User Guide – PT-Mini Mobile Eye Tracker

v. 1.11

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Table of Contents

Introduction

Congratulations on the purchase of your new Locarna PT-Mini eye tracker! The PT-Mini is designed to record mobile or stationary eye tracking videos with an unparalleled degree of accuracy and in a wide range of physical environments.

In addition, Locarna's proprietary Pictus and Annotator software make quick and easy work of video processing and analysis.

A Combination of leading-edge eye tracking technology and exclusive analysis software make the Locarna PT-Mini the most precise, versatile and easy to use real world eye tracking system available today.

1 Components

Figure 1 shows the components of your PT-Mini eye tracking system. These components are listed in Table 1.

Table 1: Components in your PT-Mini system

Item	*Description*
Eye tracking glasses **#PT-M-c1E01**	Update rate of 30 frames / second; 720 x 480 resolution color camera.
Video recording device (recorder) **#PT-M-c1R01**	Display, keyboard, and memory for recording up to 20 hours of high-quality tracking video data.
Pictus & Annotator CD **#PT-M-c1A01**	Pictus eye tracking software for generating video and raw data files containing eye gaze and visual fixation information. Annotator software for associating text tags to sequences of video.
Calibration grid **#PT-3-c1C02** (large)	Standard (120 cm x 90 cm; 4' x 3') calibration grid is included.

Your PT-Mini glasses and recorder capture video footage which you can then transfer to a PC equipped with the included copy of Pictus and Annotator software for processing. Pictus calculates eye gaze and visual fixation data. Pictus also creates scene camera videos with superimposed graphics, such as a cross hair and circles, to visually indicate eye gaze and visual fixations, respectively, on your collected videos. Annotator enables you to analyze your tracking data in an effective manner. It allows you to quickly associate meaningful text tags (descriptions) to intelligently-segmented sections within the video sequences.

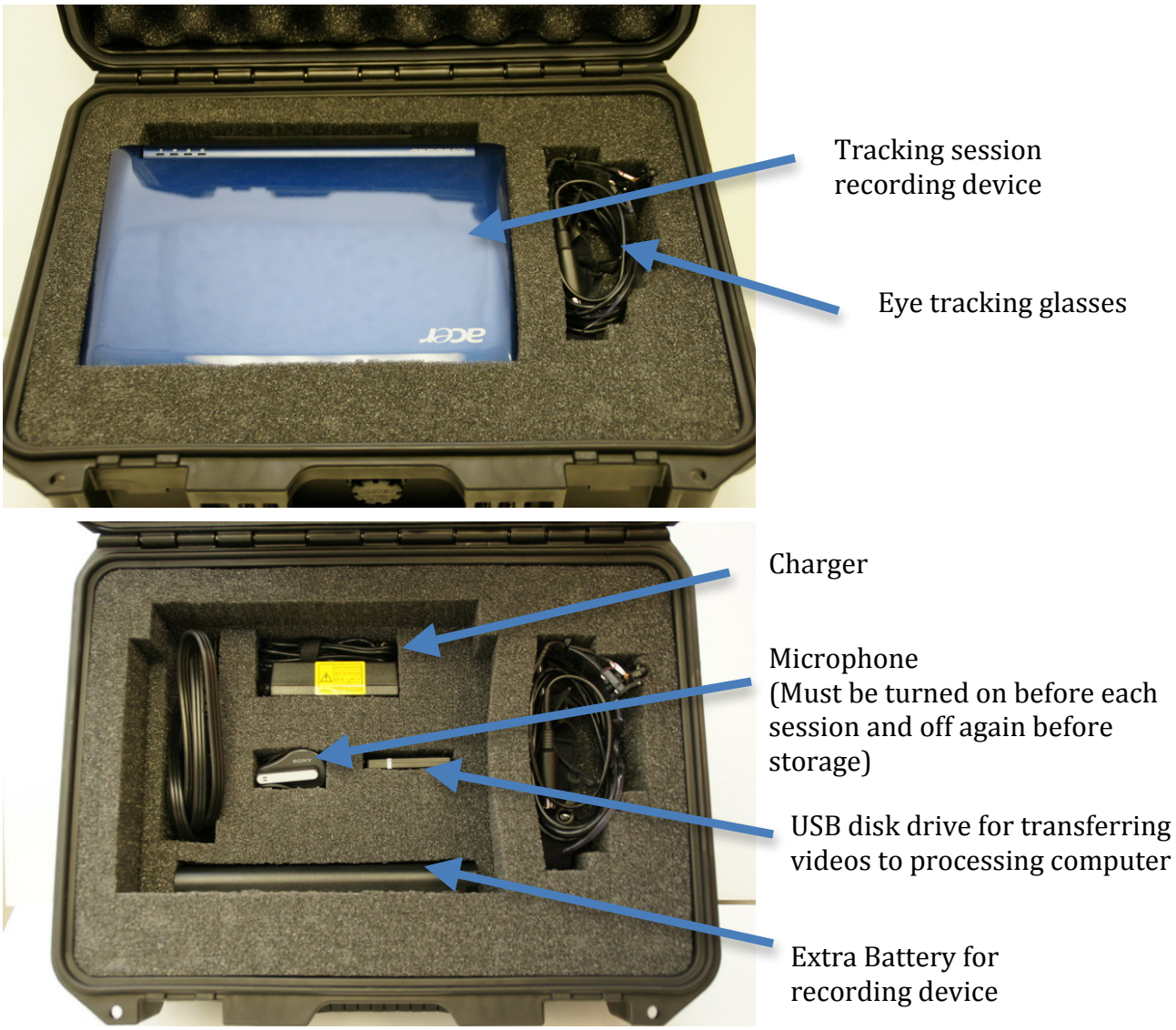

Figure 1: Components in your PT-Mini system.

