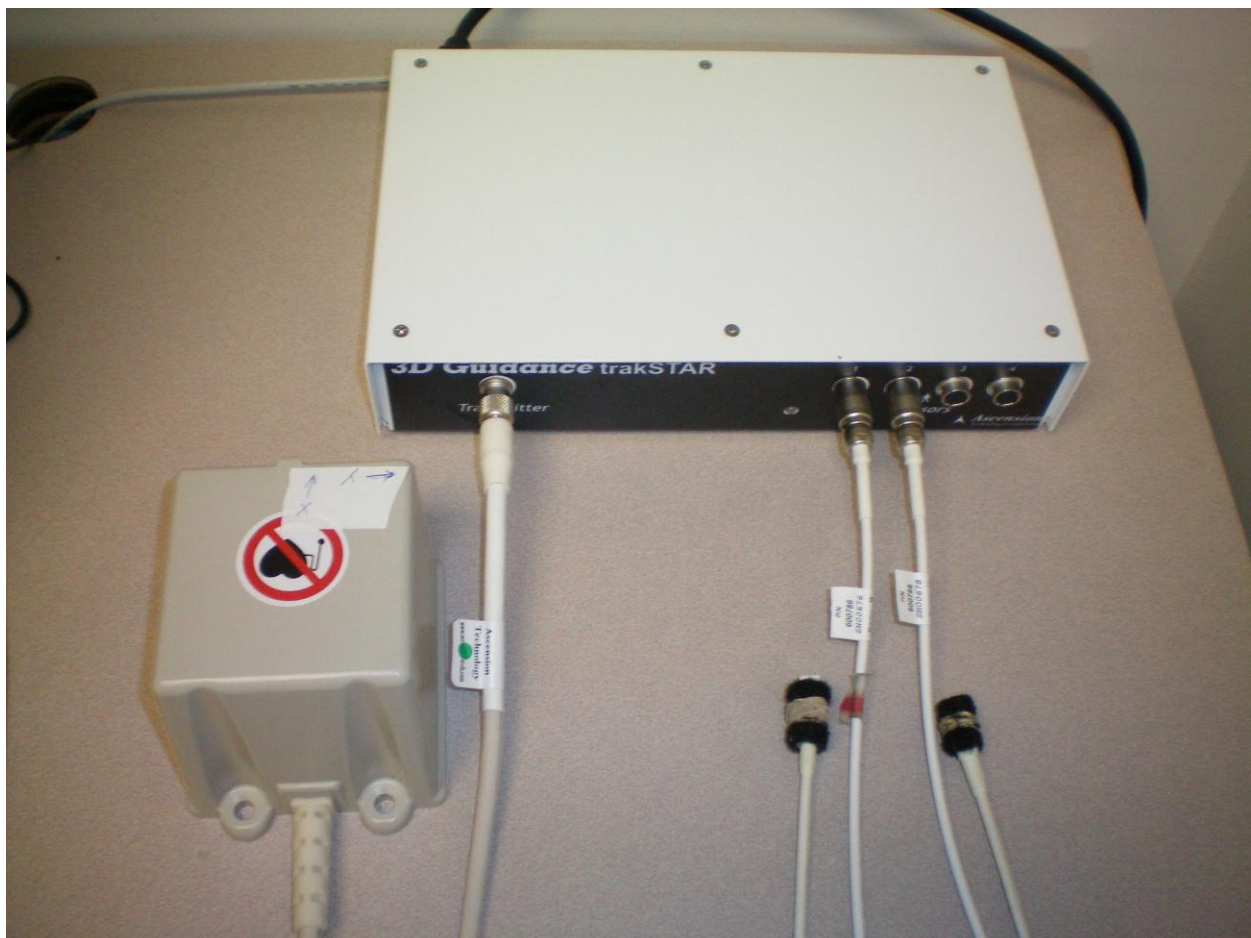
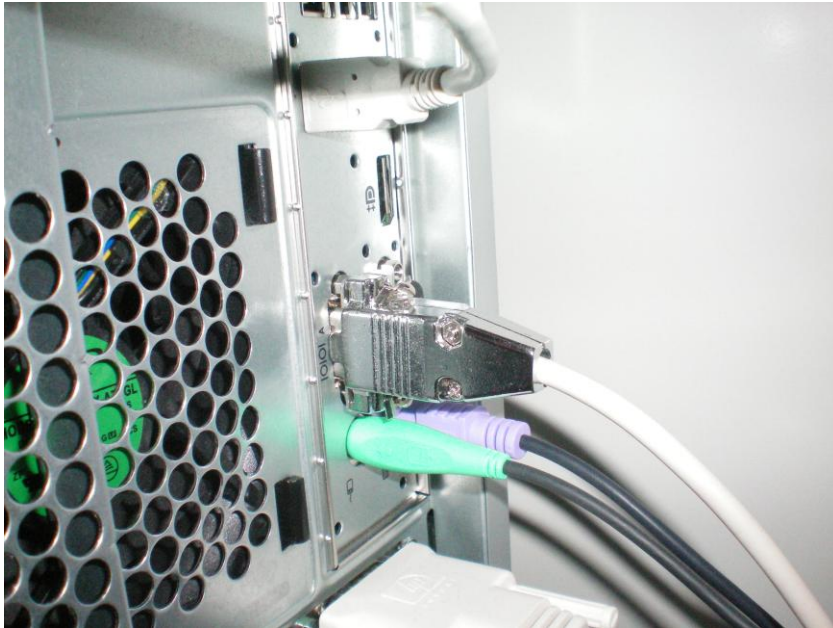


Figure 6 - ATC TrakStar - Rear Panel with USB (left) and Power cables (right)



The USB cable from the TrakStar plugs into a USB connector on the data collection computer.

Figure 7 - Data Collection Computer - USB and Serial Connections



The Data Collection Computer accepts data from the ATC TrakStar through a USB cable (Figure 7, top white cable), RS-232 Serial data from the MobileEye Video Analysis Laptop (Figure 7, middle – white cable with chrome connector). The green connector is from a PS/2 mouse, the purple connector is from the PS/2 keyboard, and the bottom white connector is a custom video to dual VGA adapter cable for the graphics card.

Data Collection Computer & Programs

The data collection computer is an HP desktop running Windows XP. There are a number of programs on the data collection computer:

- Serial Out Port Viewer – a program to test the serial connection from the MobileEye laptop.
- Eyetrack Calibration – presents a grid of dots for calibrating the ASL MobileEye
- Eyetrack Collection – data collection program synchronizing the MobileEye and TrakStar data.

Output Data Files

Data files generated by the Data Collection program are in Comma Separated Values (.csv) text format for import into a spreadsheet program like MS Office Excel.

Output Data File Format

The first four lines of the file are taken by file and header information.

The first line is a shortened version of the file name: “S1-B1-T1”.

The second and third lines are usually blank, allowing for future annotation within the spreadsheet file.

The fourth line is the column header for all the data on line five.

All the data from line 5 onwards is based on video data received from the MobileEye system, based on 30* video frames per second.

*Note: Due to the 20 ms serial port buffer read rate within the Windows XP operating system, the time stamp for each video frame may be late by up to 20 ms, as reflected in SMPTE timecodes of occasional 29 or 31 frames within any one second. Overall the timing is excellent with no lost serial data, and an average rate of 29.97 video frames per second as per the NTSC video standard.

<http://en.wikipedia.org/wiki/NTSC>

Output Data File Column Headers

The fourth row of the output data file consists of column headers for the data.

The first three columns are the redundant information of Subject, Block, and Trial. Each *.csv (comma-delimited text file) also has the following columns:

Columns 4 and 5 are the time and video frame number of that trial, starting with time zero and frame 1 at the beginning of that trial. Indicates the onset of the Eyetrack Clear LED.

Columns 6 and 7 are the time and SMPTE coded frame number relative to the overall video tape time (or video file time) of the testing session. You will need to know the first recorded SMPTE value in order to trim the video file to begin at the same time as data collection from the eyetracker.

Columns 8, 9, 10, and 11 are the Eye Status from the MobileEye (0- good, 1- bad no data), pupil diameter in millimeters, and point of gaze X and Y position. The units of the gaze coordinates are 1 to 640 in the X direction (positive to the right), 1 to 480 in the Y direction (positive upwards).

Column 12 is left blank.

Columns 13-15 are the X, Y, and Z coordinates of the first TrakStar sensor in raw coordinates and units (inches). The coordinate directions depend on the orientation of the TrakStar transmitter, and are relative to the starting position of the sensor at the time of sensor initiation and calibration.

Columns 16-18 are the Azimuth, Elevation, and Roll angles of the first TrakStar sensor in degrees, also relative to the transmitter.

Columns 19-21, 22-24 are the XYZ, AER values for the second TrakStar sensor.

Columns 25-27, 29-31 are the XYZ, AER values for the third TrakStar sensor.

Columns 32-34, 35-37 are the XYZ, AER values for the fourth Trakstar sensor.

Note: The XYZ and AER values are all zero if there is no sensor attached or no TrakStar detected.

Data Acquisition

In order to properly collect and integrate MobileEye gaze data and TrakStar kinematic data, each system must be properly connected and properly configured and calibrated during data collection.

Physical Connections

All of the equipment must first be powered up and properly connected to the data acquisition computer.

1. The ASL MobileEye head-mounted optics is connected to the portable DVR (see Figure 1).
2. The FireWire output cable from the MobileEye DVR is connected to the FireWire input port on the MobileEye video analysis laptop (see Figure 2).
3. The 9-pin serial cable from the ASL MobileEye analysis laptop is connected to the 9-pin serial port on the HP data collection computer (see Figures 3 and 7).
4. The ATC TrakStar needs the transmitter and at least one sensor cable plugged in to the front panel. The power cable needs to be plugged into a power outlet. Make sure the TrakStar USB cable is connected from the TrakStar to one of the data collection computer's USB ports (see Figures 6 and 7).
5. Turn on the MobileEye Laptop Computer and Data Collection Computer at this point and let them boot up. Log in as necessary and let the operating system do its normal startup.

Configuring MobileEye System

The ASL MobileEye needs to be calibrated for each subject.

1. Turn on the ASL MobileEye DVR, it should temporarily display the date and time. It will display a double image on the subject's eye and point of view (POV) on the video screen.
2. Turn on the ASL Video Analysis Laptop. It should automatically log in as the MobileEye user. No password is required. Give the computer a few minutes to complete its startup sequence.
3. Run the EyeVision software by double clicking the EyeVision icon on the desktop. The screen image should look like Figure 4. Click the Scene button to switch to the subject's point of view scene if necessary. The red point-of-gaze crosshairs should be operational, albeit with improper calibration.
4. Under Subject Profile use a new Save As file name suitable for your new subject number and date.
5. Calibrate the MobileEye system using 10-15 points equally spaced over the subject's point of view. You can use the program **Eyetrack Calibration** on the data collection computer to generate 15 equally spaced gaze points. See the MobileEye documentation for instructions on calibration.

6. Check that the calibration is good over most of the range of subject's field of vision.
7. Make sure to save the calibration data one last time: under Subject Profile click Save.

Configuring TrakSTAR

The Ascension Technology Corporation TrakStar is very simple, as long as the transmitter, and at least one sensor, power and USB cables are all plugged in (along with the data collection computer), switch on the TrakStar.

An indicator LED on the front of the TrakStar should light up amber for about 6 seconds, then blink green to indicate it is ready. The data collection computer may make a sound to indicate that it has detected the TrakStar USB signal.

Configuring Data Collection Computer

The Data Collection Computer should be on already, fully logged into the operating system, and should have completed the normal boot up procedures. You may need to disable the wireless network card to stop the operating system from trying to connect to the wireless network during data collection.

1. Start the Eyetrack Collection program by double clicking the Eyetrack Collection icon.
2. The screen of the Data Collection computer should look like Figure 8, with changing values for the Mobile Eye pupil diameter (millimeters), plus the X, Y position of the point of gaze (max 640 x 480 pixels).
3. Click the TrakStar Start button to initialize the TrakStar. The indicator LED on the TrakStar front panel will go amber for 3-5 seconds, blink green for 2-5 seconds, then glow solid green, and the transmitter should make a slight 60 Hz hum. During this time the Eyetrack Collection program should freeze, then start to display changing values for the TrakStar sensors, XYZ position in inches, along with orientation values Azimuth, Elevation, and Roll in degrees. See Figure 9 for an example image with MobileEye and TrakStar data.

