Eye Tracking Glasses

This manual is to provide information to work with the Sensomotoric Instruments (SMI) *Eye Tracking Glasses* in Aalto Behavioral Laboratory (ABL). Further helpful information can be found from the SMI's *iViewETG Manual* and from the web page www.smivision.com. Contact ABL personnel in any trouble.

1 System setup

This chapter explains the wiring of *Eye Tracking Glasses* (ETG) and basic settings needed to run the experiment.

1.1) Components

Most of the components are located in the briefcases (AC shelf). There is one case for each ETG system and one case for each recording unit (4 cases in total). Plus there are Routers for remote use and corrective lens sets, which you can use with the system. All these equipment can be found from AC Shelf.

Component	Image, details (Glasses 1)	Image, details (Glasses 2)
Briefcase, including laptop, Glasses, power supply and manuals	EYE TRACKING GLASSES1	EYE TRACKING GLASSES2
Eye Tracking Glasses Device v.1	GLASSES1 ID: ETG-1.8-1316-362	GLASSES2 ID: ETG-1.8-1316-365
Lenovo ThinkPad x220 Product ID:4290E2	GLASSES1 – LAPTOP ETX0800002-1319SG	GLASSES2 – LAPTOP ETX0800001-1319SG

Lenovo AC adapter	x 2 GLASSES 1&2 LAPTOP POWER SUPPLY Model ADLx90NDT3A
Briefcase, including recording unit, battery chargers, USB-chargers, batteries and USB-cables	x 2 RECORDING UNIT 1&2
Recording Unit 2.0 Model GT-I9505	x 2 RECORDING UNIT 1&2 ID 1: RUET-2.0-1350-0246 ID 2: RUET-2.0-1407-0313
Battery charger	x 4 Samsung – EP-B600CEWE
USB-Cable	x 6 USB Cable A to mini-B

Battery, Samsung Phone	x 6 Samsung- B600BE	
Battery, external	x 4 Adapter Universe – SMI Model 4163	
Router, remote	ROUTER GLASSES 1 Belkin – N1 Vision Wireless Router Model: F5D8232-4 S/N: 20801823206034 ROUTER GLASSES 1 DVE Switching Power Adapter Model DSA-15P-12 5207 HB	ROUTER GLASSES 2 Linksys- Wireless A+G Broadband Router Model: WRT55AG ver.2 S/N: MDJ105500166 GLASSES 2 ROUTER Power Adapter – LinkSys – Cisco systems Model MU15 GLE0509

Corrective Lens Set	
	CORRECTIVE LENS SET 1 & 2 ETG CLM 2.0

1.2) Wiring of the Eye Link system

Eye Tracking Glasses can be used and connected in different ways.
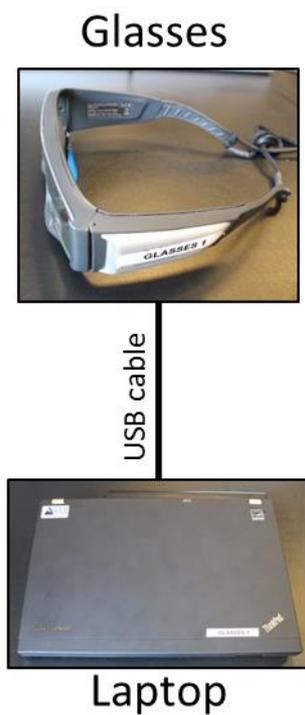
1) Glasses with the Laptop