2 Eye Tracking Fundamentals

This section summarizes how your Locarna eye tracker works. The details in this summary will help you obtain the highest quality eye tracking data possible.

2.1 Building a Relationship between the Scene and Eye Cameras

The PT-Mini eye tracking glasses have two cameras: an eye camera and a scene camera. The eye camera records a video of the eye and the scene camera records a video of the outside world with relation to the user's head.

When you first put on a pair of eye tracking glasses, there is no relationship (or map) between the scene camera and the eye camera. Calibration is needed to build a map between a person's eye and his/her view of the outside world. A new map (calibration file) is needed each time the eye tracker is used. Different

people will have unique facial features which each require a different map. Further, each time a person puts on a pair of PT-Mini glasses, the glasses may rest in a slightly different position on the person's face so the camera orientations may have to be adjusted. Any of these situations may change the mapping between the eye camera and scene camera and thus require a calibration.

Figure 2 illustrates mappings from regions of the scene camera to regions of the eye camera during calibration. This example assumes you are looking at the 3x3 grid of points in the included calibration poster. When looking at dot 1, the center of the eye pupil will be towards the upper left. When looking at dot 2, the center of the eye pupil will be towards the upper middle. Eye pupil centers for dots 3 – 9 will similarly map from a particular point in the scene camera video to a point in the eye camera video. The collection of 9 scene camera dots and their corresponding 9 eye camera dots collectively define a mapping from the eye camera video to the scene camera video. Once this mapping has been recorded, you are *calibrated*. The Pictus software uses this calibration mapping to produce eye gaze data for the scene camera video. In other words, calibration mapping enables your PT-Mini to determine where you are looking.

2.2 Arrangement of Calibration Points

When creating a calibration map, the black dots on the calibration poster should span as much of the scene camera's field of view as possible while still remaining within the field of view. Increasing the field of view spanned by the collection of calibration points will maximize the ability of your PT-Mini to accurately track where ever you are looking. Figure 2 shows examples of good and poor arrangements of points during calibration. In Figure 2b, the points evenly span the majority of the scene camera's field of view. This is the ideal situation for calibration.

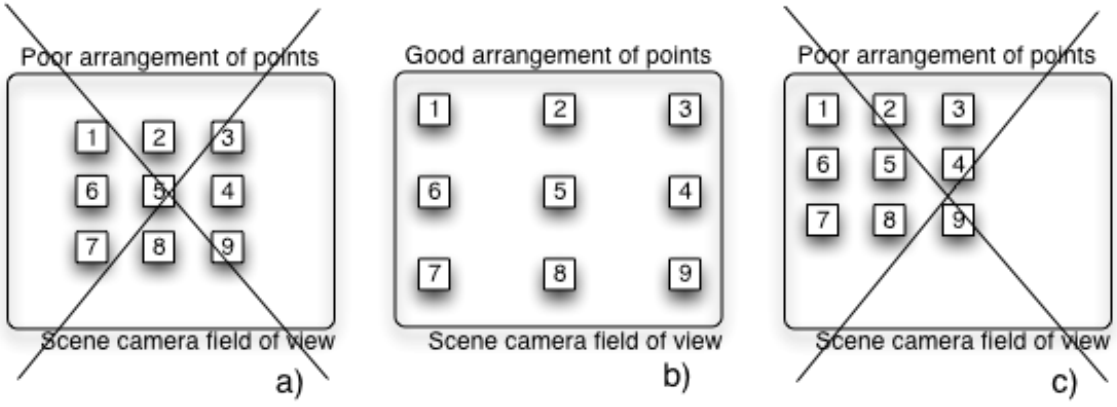

Figure 2: Example good and poor arrangements of calibration points.

3 Hardware Setup

Follow these steps to use the PT-Mini hardware to collect tracking data. You can collect a series of tracking sessions with a total duration of up to 20 hours before

transferring the data to the external drive for further processing with the included Pictus software (which must be installed on a separate PC).

Perform the following steps to start using your PT-Mini:

3.1 Step 1: Product Assembly

1. *Connect:* Connect the eye tracking glasses into the side of the video recording device (note that the plug has a specific orientation). If you wish to record sound, connect the included lapel microphone to the microphone jack located beside the connector for the glasses. The microphone should be turned on before using. Be sure to turn the microphone off after every use to conserve the battery (2025 lithium battery).

Figure 3: Plugging the glasses' cable and the lapel microphone to the side of the video recording device.

2. *Battery:* Ensure the battery is fully charged before using the eye tracker. Use the AC power adapter (included) to charge the recorder battery. If the eye tracking session is to take place in a stationary position and there is outlet power available, keep the recording device plugged in throughout the study to maximize the battery lifespan.
3. *Power:* Press the power button on the recorder. Double click the "Locarna PT-Mini" icon on the desktop. The eye tracking calibration software will load (see Figure 5).

   Naming Structure: The eye tracker will name each tracking session using the current date and time as shown in the upper middle part of Figure 5. The previously recorded sessions are shown in a list format.