Figure 8 - EyeTrack Collect Program - Startup

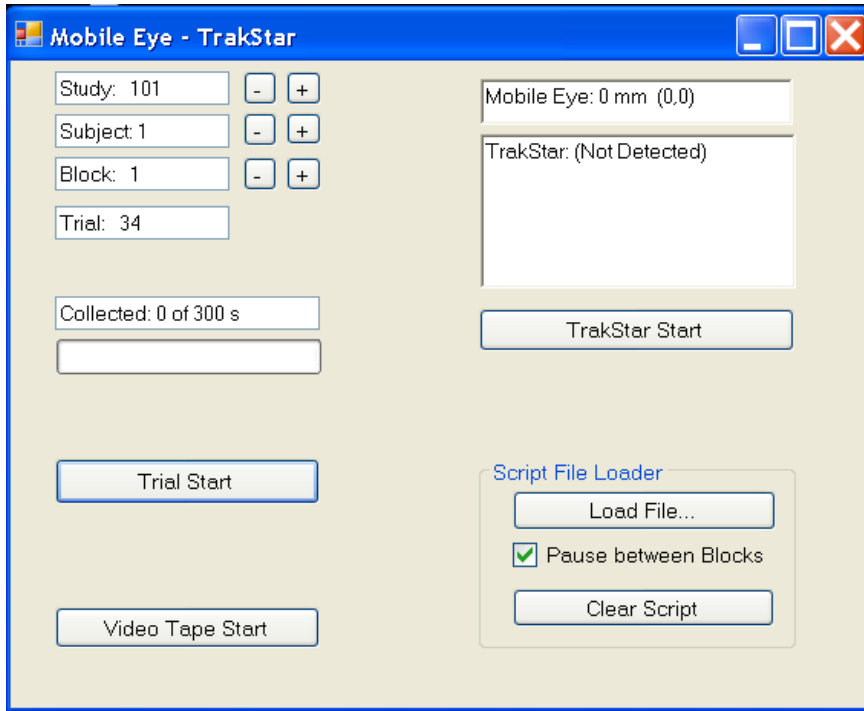
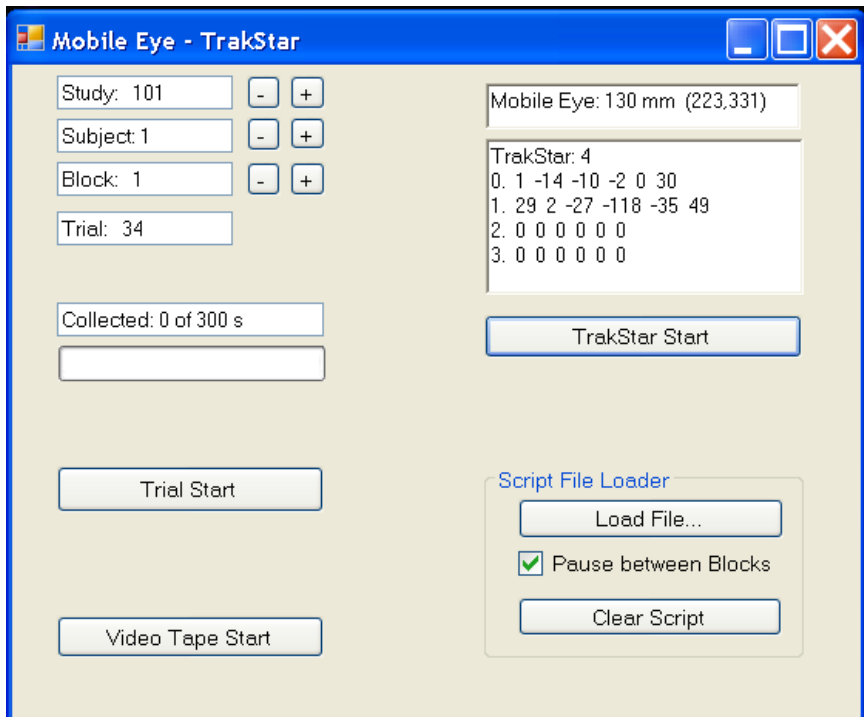


Figure 9 - Eyetrack Collect Program - With MobileEye and TrakStar Data



Testing Session - Video Onset Synchronization

This project is about 2D video image analysis time-synchronized with gaze and kinematic data. In order to do this the video tape and Eyetrack Collection program must have a simultaneous start time. The Eyetrack Collection program illuminates an LED when its internal video tape timer starts at zero. All other times are now relative to this "Video Time Zero" within the Eyetrack Collection program. The video file will need to be edited so that the onset of the LED is the first frame in the file. This ensures that a trial starting at 5:00 minutes on the video timer can be found at 5:00 minutes into the video file.

1. Start the MobileEye Digital Video Recorder (DVR) by first pressing and holding down the left Record button, then pressing the right Record button. The video tape should start to move, and red dot should appear. If the DVR beeps that means that you have not loaded a tape, or the tape is write-protected.
2. Start video recording in the EyeVision program on the Video Analysis laptop by clicking the Start button inside the Video Recording panel on the bottom right hand side of the program window. The two button captions should change from Start and Pause to Stop and Pause.
3. Make sure the Video Start LED is visible on the Mobile Eye scene camera by having the participant look at the LED.
4. On the data collection computer click the mouse on the Video Tape Start button within the Eyetrack Collection program window. The video start LED will illuminate for 2 seconds, and the caption in the video button will change to a timer counting up in seconds.

Testing Session - Setting Study, Subject, and Block

The Data Collection program is now ready to collect and save data. At this point the Study number, test Subject number and testing Block number can be incremented or decremented. With each change of Study, Subject, or Block the Trial number is updated to reflect the next trial number to be saved. In the examples above, in Study 101, Subject 1 has 33 trials already saved, so this trial (the next one to be saved) is trial number 34.

The Study, Subject, and Block values should be modified only collecting a trial. These values can be modified during data collection, but it is not recommended due to the computation overhead potentially interfering with data collection.

The values of Study, Subject, Block, and Trial at the end of data collection are used to generate the file name for the saved data. Once data has been saved, the trial number is updated and displayed on the program screen.

Testing Session – Collecting a Trial

A second LED illuminates for the duration of each data collection trial, allowing easy video extraction of individual trials.

1. At the beginning of each trial make sure the trial indicator LED is in the subject's field of view.
2. Click the Trial Start button on the Eyetrack Collection program window. The video tape time, trial time, MobileEye gaze information, and TrakStar kinematic information is being recorded from this point. A second LED illuminates and stays lit for the duration of the trial. The button caption changes to Trial Stop, and trial collection time is displayed numerically and graphically with a progress bar.
3. Trials can be up to 5 minutes long (300 seconds) at which point data collection stops automatically.
4. Click the Trial Stop button to manually end data collection.

Testing Session – End of Session

Once data collection has finished you can stop video recording and consolidate all the data files into one directory on a different computer for analysis and video editing and analysis.

5. Stop and Save the MobileEye Video Tape:
 - a. Stop the MobileEye DVR by pressing the Stop button.
 - b. Press the Eject Button to remove the tape.
 - c. Label the tape with the Study and Subject numbers, along with the date.
 - d. Write-protect the tape by moving the plastic tab from REC to SAVE.
 - e. Turn off the DVR
6. Stop and save video capture on the Video Analysis Laptop:
 - a. Press the Video Recording Stop button.
 - b. Stop the EyeVision program by clicking the red X in the upper right corner of the program window.
 - c. Copy the video file to a flash drive for later analysis. The example video file from Figure 4 will be **C:\Studies\Study101\S1\S1 Calibration March 24, 2010 00000.avi**.
 - d. Turn off the Video Analysis Laptop.
7. Stop and save kinematic files on the Data Collection Computer:

- a. Stop the Eyetrack Collection Program by clicking the red X in the upper right corner of the program window.
- b. Copy the trial files to a flash drive for later analysis. The example trial files from Figure 9 will be named **C:\Study101\S1\S1B1T1.csv** through **\S1B1T34.csv**.

Program and Data File Locations - MobileEye Laptop

The ASL MobileEye programs came pre-installed on a Lenovo R500 laptop. The EyeVision video analysis and configuration programs are installed from the ASL MobileEye Software CD, version 2.2.9 and are located at:

C:\Program Files\Applied Sciences Laboratories\Mobile Eye\Eyevision.exe

C:\Program Files\Applied Sciences Laboratories\Mobile Eye\EyeVisionConfigTool.exe

Captured trial videos and calibration files will be saved under the given study directory, in the example above they would be found at:

C:\Studies\Study101\S1\S1 Calibration March 24, 2010 00000.avi

C:\Studies\Study101\S1\S1 Calibration March 24, 2010.evi

Data Collection Computer - Program and Data Files

The Data Collection computer (HP Compaq model dc7900 desktop) contains the compiler for creating the data collection program, three Data Collection programs, and the collected study data.

Program Compiler

The compiler used throughout the project was Microsoft Visual C++ Express 2008, downloaded from: <http://www.microsoft.com/express/Downloads/#2008-Visual-CPP>

The Visual C++ Express 2008 program is installed by default at:

C:\Program Files\Microsoft Visual Studio 9.0\Common7\IDE\VCExpress.exe

Data Collection Program Locations

There are a total of three data collection programs: Eyetrack Clear LEDs to turn off the two indicator LEDs on computer startup, Eyetrack Calibration presents timed calibration dots on the screen, and Eyetrack Collect that actually captures vision and kinematic data:

The Eyetrack Clear LEDs program is located at:

C:\Documents and Settings\Administrator\My Documents\Visual Studio 2008\Projects\Eyetrack Clear LEDs\Debug\Eyetrack Clear LEDs.exe

The Eyetrack Calibration program is located at:

C:\Documents and Settings\Administrator\My Documents\Visual Studio 2008\Projects\Eyetrack Calibration\Debug\Eyetrack Calibration.exe

The Eyetrack Data Collection Program is located at:

C:\Documents and Settings\Administrator\My Documents\Visual Studio 2008\Projects\Eyetrack Collection\Debug\Eyetrack Collection.exe

Collected Data File Locations

The true address of any “My Documents” directory differs depending on the individual computer’s login name, etc. Since our data collection program can not easily deal with this variability, all study data is saved in one common directory structure on all the necessary hard drives: **C:\Studies**. Each study has a unique name, starting with Study 2010 #1: **C:\Studies\Study101**. Each subject has a unique sub-directory holding all their study files, making the first data file’s complete file path:

C:\Studies\Study101\S1\S1B1T1.csv

Data Backup

Once a subject’s data has been collected, the video and calibration files from the ASL Laptop and kinematic data from the Data Collection Computer will be saved on a third Data Analysis computer. This provides multiple physical copies of the original data in case of accidental file deletion or modification during analysis. All the files associated with each study and subject will be in one directory (for example):

C:\Studies\Study101\S1\S1B1T1.csv

C:\Studies\Study101\S1\S1B1T1.xls

C:\Studies\Study101\S1\S1 Calibration March 24, 2010 00000.avi

C:\Studies\Study101\S1\S1 Calibration March 24, 2010.evi

Sample Experiment Protocol

Example 1: Tea-Making Task

Tea-making task objects: electric kettle with water; cup and saucer, tea bag, sugar jar, milk, spoon.

Instructions: Only use your right hand. Start each trial with your hand held still in the marked spot. For this task, you must make a cup of tea with sugar and milk.

Measures: separable actions and transitions from one action to another, fixations to different parts of the same object.

Example 2: Copy a Design Task

Copy a design task objects: model, source, grid-like workspace configuration.

Instructions: Only use your right hand. Start each trial with your hand still in the marked spot. For this task, you must make a copy of the source object to your right.

Measures: fixations alternate between the source and model.

Experiment Design Considerations

Setting up the Scene

Place each object in its previously designated location that has been identified as an easy reach and measured in terms of visual angle from a seated position. The starting location of the hand should be marked.

Calibration

Measure the seated height of the participant and the distance from the eyetracking glasses to a target object position.

Calibration can be done free-form or with the computerized calibration program. Either calibration technique needs to be done at the averaged distance of the location of the objects.

Preview

You may want to cover the scene prior to trial initiation and allow a set period for preview (e.g., 30 s).

Preparation for Coding

Prior to coding, you will want to identify all possible targets and distractors in the scene to be coded, as well as the parts of the object you would like differentiated, the separable action components, the location of the objects in space (left, right), how close the gaze needs to be to an object to count it, and the criteria for determining a saccade and fixation (e.g., velocity thresholds and dwell times).