Image 1. Glasses are connected to the laptop with USB-cable (attached permanently to the Glasses)
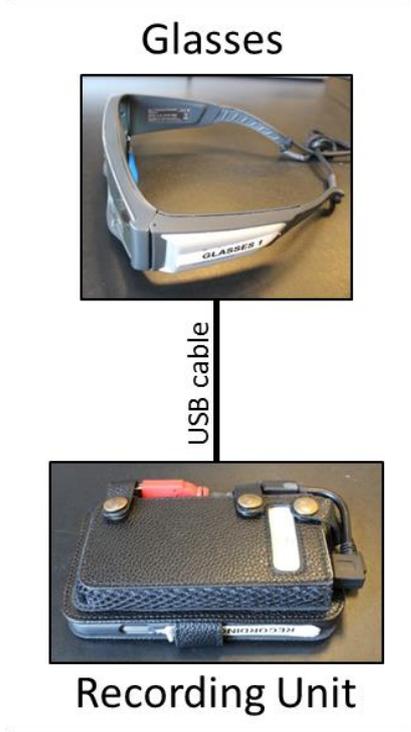
2) Glasses with Recording Unit

Image 2 Glasses are connected to the recording unit with USB-cable (attached permanently to the Glasses)
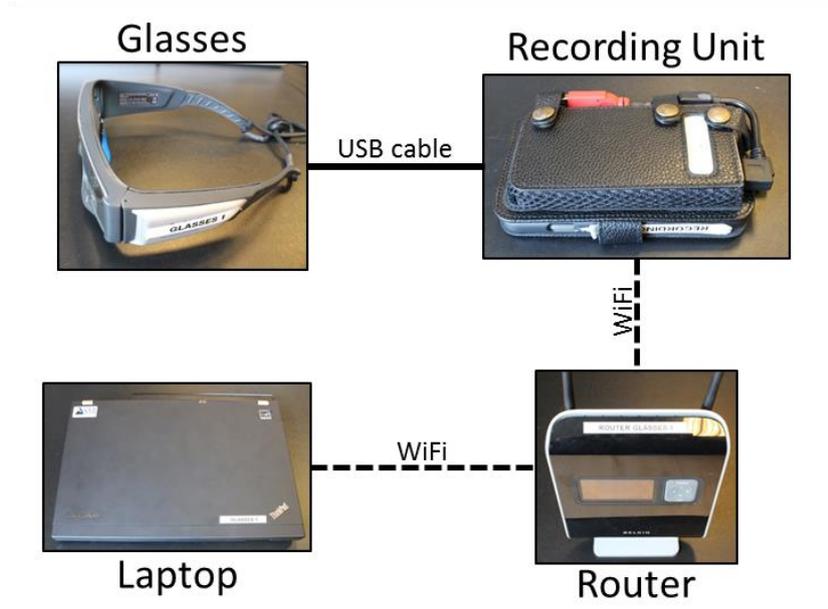
3) Recording unit with remote option

Image 3. Glasses are connected to the recording unit with USB-cable. Mobile phone of the recording unit is connected to the laptop via Router. Both Laptop and Recording Unit are connected to Router via WiFi.
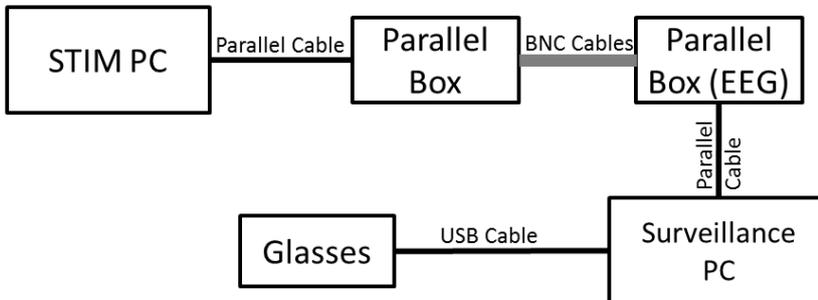
4) External triggers to the Glasses

Image 4. Glasses can be triggered; if they are connected to a PC with Parallel Port (SMI laptop doesn't include a parallel port). In this setup, Glasses are connected to a PC (Surveillance PC) as in Image 1. Triggers are received from STIM PC through Parallel Boxes to Surveillance PC.

1.3) ETG Laptop

Eye Tracking Software *iView ETG* is installed on the SMI laptop. You can also use any other Windows computer if you download the ETG software from www.smivision.com website. Glasses are connected directly to the laptop via USB cable. The data will be stored on the SMI laptop, but it should be transferred somewhere else after measurement.