Options:

- *Video* > *Disk*: Transfers all selected tracking sessions to the external USB drive. You can select sessions by clicking on the list. Selected sessions are shown with a check mark on their left side.
- *Eject Disk*: Safely removes the USB drive from the tracker. Press this after completing the transfer of tracking sessions to the external drive or when you want to remove the external drive for other reasons.
- *Erase Video*: Erases all currently selected tracking sessions. You can select sessions by clicking on the list. Selected sessions are shown with a check mark on their left side.
- *Start Calibration*: This will start the calibration process for the current tracking session (as displayed on the upper middle part of Figure 5).
- *Exit*: Stops the program.

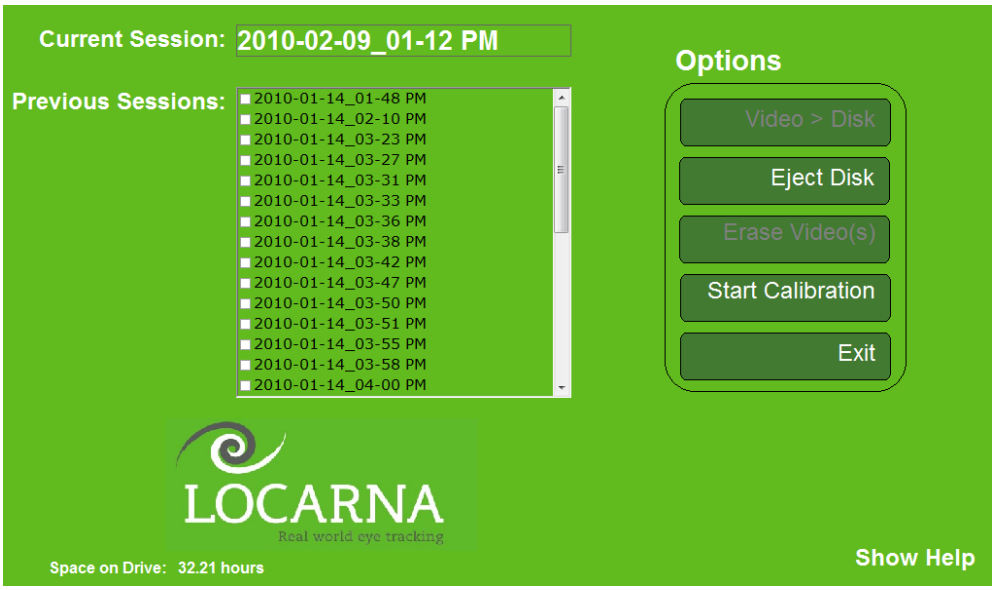

Figure 5: Main screen of the eye tracking capture software.

3.2 Step 2: Calibration

1. *Wear Glasses:* Wear the eye tracking glasses and tighten the head strap such that the glasses fit snugly against the face.
2. *Start Calibration:* Select "Start Calibration" from the main screen (Figure 5). The display will show two images: (i) scene video and (ii) eye video. While the user looks straight ahead, adjust the eye camera such that their eye pupil appears in the center of the left image (see Figure 6). If the scene camera image is blurry, twist the scene camera lens until the image appears in focus.

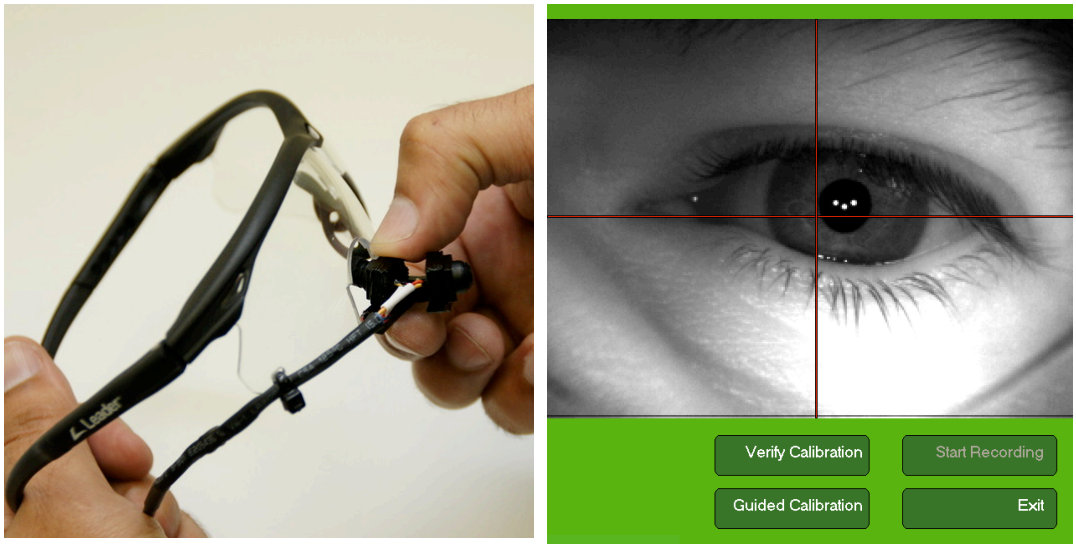

Figure 6: Adjusting the eye camera (left) until the eye pupil is centered (right) when the participant looks straight ahead.

You may also wish to adjust the scene camera position to have a field of view that is most appropriate for your eye tracking session. Figure 7 shows a person using a small screwdriver to adjust the scene camera's field of view.