Data Analysis

The following is an overview of the stages required for analyzing the eyetracking data:

1. Edit the video output file to correspond with the first SMPTE timecode recorded in the data collection output code using QuickTime Pro.
2. Convert the data collection output into an iLab-compatible format containing pupil diameter and x- and y-coordinate gaze information.
3. Load gaze data into iLab to initiate the automatic detection of saccades and fixations. Output those reports.
4. Run script to append iLab outputs to data collection output file as flag variables. Create subset file containing SMPTE timecodes and saccade and fixation flags for input into InqScribe.
5. Load SMPTE data into InqScribe. Jump to saccade and fixation times within InqScribe. Use snippets to annotate video according to object being looked at. Export text file.
6. Append InqScribe output to original data collection output file.
7. Create a timeline graph in Excel from the appended data collection output file. (optional)

Video Trimming

First you must note the first SMPTE timecode demarcated in the data collection output file and trim the video to that start time in QuickTime Pro. Open the video in QuickTime and look for the selection sliders along the play status bar below the video (see #1). Move the right-most slider all the way to the right, reflecting that you want the entire end of the video (see #2 right-most dark triangle). Move the left-most slider to the timecode first referred to in the data collection output file (see #2 left-most white triangle). You may notice in the video that if the white LED is within the field of view, it turns on at the point where the new video clip begins. Once you have selected the area to be trimmed, click on the Edit menu and then click Cut. Save your new video clip.

Figure 10 - Location of sliders to trim video in QuickTime Pro



Figure 11 – Move sliders to start and endpoint of desired video clip



File Conversions

All data conversions are scripted in VBA and can be accessed through MS Access. Start Access and open the database entitled 'ConvertDB'. If you get a Security Warning window, click 'Options' then 'Enable

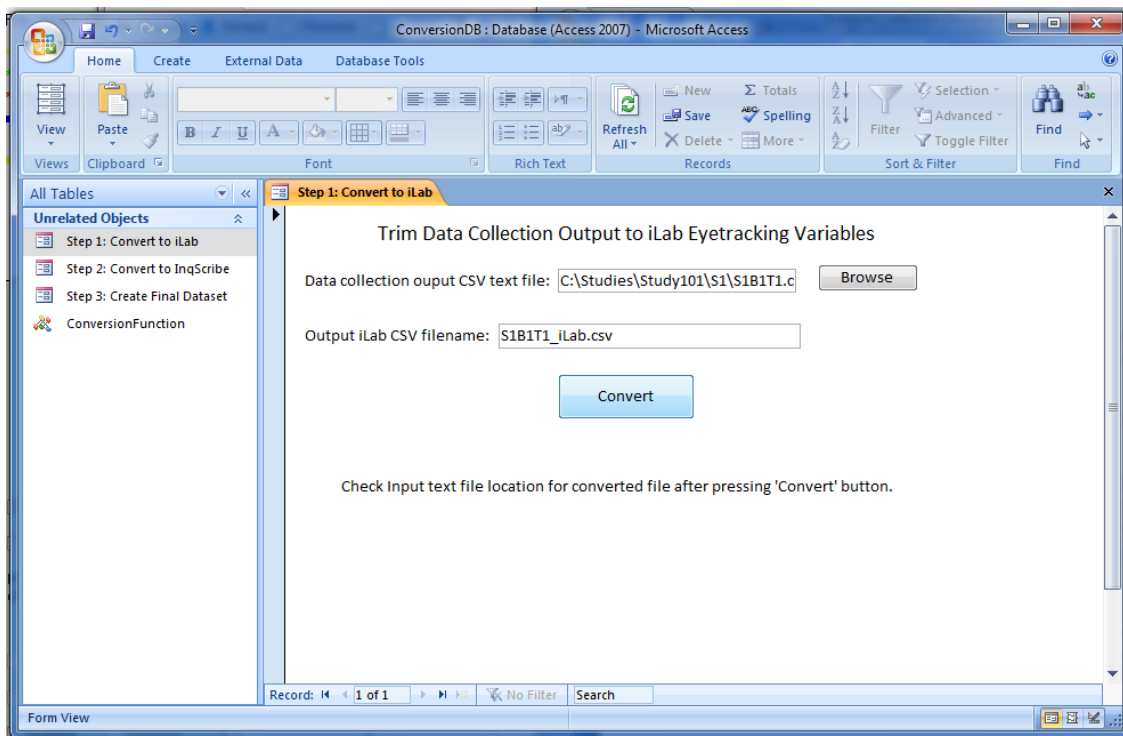
this content' and click 'OK'. Along the left-hand pane you will notice a number of Forms that are listed in steps. To complete a file conversion, simply click on the appropriate step.

Step 1

The first file conversion simply creates a subset of variables from the data collection output file.¹

1. Right-click on Step 1 in the left-hand pane and select 'Open'.
2. Choose the data collection output file in CSV format for the first field using the Browse button, e.g., **C:\Studies\Study101\S1\S1B1T1.csv**
3. In the second field, give the output CSV file for iLab a new filename, e.g., **S1B1T1_iLab.csv**
4. Click convert and look in the file folder where the data collection file is located for the new iLab file, e.g., **C:\Studies\Study101\S1\S1B1T1_iLab.csv** You are now ready to use iLab!

Figure 12 – Step 1: Convert to iLab



¹ This subset prevents errors in iLab due complex SMPTE time codes and negative values. Further, iLab's native fixation and saccade functions will only output eyetracking relevant variables along its own time code.

Figure 13 – Original Data Collection CSV File format

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	S2-B1-T1														
2															
3															
4	Subject	Block	Trial	Video Frar	Time (s)	Video Tim	SMPTE	Eye Status	Pupil Diam	Gaze X	Gaze Y	TrakStar X	Y1	Z1	a1
5	2	1	8	156	5.168	512.249	00:08:32:07	0	142	180	306	6.691	-7.431	-0.523	3
6	2	1	8	157	5.209	512.29	00:08:32:08	0	142	183	292	5.878	-8.09	-1.564	2
7	2	1	8	158	5.25	512.331	00:08:32:09	0	143	184	291	5	-8.66	-2.588	2
8	2	1	8	159	5.27	512.352	00:08:32:10	0	141	183	293	4.067	-9.135	-3.584	1
9	2	1	8	160	5.311	512.393	00:08:32:11	0	138	183	293	3.09	-9.511	-4.54	1
10	2	1	8	161	5.352	512.434	00:08:32:12	0	132	183	293	2.079	-9.781	-5.446	

Figure 14 –iLab formatted CSV File format

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	142	180	306												
2	142	183	292												
3	143	184	291												
4	141	183	293												
5	138	183	293												

Step 2

The second file conversion takes the two Excel-formatted results saved from iLab and matches the data to the SMPTE timecode from the data collection output file.

1. Right-click on Step 2 in the left-hand pane and select 'Open'. Choose the two relevant iLab Excel-formatted output files using the Browse button, e.g.,
C:\Studies\Study101\S1\S1B1T1_Saccades.xls, C:\Studies\Study101\S1\S1B1T1_Fix.xls
2. In the third field, choose the data collection output file in CSV format, e.g.,
C:\Studies\Study101\S1\S1B1T1.csv
3. In the fourth field, give the output tab-delimited file for InqScribe a new filename, e.g.,
S1B1T1_InqScribe.txt Click convert and look in the file folder where the data collection file is located for the new InqScribe file, e.g., **C:\Studies\Study101\S1\S1B1T1_InqScribe.txt** You are now ready to use InqScribe!

Figure 15 – Step 2: Convert to InqScribe

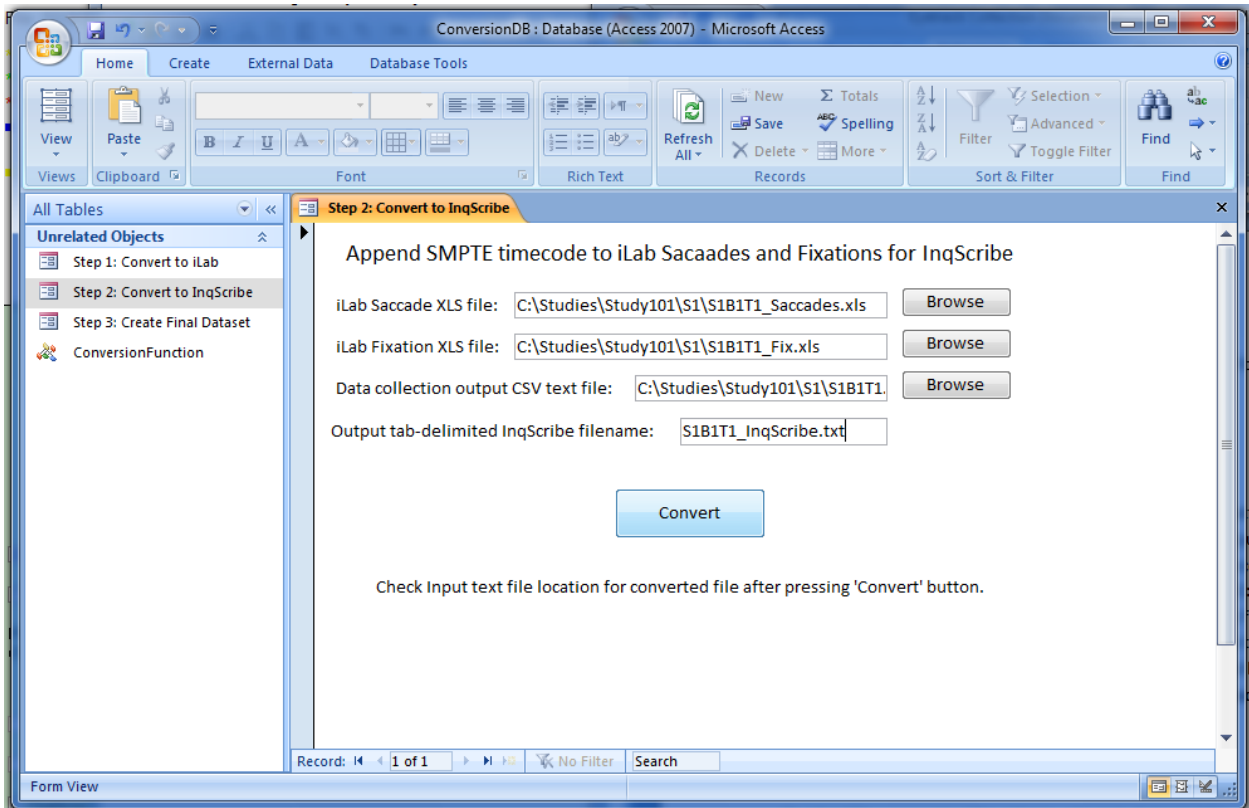


Figure 16 – iLab Fixation Saved Results File

The screenshot shows the Microsoft Excel interface for a workbook named 'S2-B1-T9_Fix'. The 'View' ribbon is active, and the 'Fixations' table is displayed. The table contains the following data:

Trial	start code	Fix	x	y	xDir	Dist	Start	Duration	%Zero	
1	1	1	1	175	336	-	0	33	100	43
2	1	1	2	184	296	R	41	167	1467	43
3	1	1	3	270	302	R	86	1633	167	43
4	1	1	4	309	300	R	38	1800	1200	43
5	1	1	5	399	270	R	95	3033	1500	43

Figure 17 – iLab Saccade Saved Results File

Trial	start code	Sacc#	Start	End	peak vel	mean vel	sac React	time-to-P	dist(deg)	%Zero	
6	1	1	1	6667	6733	8.80E+01	31.3	6667	6700	2.1	0
7	1	1	2	6833	6967	3.70E+01	11.2	6833	6867	1.5	0
8	1	1	3	8033	8133	5.60E+01	22.7	8033	8067	2.3	0
9	1	1	4	9567	9633	8.90E+01	32.5	9567	9600	2.2	0
10	1	1	5	10700	10800	1.10E+02	38.3	10700	10733	3.8	0

Figure 18 – InqScribe formatted Tab-limited File format

```

00:00:22.23      00:00:23.23 right saccade
00:00:23.24      00:00:24.02 fixation
00:00:24.03      00:00:24.05 right saccade
00:00:24.06      00:00:26.17 fixation
00:00:26.18      00:00:26.20 left saccade
00:00:26.21      00:00:27.15 fixation
    
```

Step 3

The third file conversion takes the tab-delimited file exported from InqScribe and appends the hand-checked fixation and saccade data, as well as the object identity notation to the original data collection output file based on the SMPTE timecode.