Noticed: Updating of the Glasses can be done through Begaze software, and that's why it's installed on the laptop. Avoid doing the analysis on the laptop, but do it in Analysis Corner (Magnet House, 4th floor, Coffee room) instead.

2 Recording with ETG Software

The iViewETG recording software is installed on the laptop. The usage of the software doesn't require any license dongles, and you can download it to any Window PC.

2.1) Setting up the system

Start the iView ETG software by clicking "iView ETG" on the desktop.

When Glasses are connected to the laptop, click "Use Local Glasses". In case you want to use remote connection, choose either "Observe a Remote ETG" or "Control a Remote ETG" depending whether you like to control the eye tracker or not.
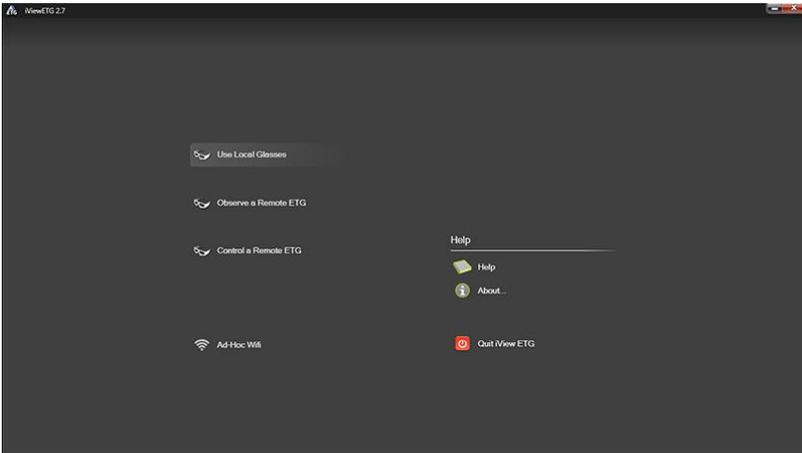
After choosing the way to handle Glasses, it might get a while, before the system is ready. Three icons on the top right corner should all be green, before proceeding to the next step. If the icons won't turn green after a minute or so, try to restart the software or boot the system.
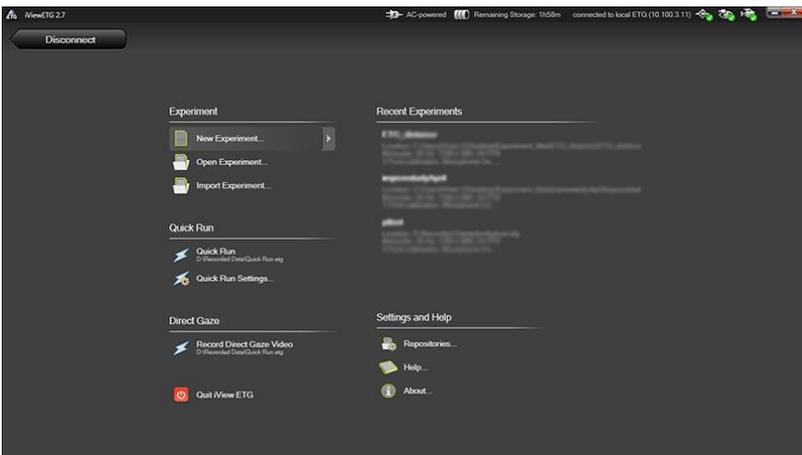
Open existing Experiment from "Recent Experiments" or "Open Experiment". You can also create a new one from "New Experiment".
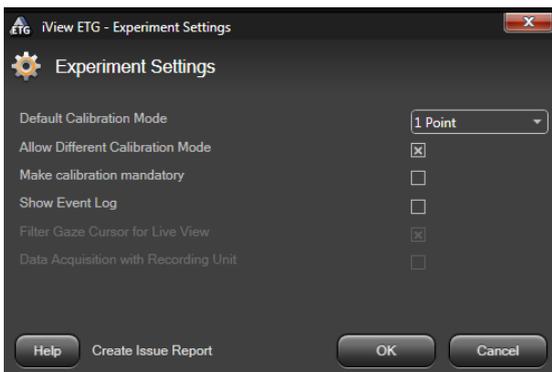
In the Experiment window, you change experiment settings (subject parameters, experimental settings and hardware configure). To alter parameters, you must unlock the screen first by clicking the "blue lock". You must lock it back before you can proceed to measuring.
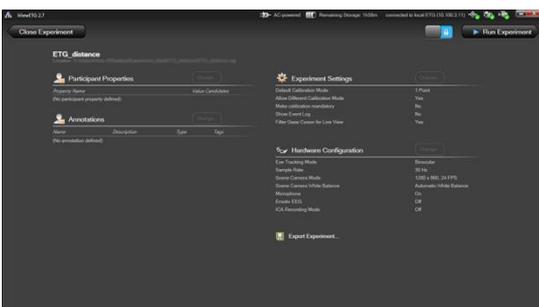
In "Experiment Settings", set the correct number of calibration points. Practice has shown that it's wise to use "Allow Different Calibration Mode", so that you can try different things, if something doesn't goes as planned in the calibration.