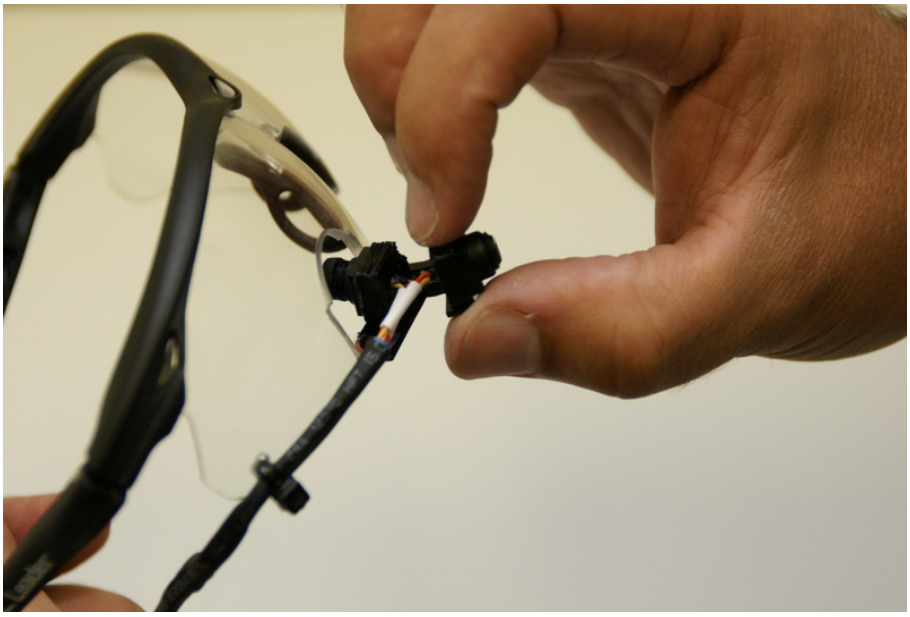

Figure 7: Adjusting the field of view for the scene camera.

3. *Setup:* Setup the included 3x3 calibration grid. Have the user view the grid such that the 9 black dots align near the centers of the red 3x3 grid lines (Figure 8).

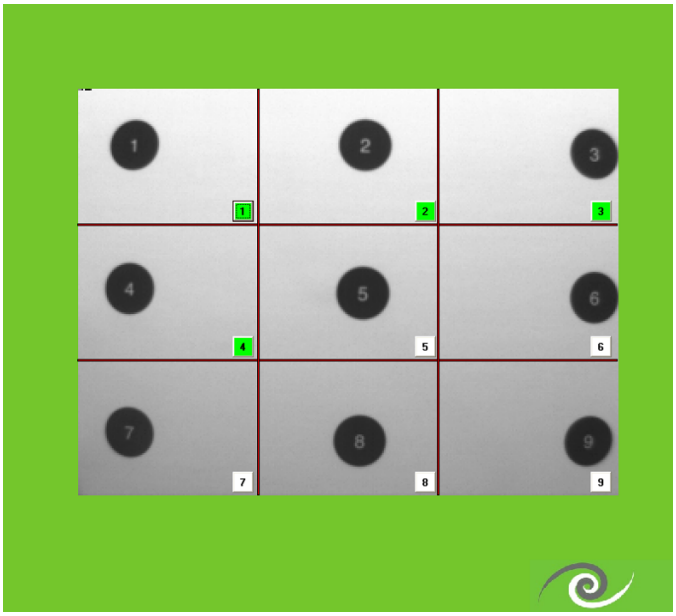

Figure 8: A 3x3 calibration grid of black dots being viewed by the scene camera. Each black dot is contained within the red lines.

4. *Calibrate:* Have the user visually fixate on (look at) the centre of dot 1, then press the '1' button on the keyboard to record the first calibration point. For dot 1, the pupil in the user's eye video should appear to focus towards the upper right. Before pressing the '1' button, make sure the user's pupil is stable (not moving), that the user is not blinking and that dot 1 is centered within the upper left cell of the scene video. Successively, repeat this process for marks 1 through 9. You have now calibrated the user.

   Small white icons in the bottom right of each cell provide feedback during the calibration (refer to Figure 8). These icons are numbered 1-9, and are all white when you first load the calibration screen. After calibrating each dot, the icon will turn green to indicate that you've saved a calibration dot for that particular camera region. You can re-calibrate a particular dot (i.e., region of the screen) by pressing the number key (e.g., "4" to repeat dot 4). The icon will change from green back to white. Have the user visually fixate on the dot of interest, and press the number key again (e.g., press "4" to save the calibration dot; the "4" icon will turn green).

5. *Verify:* Verify the calibration data by pressing the 'verify calibration' button. A screen similar to Figure 9 will appear. Upon loading, the scene camera image (left side of Figure 9) should display a red dot successively over each of the 9 black calibration dots. There will also be a small green dot right at the center of the calibration dot. At the same time, the eye camera (right side of Figure 9) should display a white region over the user's pupil. Additional coloured pixels may also indicate other regions that the tracker software has considered as pupil candidates. For example, a thin shadow under the upper eyelid is shaded in blue (right side of

Figure 9), but the region was correctly rejected as a non-pupil region. The green dots represent the centers of the captured regions of interest (e.g., the black calibration dot or eye pupil).

After all 9 dots are processed (typically 10-20 seconds), the eye camera will display the current views of the scene and eye cameras. The scene camera will show a reduced frame rate real-time eye tracking display. A green crosshair indicates the centre of the user's eye gaze. Check that the eye tracking quality is acceptable by viewing this display. For example, you may wish to have the user look at each of the 9 black dots in the 3x3 calibration grid again. While looking at each black dot, if the green crosshair appears near the dot, one can safely assume the user has been successfully calibrated. This display is for calibration testing only, and is **not** recorded. If you are satisfied with this calibration, select "Verify" (lower left of Figure 9). Otherwise, select "Re-do Calibration" (lower right of Figure 9) to erase the current calibration, and perform calibration again.