1. Right-click on Step 3 in the left-hand pane and select 'Open'. Choose the InqScribe tab-delimited exported file using the Browse button, e.g.,
C:\Studies\Study101\S1\S1B1T1_InqScribe_coded.txt
2. In the second field, choose the data collection output file in CSV format, e.g.,
C:\Studies\Study101\S1\S1B1T1.csv
3. In the third field, give the final appended CSV file a new filename, e.g., **S1B1T1_Scored.csv**
4. Click convert and look in the file folder where the data collection file is located for the new final dataset, e.g., **C:\Studies\Study101\S1\S1B1T1_Scored.csv**² You now have a complete dataset!

² Note that a second CSV file will be saved with the same filename and the word 'Timeline' appended to it with the same data but in a format suitable for the Timeline template (see below), e.g., S1B1T1_Scored_Timeline.csv

Figure 19 – Step 3: Create Final Dataset

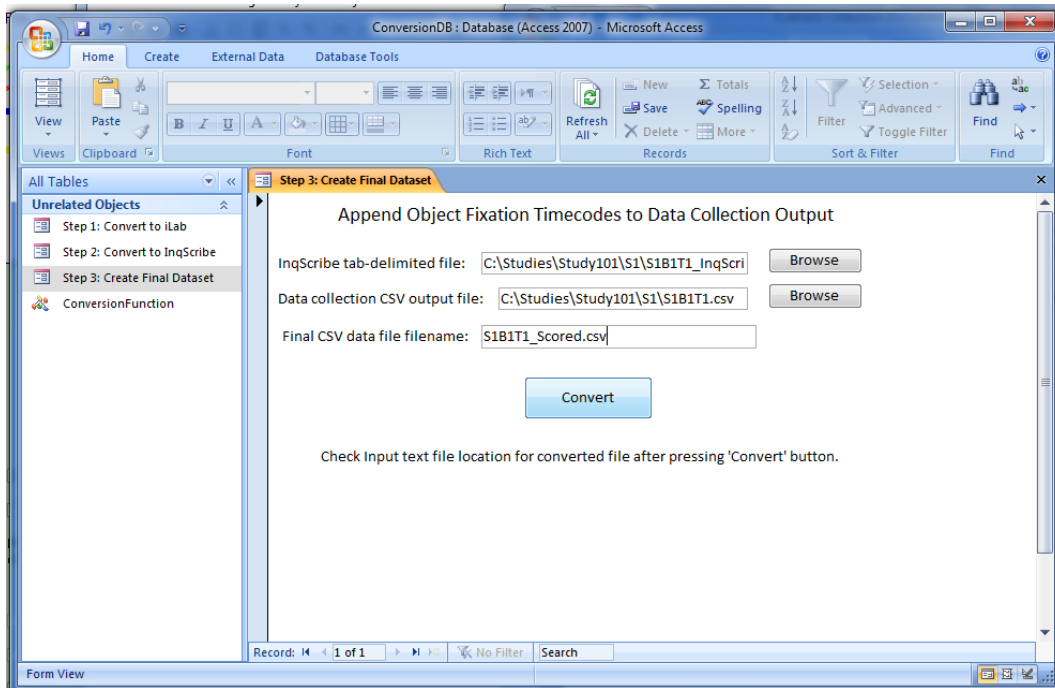


Figure 20 – InqScribe Exported Tab-delimited File

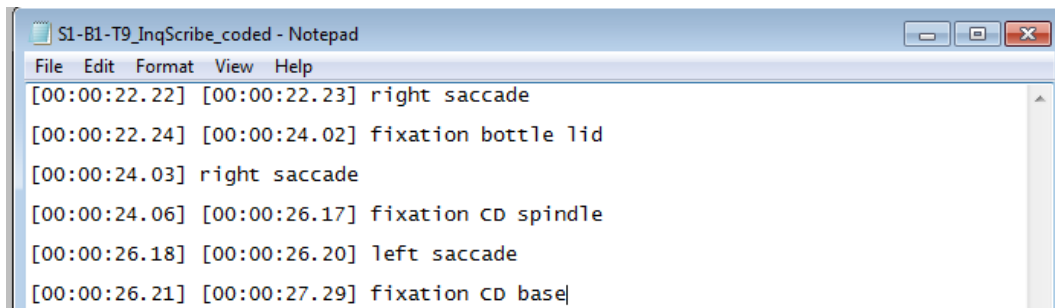


Figure 21 – Final Appended Dataset with Fixation Object and Saccade Information

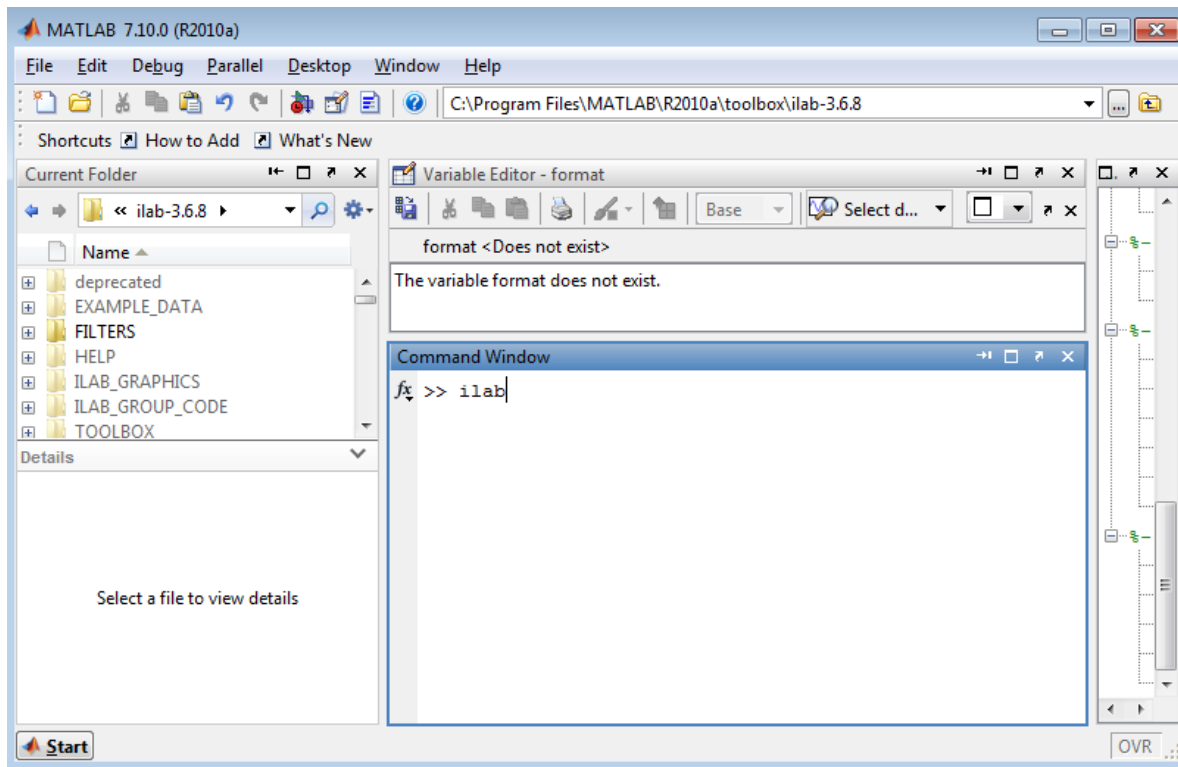
	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT
1	r3	X4	Y4	Z4	a4	e4	r4	FixSaccad	Location	
41	9.4	2.079	9.781	8.387	9.4	44	9.4	TallCyl	Top	
42	13.9	3.09	9.511	8.91	13.9	42.8	13.9	TallCyl	Top	
43	18.3	4.067	9.135	9.336	18.3	41.1	18.3	TallCyl	Top	
44	22.5	5	8.66	9.659	22.5	39	22.5	TallCyl	Top	
45	26.5	5.878	8.09	9.877	26.5	36.4	26.5	TallCyl	Top	
46	30.1	6.691	7.431	9.986	30.1	33.4	30.1	TallCyl	Top	
47	33.4	7.431	6.691	9.986	33.4	30.1	33.4	Saccade	Right	
48	36.4	8.09	5.878	9.877	36.4	26.5	36.4	Saccade	Right	
49	39	8.66	5	9.659	39	22.5	39	Saccade	Right	
50	44	9.781	-2.079	5.446	44	-9.4	44	Can	Top	
51	42.8	9.511	-3.09	4.54	42.8	-13.9	42.8	Can	Top	
52	41.1	9.135	-4.067	3.584	41.1	-18.3	41.1	Can	Top	
53	39	8.66	-5	2.588	39	-22.5	39	Can	Top	
54	36.4	8.09	-5.878	1.564	36.4	-26.5	36.4	Can	Top	

Fixations and Saccades Analysis in iLab

iLab is a Matlab toolbox designed to identify fixations and saccades. After opening Matlab, make sure you are in the iLab root directory, e.g., **C:\Program Files\MATLAB\R2010a\toolbox\ilab-3.6.8**

At the Matlab Command Window's ">>" prompt type "ilab".

Figure 22 –Matlab Command Window



A new window will open for iLab. From the File Menu select "Convert Text File".

iLab will ask a series of questions through small pop-up windows labeled "Convert a Text File"³. Respond in the following manner:

Choose a column delimiter: comma

Enter the number of columns (sic): 3

Enter column number for Horizontal Eye Data: 2

Enter column number for Vertical Eye Data: 3

Enter column number of Pupil Data or 0 for none: 1

Enter column number for trial starts and stops or 0 for none: 0

Enter the data sampling rate in Hz: 29.97

³ It is possible to set up a function to automatically do the conversion of files that do not change in format using the `ilabConvertFileTemplate.m` in the iLab directory. This function should be placed under the iLab toolbox directory so that it can be called from within iLab.

Enter the subject ID: [put in a number here]

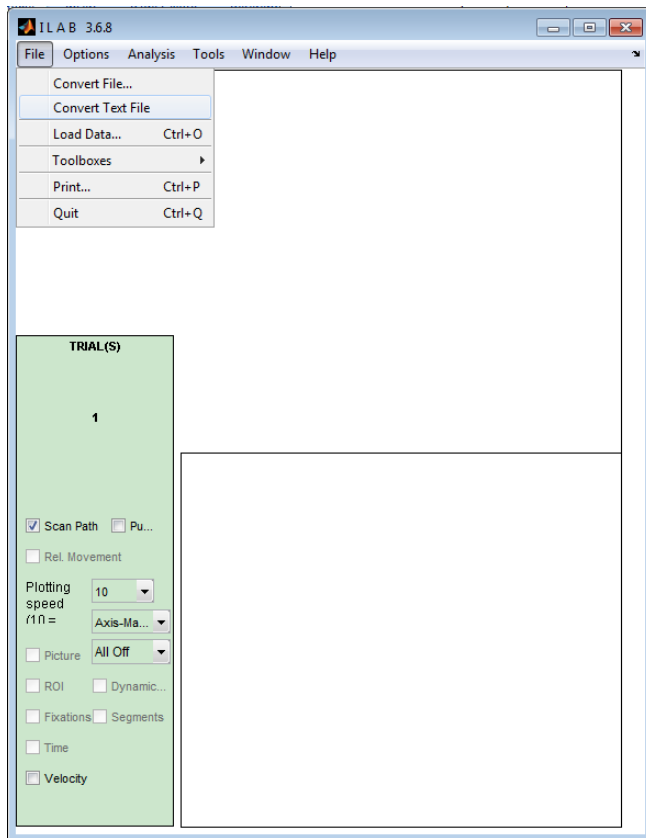
Enter the file creation date: [optional, can leave blank]

Enter the file creation time: [optional, can leave blank]

Enter a description: [optional, can leave blank]

An iLab warning message will come up that no Serial codes were found, and that it placed its own Start and Stop codes in the data. Click 'OK'.