If you make calibration "mandatory", then you cannot use the 0-point calibration.

When using TTL pulses or other messages from external device, you should choose "Show Event Log", to make triggers visible during the recording for monitoring purposes.

2.2) Before measuring

2.2.1 Preparing the Glasses

Put the Glasses on. Make sure they are stable and won't slide on top of the hair. Tighten the strap from the back.

Start recording, by pressing "Run Experiment" in the Experiment window. Recording window will appear. The small window on the left will show an eye icon (trackability), which indicate whether the glasses are placed correctly. If not, there will be an arrow pointing up or downwards. The arrow shows in which direction the nose peace should be moved.

There are two different nose pieces: blue and red.

- **Red piece:** intended for smaller head sizes, positions the camera higher and further way from the eyes. The eyes become lower and smaller in the eye image.
- **Blue piece:** intended for bigger head sizes. Puts camera lower and closer to the eyes. The eyes become bigger and are locates higher in the eye image.
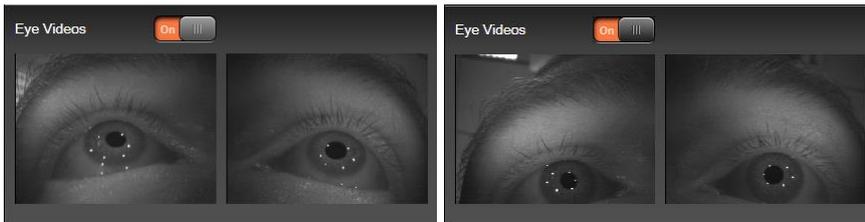

Image 5: You can monitor from "the Eye Videos" (click to enable) how the eyes are located. The eyes should locate in the center of the image and be large enough. Notice that the Eye Videos are not visible during the recording.

Eye tracker creates 6 cornea reflections to the eyes, the system needs 4 of them to be visible to be able to work properly.

If the head is large, you can try to set the glasses without the nose piece. This brings the glasses very close to the eyes though, plus the glasses can be uncomfortable on the nose.

2.2.2 Defining the Participant

Before recording, you need to define "New Participant" first. After, the system starts to learn the model of the eye ball. It's instructed that the subject should look around at least 30 seconds before recording.

2.3) Calibration

Put a sticker marker or a tape on the wall as a calibration point (you can use also monitors, etc..). Calibration should be done from around 1,5m distance at the eye level.

In a calibration, ask subject to be still and look at the marker. Click the marker on the video screen.

Start the calibration by clicking "calibration":

- 0-point: Calibration is not needed: the system will form a model based on the cornea reflections only. Normally this is not good enough for experiment, but is indicative. If you want to use this, make sure that "mandatory calibration" is not checked in the experiment window.