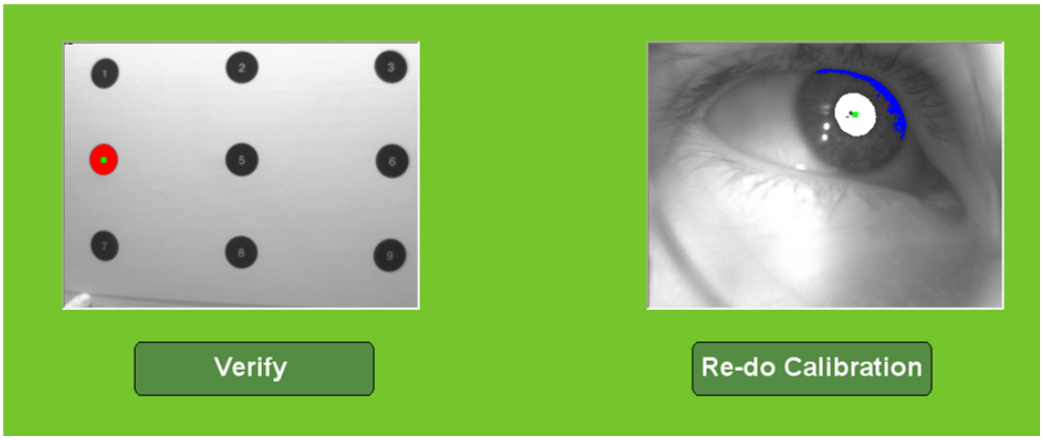

Figure 9: Calibration verification screen.

3.3 Step 3: Track Your View of the World

1. *Start:* Press the "Start Recording" button to start recording up to 1 hour of video data. A dialog will pop up to indicate that eye tracking data is being recorded. Press the "Stop Recording" button to stop recording.
2. *Eye Track:* The PT-Mini will record up to 1 hour of video as the users view their world. The recorder will also record with the lid closed. The glasses will automatically adjust to most lighting conditions and environments.
3. *Finish:* Open the lid to the recorder if it was previously closed. If less than 1 hour of video was recorded, stop recording by pressing the "Stop Recording" button. The recorder may get hot after an extended recording time. If the recorder is hot to touch after recording an eye tracking session, let the recorder cool down before resuming eye tracking.
4. *Backup Data:* Connect the external memory device to the USB slot in the recorder (see Figure 10). Wait a few seconds for the external memory

device to be recognized. Transfer your newly collected data by selecting "Video -> Disk" from the main Locarna screen (see Figure 5). You can select which tracking sessions to transfer by clicking on them (a small check mark appears besides the session name). After the files have transferred, press the "eject disk" button to safely remove the external USB drive. Follow this by disconnecting the external memory device from the recorder, and connect it to a USB port on your analysis computer (that which has Pictus and Annotator installed). The computer will automatically recognize the device. Copy the files from the external memory device to a folder of your choice on your analysis computer for processing and analysis with Pictus eye gaze and visual fixation software (see Section 4 below).

Figure 10: Connecting the external memory device to the recorder.

4 Using Pictus Eye Gaze & Visual Fixation Software

Pictus takes the video recorded with your PT-Mini eye tracking glasses, and produces eye gaze and visual fixation video and data files.

Perform the following steps to generate eye gaze and visual fixation data:

4.1 Step 1: Startup

1. *Load:* Start Pictus software from your analysis computer (e.g., start > All Programs > Locarna > Pictus Eye Gaze Calculation).
2. *Select source tracking session folder:* Select your desired raw eye tracking files by pressing the "Browse for Video" button. Each tracking session is stored by the Pt-Mini eye tracker in a series of files within a directory. After Selecting the tracking session to process, press the "Next" button (Figure 11).

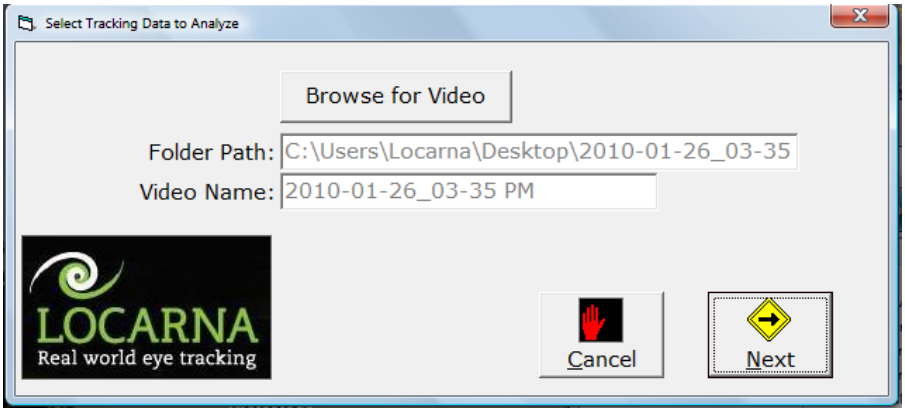

Figure 11: Loading tracking session from tracking session folder.

3. *Select options for processing tracking session:* The screen presented in figure 12 contains all the options for processing your tracking data. These options are separated into 2 sections: Tracking and Visual Fixations.