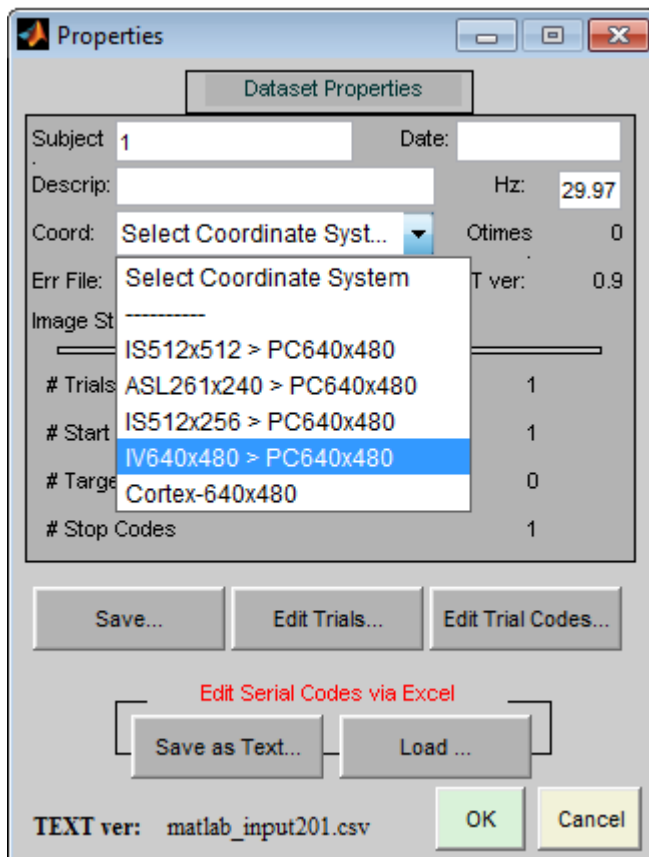
Figure 22 –iLab Main Window



If you receive an iLab error that it could not parse the text file, you need to check the input file in Excel or notepad and make sure that it follows the correct iLab format, namely, that: it has only three columns representing pupil, x, and y, all blanks have been converted to the value “NaN”, all fields are separated by a column and there are no negative values.

iLab will now open a properties window. Select the dropdown arrow next to “Select Coordinate Syst..” and choose IV640x480 > PC640x480. Then click OK. iLab will ask you if you want to save the results. Saving the results here means saving off a Matlab-formatted file that will allow you to load the data into iLab again (using the Load Data function) without having to go through the window prompts.

Figure 23 –iLab Properties Window



iLab will plot the x-y coordinates in the main window and then separately in the two lower windows.

From the Analysis menu, choose the Fixations analysis. Here you can set how you want to calculate a Fixation:

1. The Velocity/Distance calculation is default and most typically used in our labs.
2. Our data is in Pixels, so it is easiest to make changes to the Horizontal and Vertical movement parameters in pixels. These parameters should be defined as part of the experiment.
3. You will also need to set the minimum fixation duration based on study parameters.

Once you click OK, a Fixation Results Window will appear which identifies each individual fixation in terms of its x-y coordinate, the direction of saccade to that fixation, the distance traversed in pixels, the beginning time of the fixation in seconds, and the length of the fixation in seconds. You can close this window.

Figure 24 –iLab Fixations Analysis Window

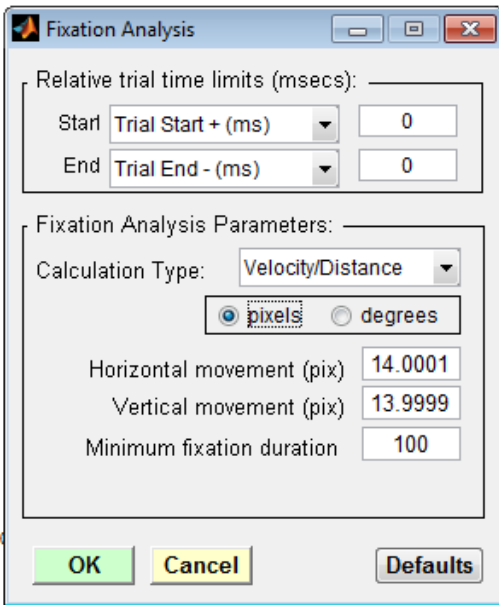
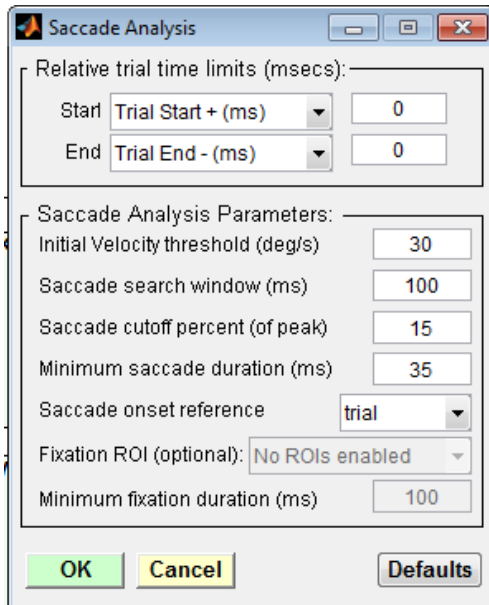


Figure 25 – iLab Fixations Results Window

Trial	Fix	x	y	xDir	Dist px	Start ms	Duration ms	%Zero
1	1	175	336	-	0	33	100	43
1	2	184	296	R	41	167	1467	43
1	3	270	302	R	86	1633	167	43
1	4	309	300	R	38	1800	1200	43
1	5	399	270	R	95	3033	1500	43
1	6	313	298	L	90	4533	1133	43
1	7	172	299	L	142	5700	1233	43
1	8	174	270	R	30	7000	67	43
1	9	184	309	R	41	7067	933	43
1	10	304	314	R	120	8033	267	43
1	11	321	312	R	17	8300	533	43
1	12	421	262	R	112	8867	1000	43
1	13	386	276	L	38	9867	133	43
1	14	314	309	L	79	10067	733	43
1	15	203	308	L	111	10833	900	43
1	16	451	312	R	248	11767	133	43
1	17	473	330	R	29	11933	100	43

From the Analysis menu, next choose the Saccades analysis. Here you can set how you want to calculate a Saccade. Each of the parameters here should be defined prior to initiation of the study. Namely, the velocity threshold in deg/s to determine the initiation of a saccade, the saccade cutoff as a percentage of peak, and the minimum duration of time to be considered a saccade.

Figure 26 – iLab Saccade Analysis Window



Once you click OK, a Saccade Results Window will appear which identifies each individual saccade in terms of its start and end times, peak and mean deg/sec, time to peak in ms, and distance travelled in pixels. (If you try to read the saccade results in this window, please note that the column headers are misaligned to the data.) You can close this window.

Figure 27 – iLab Saccade Results Window

Trial	Sacc#	Start ms	End ms	vPeak deg/sec	vMean deg/sec	SRT ms	ttPeak ms	dist	%Zero
1	1	6667	6733	88.3	31.3	6667	6700	2.1	0
1	2	6833	6967	36.6	11.2	6833	6867	1.5	0
1	3	8033	8133	56.3	22.7	8033	8067	2.3	0
1	4	9567	9633	88.7	32.5	9567	9600	2.2	0
1	5	10700	10800	110.7	38.3	10700	10733	3.8	0
1	6	14067	14167	105.6	32.6	14067	14100	3.3	0
1	7	14900	15000	100.6	32.3	14900	14933	3.2	0
1	8	15933	16000	31.7	12.6	15933	15967	0.8	0
1	9	16067	16367	85.1	33.1	16067	16100	9.9	50
1	10	17067	17167	76.3	29.7	17067	17100	3.0	0
1	11	18000	20900	55.5	30.4	18000	18033	88.2	98

Click Analysis again and choose Save Results to Text. Click the checkboxes for Fixations and Saccades. This will save out the files you will need for the Convert to InqScribe function in MS Access (see section above covering File Conversions.)

Target Analysis in InqScribe

InqScribe is a subtitling program that allows you to view a video file, jump to specific SMPTE timecodes, control the playback frame-by-frame, and insert new timecodes and hotkeyed tags. These functions will allow you to manually check iLab's automatically identified fixations and add tags identifying which objects are being fixated on.

Once you have opened InqScribe, click on the 'Select Media Source' button on the top left. In the Select Media Source window choose 'Select File' and choose the video file. Next under Time Code select 'Start at Custom Time'. Enter the SMPTE timecode from the first frame of data of the data collection output file. This is the same value you used earlier to trim the initial part of the video file. Click OK.

The video should now appear in the main window of InqScribe and the SMPTE timecode displayed on the bottom left should reflect the SMPTE timecode you entered (not 00:00:00.00). If the white LED is within view, it will turn on within a frame or two of the beginning of the video.

Select File then Import than Tab-delimited Text. The Import Settings window will appear where you should make sure Unicode (UTF-8) is selected and change Imported Frame Rate to 29.97 fps (NTSC). Under Import File select Choose File and choose the file that has been output from the conversion utility. If nothing is loaded, there is a problem with the file format. Open the InqScribe transcript file you created in the conversion step earlier. Make sure each field is tab-delimited and that the file contains timecode information in the format [00:00:00.00]

Figure 28 – InqScribe Media Source Window

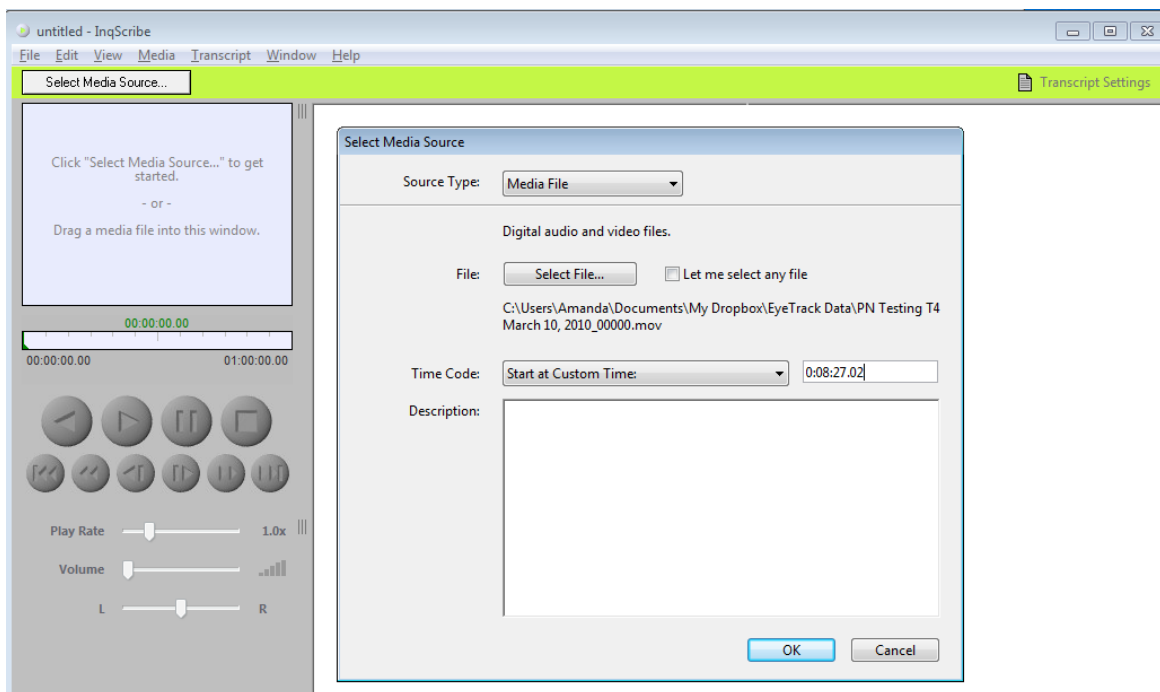
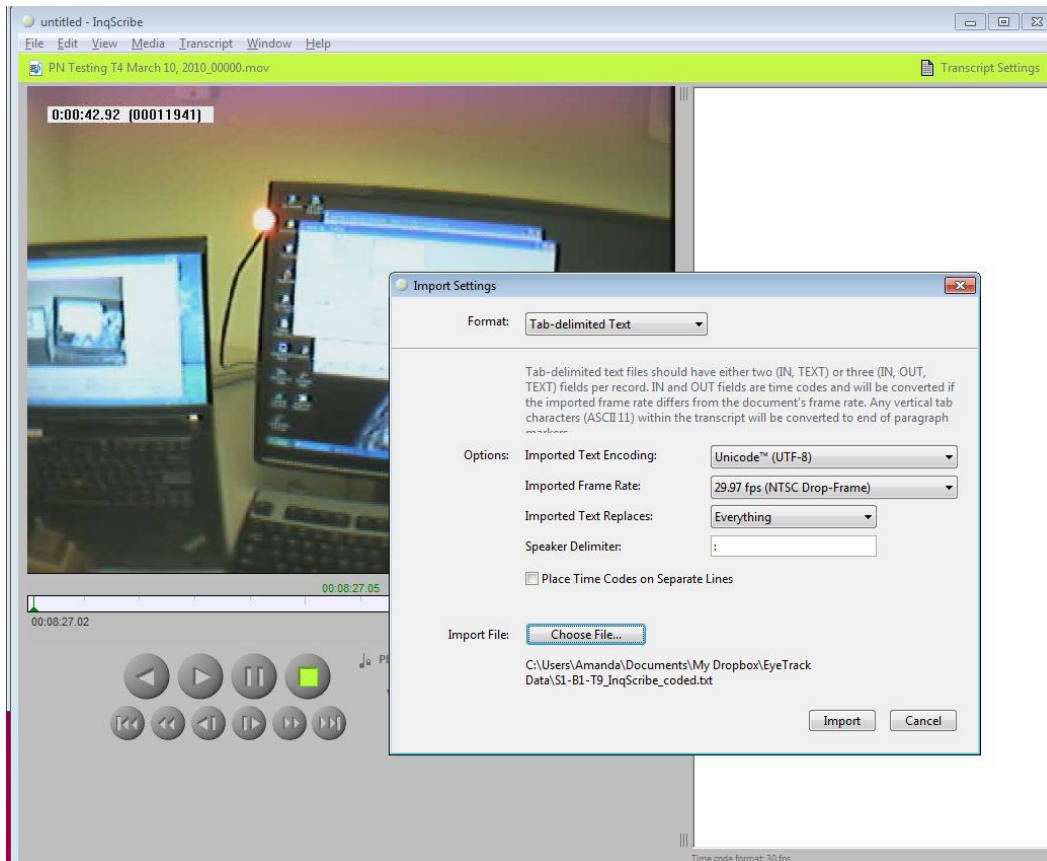