- 1-point: Does calibration on one point. Make sure when looking at the point that marker is in the middle on the video screen.

- 3-point: This calibration requires three separate markers. Go through the points one by one, by clicking each marker (as described above). See more about details how to arrange calibration points from the iViewETG Manual. Notice that head should be still during all markers.

The color of the cursor (ball) indicates the quality of the calibration. Optimally the color should be always green. The color will change as time passes, as the system gets more information about the eyes.

Notice: the tracking works best, when the eyes are looking close to middle areas (of the screen).

2.3.1 Brightness

The background's brightness of the calibration shouldn't differ much from the brightness used in the actual experiment. If there are dramatic changes in pupil size, it may effect on the tracking abilities. This is due to the pupil reactions to the brightness. Black background in the calibration enlarges the pupil and if the experiment itself is very bright: the pupil will shrink to small. The different sizes of the pupil may cause inaccuracy to the tracking.

Notice: Because the Glasses are constantly learning and building a model of an eye, it's sensitive to environmental changes. It has been seen that the Glasses might get confused of very dim conditions, even if the changes are occasionally. So avoid very dramatic changes in the brightness (for example don't flicker the lights)

3 Recording unit

3.1) Creating new settings

Recording unit can be connected and used directly with the Glasses. New experiments cannot be created in recording unit though, but they need to be defined first in the laptop and then transferred to the Glasses. After that, recording unit can read the experiment settings automatically from the Glasses.

- Connect the Glasses to ETG Laptop (with USB-cable)
- Open ETG and "Experiment" window
- Click "Export Experiment.." -> Upload to ETG (Transfers settings to the Glasses)
- Disconnect Glasses

3.2) When using the recording unit

- Connect Eye Tracking Glasses to the recording unit (mobile phone) and to external battery

- Turn on the external battery by pressing the power button

- Turn on the Recording Unit (Samsung mobile phone)

The experiment settings uploaded in the Glasses are chosen as a default experiment automatically when starting the software. If you want use some other settings, click "manage experiments".

- Press "run" to proceed to measuring
- Press "participant icon" (human portrait) and define the participant settings. Then press "create".
- Press calibration (and choose which calibration, if available).

- Follow the instructions on the right
  o Look at landmark
  o Tap the screen to freeze
  o Move cursor to landmark

- Start recording

Now you can close the lid of the phone cover, place the mobile phone into a waist bag, and strap it around the waist. Make sure the USB cable won't get loosen.

After measurement, stop recording, and close the mobile phone.

3.3) Remote observation

You can remotely observe and control eye tracking glasses on live if they are connected to recording unit, or to another computer via router.

Router is used for connecting the Glasses to the laptop. Plug in the power supply, and wait a minute or two before it's working properly.

Press menu button on the mobile phone (left bottom corner) and check WiFi settings, which will show all possible WiFi connections. Choose glasses-1 or glasses-2, depending whether you are using system 1 or 2.

3.3.1 Laptop

Connect the laptop to the router. Choose Glasses 1 or 2; make sure that laptop and Glasses are connected to same router.

Start iView X software. To start the remote observation, press "Observe a Remote ETG". If you want also to control the glasses, then choose "Control Remote ETG.
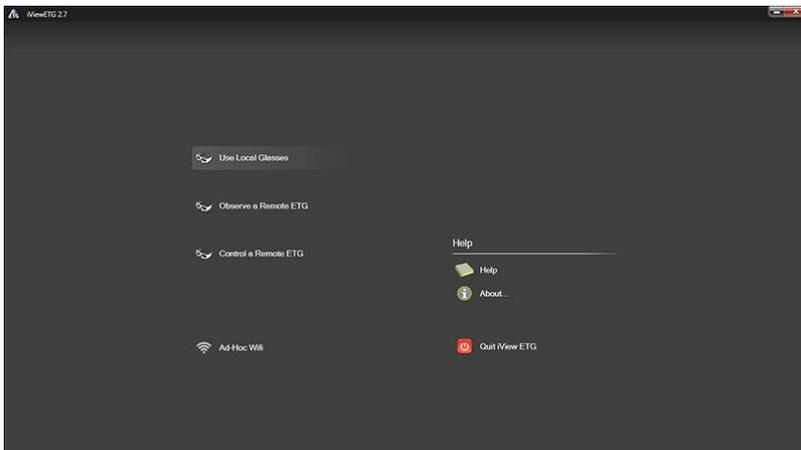
Click *Advanced* to see the connection details. Connect to the IP-address of the mobile phone. (you can see it from the WiFi connection window). Now the connection should be made and you can work normally from the mobile phone or laptop, depending which mode you have chosen ("observe" or "control").