   Tracking

   The top part of the screen allows you to select options for the processing of the eye tracking data (Tracking). The first two options found here ("Show 1 degree marks" and "Show 2 degree marks") allow you to choose whether to have the output video include circular markers around the center of the gaze location. These circular markers represent 1 or 2 degrees of field of view around the gaze location respectively. The third option for Tracking is the "Pupil Size". This slider provides the software with an estimate as to the user's pupil size in order to optimize pupil detection. This slider does not normally have to be adjusted from its default position except in cases where the user's pupil is heavily dilated because of a session recorded in near darkness or because the user was under the influence of drugs. In either of these cases, it is recommended that the estimated pupil size be increased by moving the slider to the right as required.

   Visual Fixations

   The middle part of the screen shows the options for creating visual fixations. If desired, Pictus can calculate and obtain visual fixations and create an additional output video with the visual fixations represented as white circles (see figure 14). The default name for this filename is to append "-fix" to the previous eye gaze output file (e.g., "myvideoout-fix.avi"). Pictus chooses default fixation times of 10 frames (300 ms), and a fixation circle diameter of 25 pixels. These values can be changed according to the particular needs for the study being run. To calculate fixation times, divide the desired fixation duration by the video camera frame rate (i.e. 30 frames/s). If eye gaze stays within a circle of this

specified diameter for at least the fixation time, a visual fixation will be logged. Also, a white circle will be displayed on the output video at the location where the fixation occurred (e.g., see Figure 14). Pictus also allows a separate method to obtain visual fixations based on eye gaze movement speed. This method to obtain fixations is known as the velocity threshold method. In this method, a fixation is logged when the visual gaze does not move faster than the specified number of pixels per frame (25 pixels by default). This option is desirable if the user is walking while looking at objects or if the user is looking at moving objects (i.e. a passing car).

Once the options have been selected, click the "Next" button at the lower right of the screen to proceed.

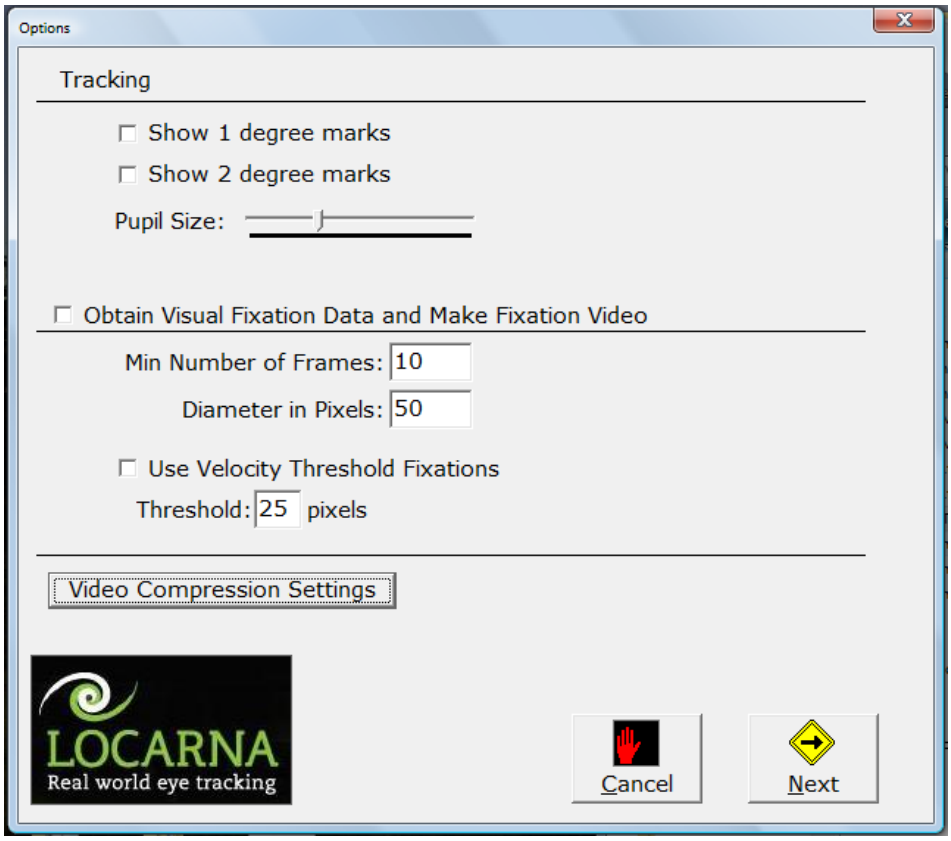

Figure 12: Processing Options.

4.2 Step 2: Calculate Eye Gaze Data

Calculate eye gaze: Press the "Continue to process video" button located in the lower middle part of the screen (see Figure 13). The eye tracker will start calculating eye gaze video and log data. A green crosshair will be superimposed on the scene camera frames. The intersection of this crosshair shows where the user is looking (see the top left of Figure 13). White dots are superimposed over the pupil (see the top right of Figure 13). A green dot is shown in the centre of the pupil. You can adjust the pupil size as the video is processed if necessary.

When done, Pictus will return to the first screen to allow you to select the next tracking session for processing.