Figure 29 – InqScribe Import Settings Window



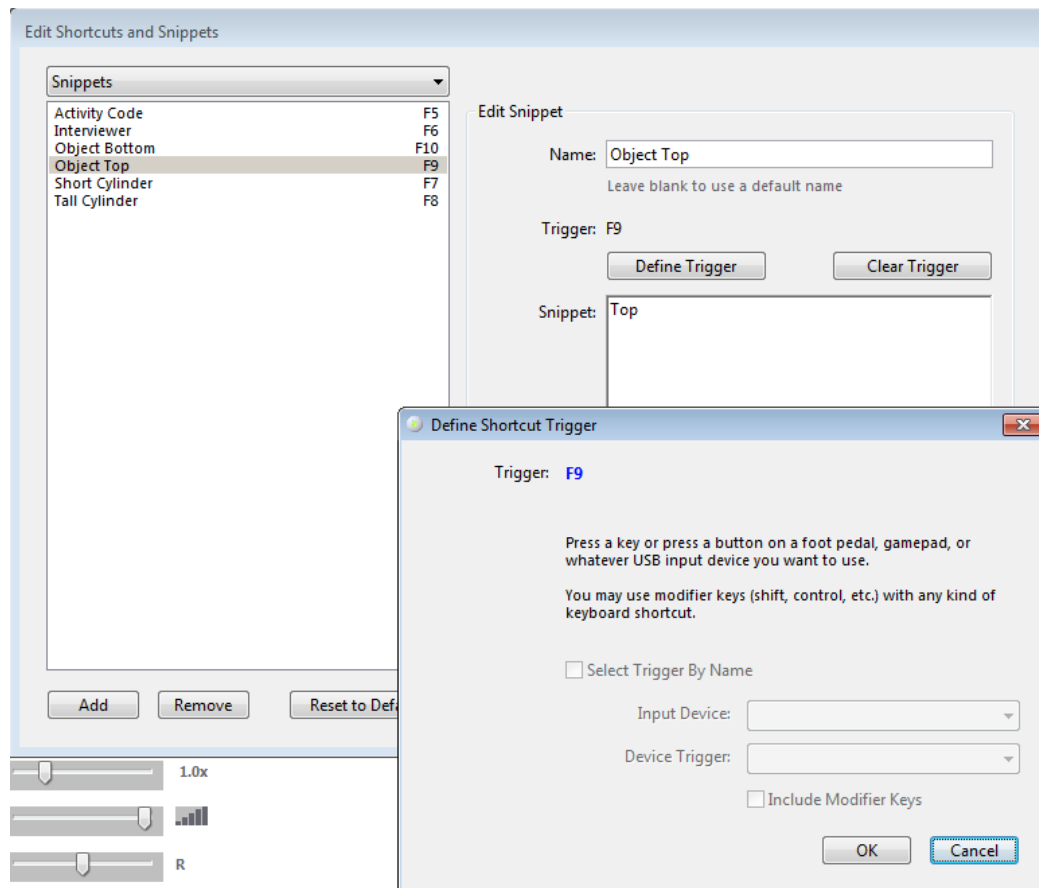
Next you need to define the targets of the experiment to efficiently identify them with a single keystroke. Click Edit and Edit Snippet. Click Add to create a new snippet. At a minimum, you should set up a snippet for each possible target object name and each relevant part of that object (see examples in the figure below). Name the shortcut then define its trigger by clicking the Define Trigger button. Once the Define Shortcut Trigger window is open simply click the button you want to assign the shortcut to and it will show next to the word Trigger in blue. For shortcuts, you typically use Function buttons (e.g., F7). Click OK to return to the Edit Shortcuts and Snippets window. You next need define the snippet by typing in the associated text. To add the next snippet click Add again, and when you have finished click Done.

One built-in shortcut you should be aware of is Ctrl+; which inserts a timecode stamp in your transcript based on the location of the slider for video playback.

Now that you have all of your shortcuts and snippets defined, you can begin coding the video transcript. You should see timecode stamps listed on the right-hand side (see File Import step above). The main task in InqScribe is to jump between saccades and fixations to ensure that the timecodes accurately reflect their onset and offset, and for fixations, to additionally record the object fixated and the part of the object fixated. There may be other information to record depending on the requirements of the experiment. For example, you may need to code what the hand is doing, e.g., reaching for the kettle,

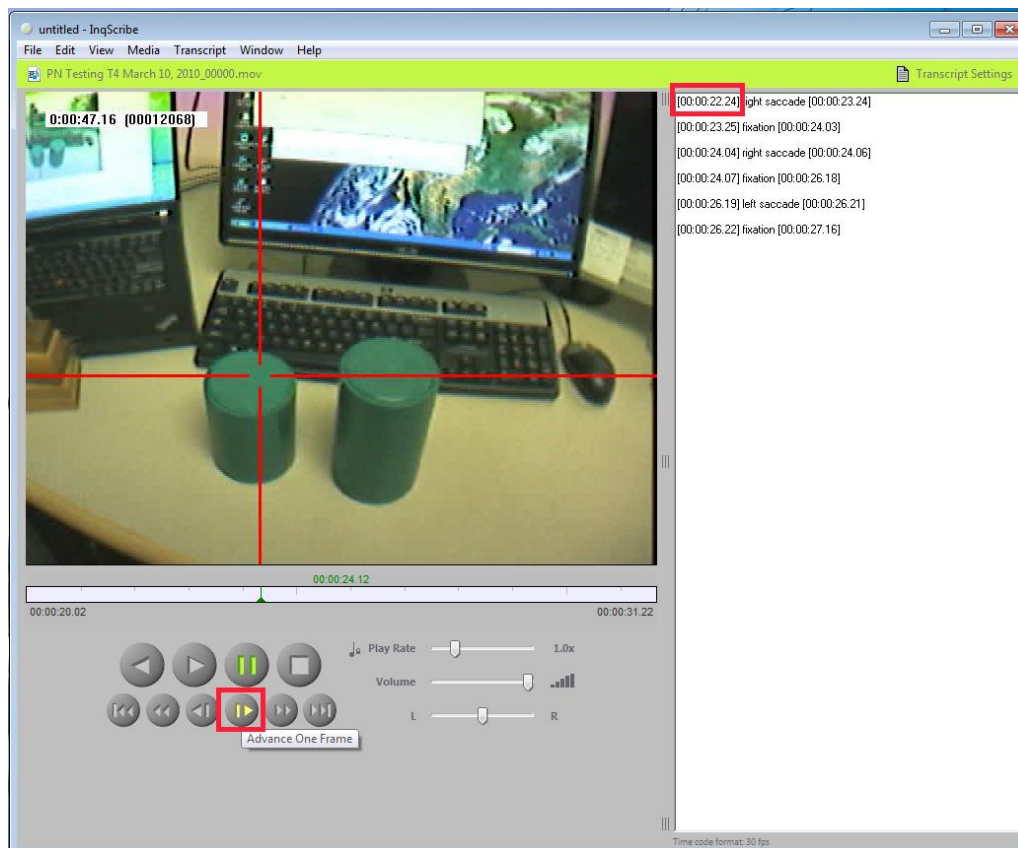
transporting the kettle, pausing, pouring the water, setting the kettle down. Further, you may want to keep track of the location of the object in space, e.g., right, left, which may vary for a given object by trial or participant. These are all possible snippets.

Figure 30 – InqScribe Edit Shortcuts and Snippets Window



It is very unlikely that the iLab algorithms miss a valid fixation or saccade. It is more likely to have over-identified fixations or saccades. Thusly, the best way to navigate through the video file is the use the saccade and fixation time codes to jump from one point in the video using the timecodes to visually check whether the position of the crosshair accurately represents the labeled timecode. You can jump to each timcode by clicking on the timecode itself in the video transcript. Once you arrive at the destination timecode in the video, you will want to check the behavior of the eye in advance and after that specific timecode to determine whether that is truly the onset or offset of the activity, respectively. To do that, use the player button that looks like |> (see also the button indicated in the figure below). This will advance the video by one frame. Similarly, <| will reverse the video by one frame.

Figure 31 – InqScribe Jump to Timecode Navigation



Based on your video accuracy check, it may be necessary to alter or even delete the timecodes in the video transcript. This can be accomplished by positioning the video playback slider at the appropriate timepoint and using the Cntrl+; shortcut to insert the correct timecode into the transcript. Object names and parts should be inserted using the snippets you defined earlier.

If you wish to return to your analysis, you can save your entire project using File and then Save. When you are finished with your visual check of the video timecodes and have added all the object labels, it is time to save off the final video transcript. There are two ways to do this. One way is just to highlight the text and copy it like you would any other text (Edit...Copy or Cntrl-C), paste the text in Notepad (Edit...Paste or Cntrl-V), and save the file off as a text. Another method is to use File... Export and select Tab-delimited text. In the Export Settings Window that appears name the file, e.g., S1B2T9_InqScribe_coded.txt, and click Export.

The video transcript file exported from InqScribe will be appended to the original data collection output file using the Step 3 conversion utility in MS Access. This completes the data processing steps for the eyetracking data.

Timeline Chart of the Tracking Data

Step 3 of the conversion process generates a second CSV datafile appropriate for creating a Timeline chart of the trial in Excel, e.g., S1B2T9_Scored_Timeline.csv

To begin, open the created CSV file and the Excel-Tracking-Timeline-Template.CSV. Notice that there are instructions for how to manipulate the template on the right-hand side. Those instructions are described in more detail below.

Look at the number of rows in the CSV file. You will need to have the same number of rows in the Timeline table. Make new rows in the timeline table NOT by inserting rows but by copying and pasting the last row. Highlight the fields for Time, Task, Duration, Height, Axis and Label. Click Cntrl-C. Then select the row immediately below the last values on the table and drag your selection down to accommodate the number of rows that you will finally need. For example, the table begins on row 5 and contains 32 values already. If you will need 500 total rows, you will need to select the area from B33-G33 all the way down to B506-G506. Once you have that area selected, hit Cntrl-V to paste the last row throughout that selection. (Note: You may need to move the chart out of the way to the right to make enough room for the extra rows. You can place the chart underneath the rows again once you have pasted them in place.)