### 4 Downloading data from the Recording unit

Connect Mobile to the laptop (or any other computer with the Begaze) and open Begaze (dongle has to be connected). Press "Collect Smart Recorder Data" to download the data.

5 Triggering parallel port triggering

iViewX software can receive TTL triggers if the computer has a parallel port trigger. Triggers will show in the data by the default. To be able to view the triggers in real time, you need to define it in the experiment settings.

To view the triggers only, enable "Event Log" in recording window (at the bottom of screen).
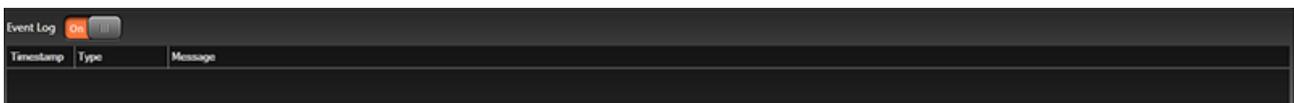
6 Subject preparation

Notice the following things when preparing a subject:

6.1) Binocular recording

Eye Tracking Glasses use both eyes, so it works binocularly. This means that you cannot have any dysfunction in your other eye, i.e. squint.

6.2) Mascara

Eye lashes will get very dark when having mascara, which can effect negatively on the pupil detection.

6.3) Contact Lenses

There are basically two types of contact lenses: hard and soft.

6.3.1 Soft lenses:

Soft contact lenses works normally quite well. The edge of lens can be seen from the eye image as a pale ring, but it usually doesn't effect on the eye tracking. On the other hand, lenses can create an extra reflection point, which is very close to 1st Purkinje image, but is normally visible only on certain angles.

If the lenses don't fit the eye perfectly, they can slide a little bit on top of the eye. This makes the tracking less precise, especially in the extreme angles.

6.3.2 Hard lenses:

Hard lenses don't usually work with the eye trackers. They tend to be less stable than soft lenses and can slide partly off the center of the eye. This will produce an eye image where the pupil is cut off partly.

6.4) Shaded eye glasses

Use dark shaded eye glasses if you are measuring outside.

6.5) Eye Glasses

You cannot use normal eye glasses when wearing the Glasses, but need to use lens correction set instead.

6.5.1 Lens correction set

There are two different lens correction sets in ABL; sets go +/- 4.0 diopter. The box includes shaded eye glasses with small magnets around the frame, so that lenses can be snapped easily on their place.

7 Data analysis

Glasses collect coordinate data on top of the video frame (on each time frame) and pupil diameter. Each session produces an idf-data file plus a scene video file (avi).

Data analysis is most easy to do in the SMI's Begaze software. Begaze requires license dongle and can be used in ANI Analysis Corner (Magnet House, 4th Floor, Coffee room).

If you like to analyze the data by your own, you can use IDFconverter to read idf-files (doesn't require a dongle) and export data into an ASCII format.

7.1) Transfering Begaze data between computers

You can zip the wanted data by clicking "Backup Experiment to File" in Begaze. This will create a file that can be moved easily. To unzip a file, choose "Restore Experiment from File". Notice that the versions of different Begaze software need to be same (you cannot open newer file with an older software).