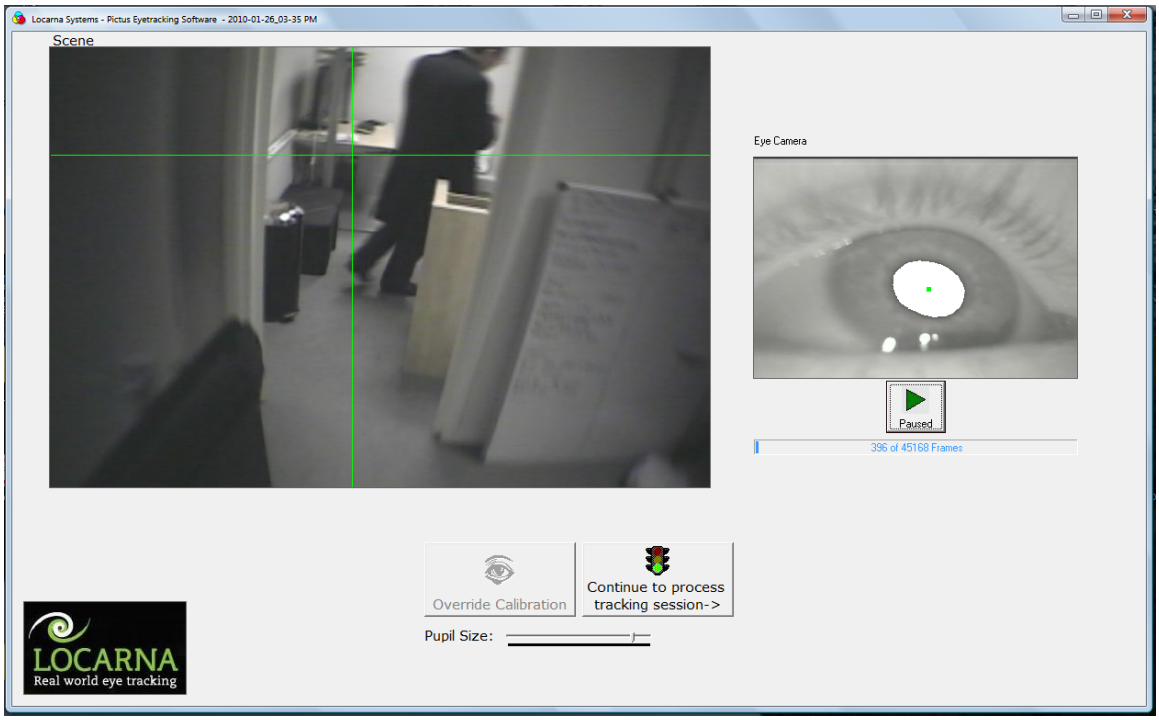

Figure 13: Processing eye gaze data. The green crosshair on the scene camera video shows where the user was looking. The green dot on the eye camera video shows the estimate eye pupil centre.

Figure 14: Example visual fixation. The white circle indicates that the user visually fixated on this scene video region (the truck).

5 Using Annotator Software

Annotator allows you to associate meaningful text tags to visual fixations in tracking sessions as identified by Pictus. This allows you to obtain usable data in a more efficient manner and reduces your video coding time compared to standard frame-by-frame annotation. In addition to this, Annotator uses image processing techniques to try to identify fixations identical to previously tagged fixations and automatically create tags for them. The output files created by Annotator are stored in comma-separated-value format (.csv) and can be post-processed using a spreadsheet application.

5.1 Annotating Visual Fixations

1. *Select source tracking data output video*: Click the "*Load*" button and select a Pictus output video filename (e.g., 2010-02-02-09-31PMout.avi) stored in your "Locarna Tracker Output" folder on your desktop. The source file must have been created with the "Obtain Visual Fixation Data and Make Fixation Video" option checked in Pictus before using Annotator (refer to Figure 12). After you select the file, Annotator loads each fixation found into a thumbnail as shown in Figure 15.

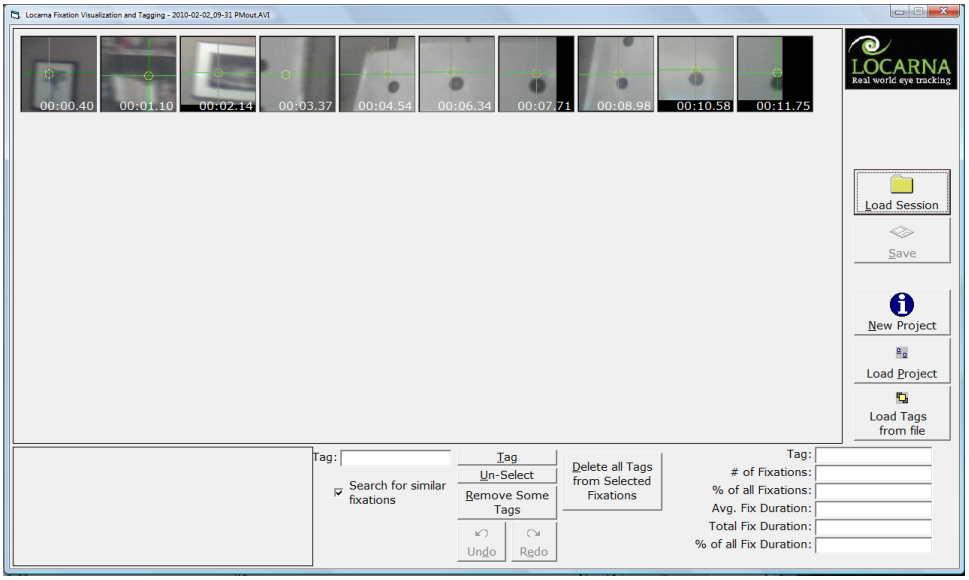

Figure 15: Annotator software loading fixations for tagging.