Figure 32 –Excel Timeline Template Data Table

Eye and Hand Tracking Timeline Template						
Title: S1T1 B9 Timeline						
Time (ms)	Task	Duration (ms)	Height	Axis	Label	
5000	Videotape onset		45	5000	Videotape onset	
5168	EyeTracker initiation		37	5168	EyeTracker initiation	
5311	1. TallCyl Fixation	1333	27	5311	1. TallCyl Fixation	
5311	1.1 TallCyl Middle	431	23	5311	1.1 TallCyl Middle	
5783	1.2 TallCyl Top	861	17	5783	1.2 TallCyl Top	
6972	2. Can Fixation	308	35	6972	2. Can Fixation	
6972	2.1 Can Top	308	30	6972	2.1 Can Top	
7382	3. TallCyl Fixation	206	23	7382	3. TallCyl Fixation	
7382	3.1 TallCyl Top	206	17	7382	3.1 TallCyl Top	
7752	4. Can Fixation	266	35	7752	4. Can Fixation	
7752	4.1 Can Top	266	30	7752	4.1 Can Top	
8141	5. ShortCyl Fixation	759	23	8141	5. ShortCyl Fixation	
8141	5.1 ShortCyl Top	432	15	8141	5.1 ShortCyl Top	
8613	5.2 ShortCyl Middle	492	10	8613	5.2 ShortCyl Middle	
9208	6. Can Fixation	102	35	9208	6. Can Fixation	
9208	6.1 Can Top	102	30	9208	6.1 Can Top	
5475	1. TallCyl Interact	2113	-10	5475	1. TallCyl Interact	
5475	1.1 TallCyl Reach	328	-15	5475	1.1 TallCyl Reach	
5844	1.2 TallCyl Grasp	164	-20	5844	1.2 TallCyl Grasp	
6050	1.3 TallCyl Hold	471	-25	6050	1.3 TallCyl Hold	
6542	1.4 TallCyl Transport	799	-30	6542	1.4 TallCyl Transport	
7382	1.5 TallCyl Place	206	-35	7382	1.5 TallCyl Place	
8346	2. ShortCyl Interact	964	-10	8346	2. ShortCyl Interact	
8346	2.1 ShortCyl Reach	328	-15	8346	2.1 ShortCyl Reach	
8715	2.2 ShortCyl Grasp	123	-20	8715	2.2 ShortCyl Grasp	
8879	2.3 ShortCyl Hold	308	-25	8879	2.3 ShortCyl Hold	
9085	2.4 ShortCyl Transport	102	-30	9085	2.4 ShortCyl Transport	
9208	2.5 ShortCyl Place	102	-35	9208	2.5 ShortCyl Place	

Instructions

- Do not insert or remove entire rows (This will mess up the labeling order in the chart).
- Edit the yellow cells. You can copy and paste, delete, insert, and sort, as long as you do not insert or delete entire rows.

To change the x-axis scale

- Right-click on the x-axis and select "Format Axis..." or use the Chart toolbar to edit the axis properties.
- In the Scale tab, choose specific minimum and maximum values.

To delete a Task

Delete the Time and Task in columns B and C, respectively.

To add a Task

- Do not insert a row. Just copy the last row of the table down as many rows as you need.
- Modify the data series to include the additional rows.
- Edit each new data point label, referencing the correct cell in column G. This is done by clicking on the data points in the chart. Then click on the specific data label that you want to edit (this should highlight just the single data point). Then, with the data point selected, type "=" then select the cell containing the Label (in column G).

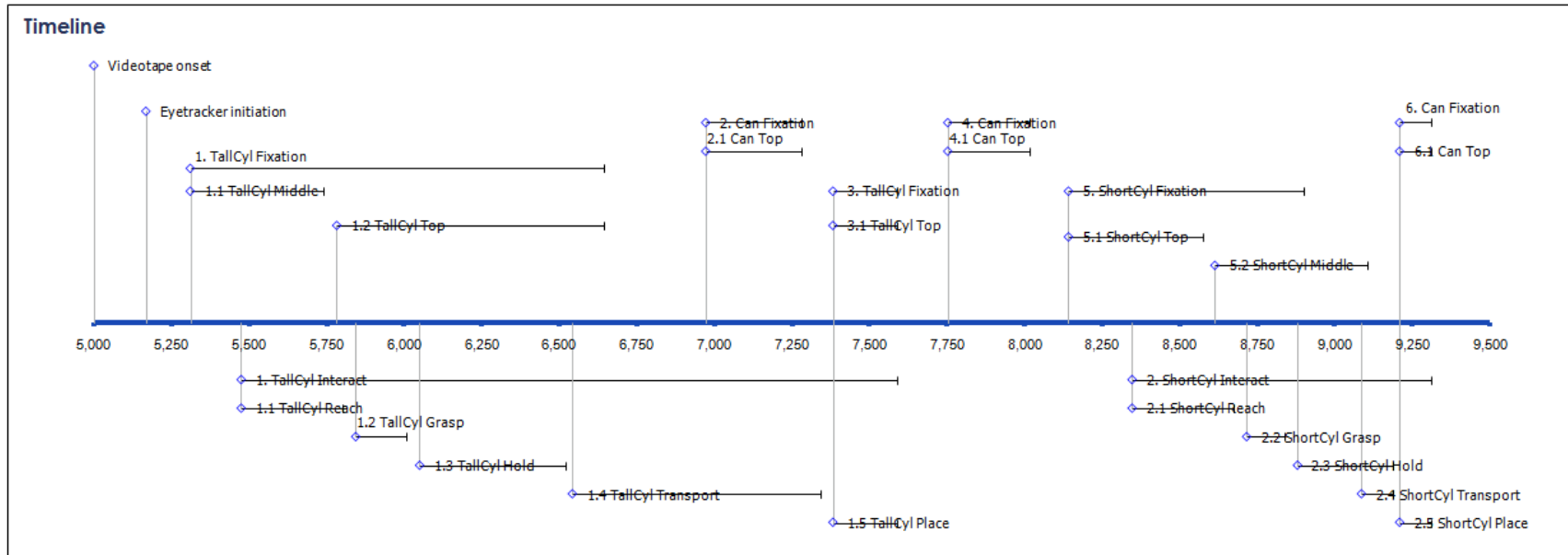
Moving Labels

You may need to move the labels around to get everything positioned just right.

Now go to your CSV file and highlight all 4 columns down to the last value (do NOT copy the whole column, actually create a box around the values by scrolling to the bottom of the values). Go back to the template and select cell B5. Cntrl-V paste the values into the template.

The data you pasted into the table should be reflected in the timeline chart. Note that you may have to adjust the labels and height of the labels for readability. When you save your work, choose Save As and select a new name. It is preferable that the template remain unedited.

Figure 33 – Excel Timeline Chart



Position Chart of the Eyetracking Data

Either the final dataset or the original data collection output file can be used to create a position overlay chart. To do this, open up either file and highlight the x and y position columns. Go to Insert then choose XY scatter and Straight Lines with Markers. Insert it into a new sheet, either by selecting a new sheet or manually cutting and pasting it on a new sheet. You can change the look of the data points by clicking on some the points to select them and then right-clicking on the selected points and choosing Format Data Series.

Figure 34 – Excel Position Chart Data Sources

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	S2-B1-T1														
2															
3															
4	Subject	Block	Trial	Video Frar Time (s)	Video Tim SMPTE	Eye Status:Pupil Diam				Gaze X	Gaze Y	TrakStar X Y1	Z1	a1	
5	2	1	8	153	5.086	512.167	00:08:32:04	0		175	343	8.66	-5	2.588	
6	2	1	8	154	5.106	512.188	00:08:32:05	0		175	334	8.09	-5.878	1.564	36
7	2	1	8	155	5.147	512.229	00:08:32:06	0		176	331	7.431	-6.691	0.523	33
8	2	1	8	156	5.168	512.249	00:08:32:07	0	142	180	306	6.691	-7.431	-0.523	30
9	2	1	8	157	5.209	512.29	00:08:32:08	0	142	183	292	5.878	-8.09	-1.564	26
10	2	1	8	158	5.25	512.331	00:08:32:09	0	143	184	291	5	-8.66	-2.588	22
11	2	1	8	159	5.27	512.352	00:08:32:10	0	141	183	293	4.067	-9.135	-3.584	18
12	2	1	8	160	5.311	512.393	00:08:32:11	0	138	183	293	3.09	-9.511	-4.54	13
13	2	1	8	161	5.352	512.434	00:08:32:12	0	132	183	293	2.079	-9.781	-5.446	9
14	2	1	8	162	5.373	512.454	00:08:32:13	0	127	184	294	1.045	-9.945	-6.293	4
15	2	1	8	163	5.414	512.495	00:08:32:14	0	122	185	295	0	-10	-7.071	
16	2	1	8	164	5.434	512.516	00:08:32:15	0	118	184	296	-1.045	-9.945	-7.771	-4
17	2	1	8	165	5.475	512.557	00:08:32:16	0	114	184	295	-2.079	-9.781	-8.387	-9
18	2	1	8	166	5.516	512.598	00:08:32:17	0	112	184	295	-3.09	-9.511	-8.91	-13
19	2	1	8	167	5.537	512.618	00:08:32:18	0	109	184	295	-4.067	-9.135	-9.336	-18
20	2	1	8	168	5.578	512.659	00:08:32:19	0	107	185	295	-5	-8.66	-9.659	-22
21	2	1	8	169	5.619	512.7	00:08:32:20	0	105	185	296	-5.878	-8.09	-9.877	-26
22	2	1	8	170	5.639	512.721	00:08:32:21	0	104	184	295	-6.691	-7.431	-9.986	-30
23	2	1	8	171	5.68	512.762	00:08:32:22	0	103	183	295	-7.431	-6.691	-9.986	-33
24	2	1	8	172	5.701	512.782	00:08:32:23	0	102	184	295	-8.09	-5.878	-9.877	-36
25	2	1	8	173	5.742	512.823	00:08:32:24	0	101	183	295	-8.66	-5	-9.659	-3
26	2	1	8	174	5.783	512.865	00:08:32:25	0	101	182	295	-9.135	-4.067	-9.336	-41
27	2	1	8	175	5.803	512.885	00:08:32:26	0	100	183	297	-9.511	-3.09	-8.91	-42
28	2	1	8	176	5.844	512.926	00:08:32:27	0	100	182	297	-9.781	-2.079	-8.387	-4
29	2	1	8	177	5.885	512.967	00:08:32:28	0	100	182	296	-9.945	-1.045	-7.771	-44
30	2	1	8	178	5.906	512.988	00:08:32:29	0	100	183	296	-10	0	-7.071	-4

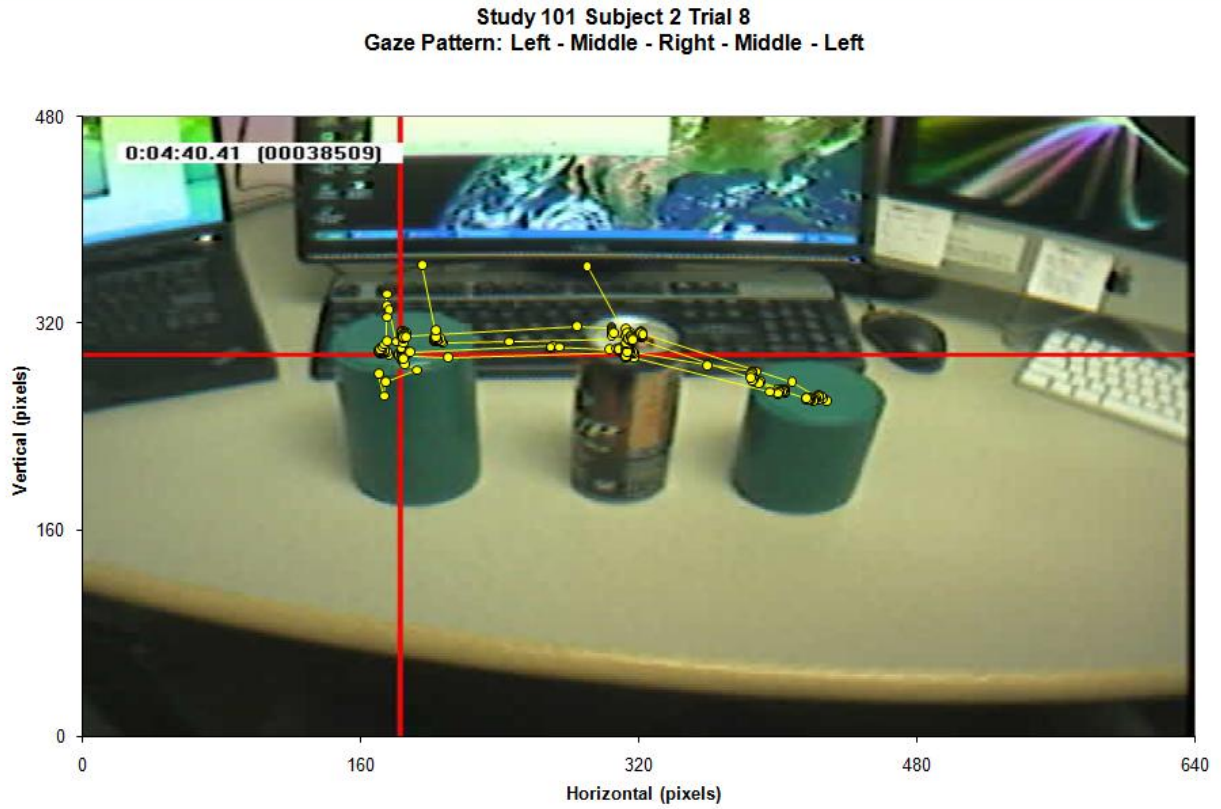
Next create the background image you would like to use by scrolling a video player to the screen capture picture you want. Make sure the video size is sufficiently large and hit the PrtSc screen on your Windows keyboard or Shift-Apple-3 on your Mac keyboard. This will store a copy of your desktop in your copy buffer or clipboard.

Open up an image editor, e.g., MS Paint or Photoshop Elements, open a new document and paste the image in using Cntrl-V or the options from the top menu for pasting. Select the portion of your desktop that you want to use for the image and crop to that selection (commands to do this vary by the image editor you use). Save off the image in a standard image format, e.g., PNG, GIF, JPG, BMP, TIF, etc.

Return to Excel and click in the white background area of the plot. Now that the plot area is selected, right-click in that area and select Format Plot Area. Select Fill and Picture or Texture Fill. Click Insert From File and select the image. The image will be scaled to fit in the background of the plot.

If the image doesn't map well onto the position of the fixations, you can shift the image using the Stretch options offsets on the same Format Plot Area Fill menu.

Figure 35 – Excel Position Chart with Background Image Example



Programming Notes

Calibration Program

The Eyetrack Calibration program is designed to randomly present a series of green dots over a period of 31 seconds for calibrating the ASL MobileEye system. The dots appear at a 3 high x 5 wide grid of dots evenly spaced over the width and height of the program window. The center dot is presented 15 times, each of the other 14 dots is presented once in random order: center dot – random dot – center dot – random dot – center dot, etc.

In a typical experiment the Calibration grid is presented at the beginning and end to check the accuracy of the calibration.

This is a very simple program, only using the start button to randomize the target positions and start the 1 second timer. After presenting the 15 center points and 14 target positions at one second each, the screen is blank for two seconds, and the program ends totaling 31 seconds.

Warning: resize or maximize the program window before you start the calibration program. The XY locations of the dots are calculated when the Start button is pressed, so expanding the window after the program has begun will result in a small dot grid in the upper left hand corner of the maximized window (please give it a try).

Compiler

The compiler used throughout the project was Microsoft Visual C++ Express 2008, downloaded from: <http://www.microsoft.com/express/Downloads/#2008-Visual-CPP>

Compiler – String Types

In its original configuration C++ uses Unicode, a difficult string type to work with. In order to use strings more easily the Strings settings was changed:

Press Alt-F7, open the Configuration Properties > General, and change from Unicode to Use Multi-Byte Character Set.

Data Acquisition Program Notes

The data acquisition program merges two data streams from two different external sensor systems and synchronizes them in time while illuminating LEDs visible in the video camera field to synchronize the digital data and video images.

MobileEye External Data Input – RS-232 Serial data

The data acquisition program receives external data primarily from the ASL MobileEye system through the RS-232 serial data port. The data stream runs at a rate of 57,600 baud, with a 10 byte data packet being sent 30 times a second. Within the data packet are values for the diameter of the participant's pupil, the validity of data, and X-Y position of the participant's point of gaze.

Compiler

The compiler used throughout the project was Microsoft Visual C++ Express 2008, downloaded from: <http://www.microsoft.com/express/Downloads/#2008-Visual-CPP>

Compiler – String Types

In its original configuration C++ uses Unicode, a difficult string type to work with. In order to use strings more easily the Strings settings was changed:

Press Alt-F7, open the Configuration Properties > General, and change from Unicode to Use Multi-Byte Character Set.

Parallel Port Digital I/O

This project uses the PC printer port for some simple digital input and output. Two electrical switches are used for inputs and two LEDs are used for indicator outputs. Three things are necessary for this Input/Output system to work –

1. Proper wiring
2. Proper drivers
3. Proper Compiler configuration
4. Proper hardware configuration

Parallel Port Cable Wiring

The PC parallel printer port is designed for the parallel transmission of digital data to and from a computer printer. The port is typically a DB-25 female connector, purple in color. The active signal levels are 0 Volts for a '0' value, and +5 Volts for a '1' value when compared to system ground. In addition to eight digital data outputs from the computer to the printer, there are four combinational input/output

lines typically used for latching data into the printer's data buffers, and handling system indicators such as 'paper out', etc.

In this case we use the eight data lines to power two indicator LEDs, and two of the four input/output lines for switch inputs.

The eight data lines are on pins 2-9 of the 25 pin printer port located on the back of the data collection PC. The lower four data lines, pins 2,3,4,5 are connected to the positive lead of LED #1, while pins 6,7,8,9 are connected to the positive lead of LED #2. The negative leads of both LEDs are connected to the common ground lines, pins 18-25. There is also a 200 Ohm resistor between the combined data lines and the LED to limit the current flow to around 20 milliamps, about 5 ma from each data line. The parallel port drivers typically put out about +4.5 Volts, combined with the 0.5 V drop across the LED means there is a 4 Volt drop across the resistor ($V = I * R$, 4 Volts = 0.020 Amps * 200 Ohms).

The two switch inputs are directly connected to pins 1 (/Strobe) and 14 (/LineFeed) and common ground (pins 18-25). The switch is normally open, meaning that pins 1 and 14 are at +5 Volts relative to ground. The computer program can read the status of the pins, and can sense when the switch is closed and either or both lines are shorted to ground.

Parallel Printer Port (simplified)

Base Address (\$378) - 8 Output Lines: pins 2-9

Base+1 Address(\$379) - 5 Input Lines: pins 10, 11, 12, 13, 15 (requires external power)

Base+2 Address(\$37A) - 4 In/Out Lines: pins 1, 14, 16, 17 (self powered)

Parallel Port Visual C++ Required Drivers

Under Windows 2000 and XP the hardware control registers of the computer motherboard are protected, only to be accessed by the operating system itself. In order to access the parallel port in a way other than for printing, a special driver INPOUT32.DLL needs to be installed and accessed:

http://logix4u.net/Legacy_Ports/Parallel_Port/Inpout32.dll_for_Windows_98/2000/NT/XP.html

The file INPOUT32.DLL has been copied into the C:\WINDOWS\SYSTEM directory and accessed through the port access code functions outlined here:

```
short Input (short portaddr)
{
    return (inp32)(i);
}

void Output(short portaddr, short datum)
{
    (oup32)(portaddr,datum);
}
```

Three files need to be included in the program's **Debug** directory: **SwitchIO.h**, **SwitchIO.cpp**, and **inpout32.lib**.

Parallel Port Compiler Settings

In order to properly compile and link the program one dependency setting within the compiler needs to be set:

Within the Visual C++ 2008 Express Edition IDE menu bar select: Project, [project name] Properties, and within the Properties Pages select Configuration Properties, Linker, Input, Additional Dependencies, and add "**inpout32.lib**", then click **Apply** and **OK**.

Parallel Port Motherboard BIOS Hardware settings:

The Printer port needs to be set to LPT1 (hardware hexadecimal address \$378), Output Only. Alternate hardware addresses are: LPT2 \$278, LPT3 \$3BC).

Changed BIOS Settings:

- Advanced – Onboard Devices – Parallel Port - \$378 (no IRQ, no DMA)
- Advanced – Device Options – Printer Mode – Output Only (not Bidirectional or EPP+ECP)

With these changes the switch input and LED outputs are working properly.

High-Speed Timer

The Windows XP operating system has a number of different timers, each with differing levels of accuracy. In this experiment we need to know the time of arrival of the MobileEye serial data with millisecond accuracy. The actual accuracy of a few system times is listed below.

1. The C++ **Timer** module has a documented resolution of 1 ms, but it is only updated every 55 ms, using a motherboard real time clock interrupt of 18.2 Hz. This is not suitable for our time needs.
2. The Windows API **GetTickCount**, the time since OS bootup, is also documented to have millisecond resolution, but it is updated at approximately 16 ms intervals (possibly depending on processor speed), and is also not suitable for our needs.
3. The very high speed timer functions **QueryPerformanceCounter()**, and **QueryPerformanceFrequency()** are based on a high speed counter in the main microprocessor triggered by the processor clock (2.6 GHz in newer machines), giving real timing resolution of better than 0.000,004 ms (4 ns).

QueryPerformanceFrequency () gives the 64 bit frequency of the high performance counter in ticks per second, in this case it is approximately 2.6 billion (processor speed is 2.6 GHz).

QueryPerformanceCounter() gives the current counter value in a 64 bit integer value. Subtracting the difference from one reading to the next, divided by the frequency, yields the time between samples.

The time values used in this experiment are rounded down to the nearest millisecond.

Serial Port Input (MobileEye)

Data from the Applied Science Laboratories (ASL) MobileEye vision system is transmitted out of the Eyetrack laptop computer through the RS-232 serial port. The MobileEye laptop (Lenovo R500) takes four pieces of digital data and encrypts it for serial data transmission in order to preserve the integrity of the data.

The data collection computer must decrypt the serial data to reconstruct the original data values from the MobileEye laptop.

Serial Port Null-Modem Cable

Serial connections were originally designed for devices that connect to a computer (modems, tablets, etc), not for connections between two computers. In order for two computers to communicate over a serial connection they must use a special “cross-over” serial cable also called a “Null-Modem” cable.

This is the pin to pin wiring used to make the dual end, 9 pin female serial Null-Modem cable:

Signal	DB-9 Female	DB-9 Female	Signal
Carrier Detect + Data Set Ready	1+6 <-----	4	Data Terminal Ready
Receive Data	2 <-----	3	Transmit Data
Transmit Data	3 ----->	2	Receive Data
Data Terminal Ready	4 ----->	1+6	Carrier Detect + Data Set Ready
Ground	5 -----	5	Ground
Ready To Send	7 ----->	8	Clear To Send
Clear To Send	8 <-----	7	Ready To Send

Serial Port on Laptop Docking Station

The MobileEye laptop computer (Lenovo R500) does not have a 9-pin serial port connector on the laptop itself, it is only available through a docking station.

Serial Port Data Encryption

The MobileEye laptop computer transmits four numbers through the serial port: Eyetrack Status, Pupil diameter, Horizontal gaze value, Vertical gaze value. Eyetrack Status is expressed in a single byte, but the other three are expressed in 16 bit, two-byte values.

For technical details of the serial data encryption/decryption see MobileEye Manual version 1.35 – June 23, 2008, section 6.3 (Downloaded from ASL).

USB Input (TrakSTAR)

Automation File Format

The program accepts a text file to automate data collection, setting the time of data collection and time between trials of data collection.

A sample file is listed below, it consists of four columns of number detailing the number of trials within each block, the number of the block to be associated with the trials, the data collection time (in whole seconds) and inter-trial interval (ITI)

Sample File:

Trials	Block	Collect (s)	ITI (s)
10	2	10	8
10	1	20	4
10	3	30	0
5	9	-1	-1

Once this file has been selected, the data collection program will collect trials of 10, 20, or 30 seconds depending on the testing block with inter-trial intervals (ITI) of 8, 4 or zero seconds between trials.

As indicated above testing blocks do not need to be in numerical order, nor do they need to be contiguous. An inter-trial time value of -1 is an indicator for manual selection to begin the next trial, while a Collect time of -1 seconds is for manual termination of a trial (equivalent to a maximum collection time of 300 seconds or 5 minutes). Inter-trial times of 0 seconds mean the program should start collecting data with no (or minimal) time between trials. A collection time value of 0 will result in the collection of zero or one data point.

After collecting 35 trials detailed in the above script file, the data collection program will stop at the beginning of Trial 36, the sixth trial to be collected in Block 9. Data collection will start after manual trial initiation, and run until manually stopped, or the maximum 300 seconds.

Warning: while it is possible to change Study, Subject, and Block values during automated data collection, be aware that doing so can have unintended effects. Trial file names are created based on Study, Subject, Block, and Trial values detected at the end of data collection, but the number of trials completed by any particular subject in any particular Study and Block are updated dynamically when the Study, Subject, Block increment and decrement buttons are pressed. Changing any of these values during data collection is not recommended.