2. *Selecting Fixations:* You can select one or more fixations by clicking on their thumbnail (click again to un-select). Multiple tags can also be selected with standard Microsoft Windows <shift>+click and <ctrl>+click operations. Selected fixations will have a green border to indicate they are currently selected. If you would like to see the video segment to which a fixation refers, double-click on the fixation and the video segment will be shown in a loop. To exit the video display, simply click on the video.

3. *Tag fixations:* You can add a tag to the selected fixations (those with green border) to associate a tag to them. The tag is typed in the box labeled "Tag". To apply the entered tag to the selected fixations, click on the "Tag" button. For example, as shown in Figure 16, two fixations were selected and a "Picture Frame" tag was assigned to them.

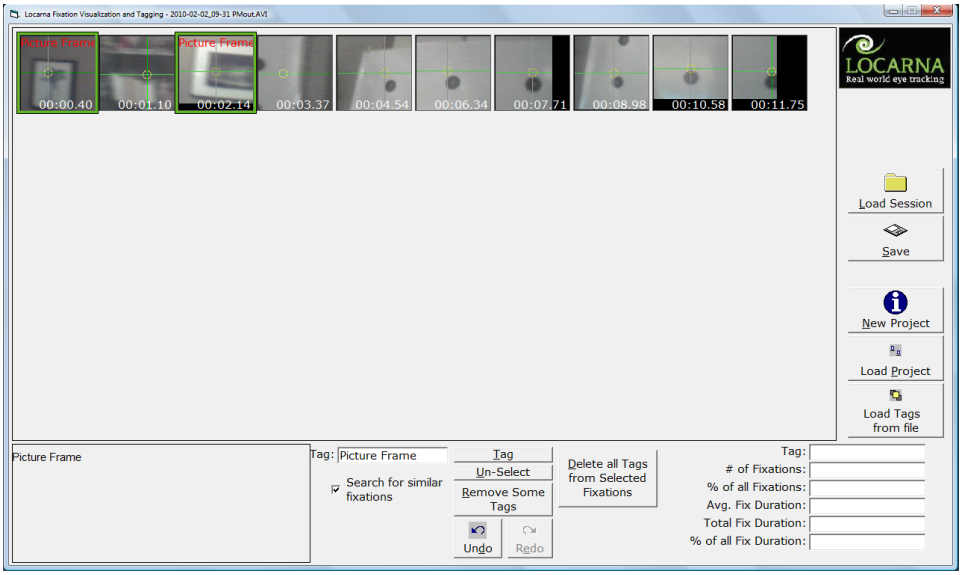

Figure 16: Tagging two fixations with "Picture Frame"

4. *Using the Tag Cloud:* As you tag fixations in a session, Annotator will be creating a tag cloud with the tags used. This tag cloud will allow you to get an idea as to the frequency with which each tag is used (the larger the font for a specific tag, the more frequently it is being used). You can also tag new fixations with a previously used tag by clicking on the tag within the tag cloud. When you click on a tag in the tag cloud, you immediately select all fixations that have been tagged with this tag and the text box is filled with this tag allowing you to tag other fixations with this tag. In addition to this, you get a brief statistical summary of the selected tag in the bottom right corner of the screen.
5. *Removing a Tag:* To remove a tag from a selected fixation, first select one fixation, the select the "Remove Tags" button. If more than one tag is associated with the selected fixation, you will be prompted to select which tag(s) you wish to remove.
6. *Removing Multiple Tags:* To remove all tags from multiple selected visual fixations, select the "Delete all Tags from Selected Fixations" button.
7. *Dealing with Mistakes:* The "Undo" and "Redo" buttons enable you to undo and redo your last action. For example, if you delete tag by mistake, press the "Undo" button to restore the previous state (i.e., undo the deletion).

8. *Loading Tags:* If you have already annotated a similar video, you can load the tag cloud from that video instead of re-typing each tag. For example, if you created tags "apple", "orange", and "banana" for participant 1 of a 20 person empirical study, you can load tags from participant 1 before annotating the videos for participants 2 – 20. To load tags, press the "Load Tags from file" button at the right of the main Annotator window (see Figure 16), and then, when prompted, select an eye tracking video collection that already contains a tag cloud. The tags from this previous annotation session will now be loaded into your tag cloud at the bottom left of your Annotator window.

5.2 Summary Statistics

Summary statistics for a particular visual fixation can be displayed in the bottom right corner of the main Annotator window (see Figure 15). To see summary statistics, click a tag in the tag cloud. The tag name will appear in the "Tag: " field, and statistics will appear below. For example, suppose we have tagged 5 of the 7 visual fixations for the tag "calibration dot", the summary statistics will update to show "5" for "# of Fixations", "70%" for "% of all Fixations", as well fixation duration information.

5.3 Using Annotator Data

Annotator generates a series of comma-separated-value files with information about the tags, fixations and a simple statistical summary for later use. The files created are all stored in the "Locarna Tracker Output" folder on your desktop. Each of the created files has a prefix based on the name assigned to the tracking session (i.e. 2010-02-02-09-31PM) The following is an overview of the created files and the appended postfix:

- <Name> + Annotation.csv: This file contains details for each tagged item and its associated fixation.
- <Name> + Statistics.csv: This file contains simple statistics calculated on the tags used for the tracking session.
- <Name>+ Tags.csv: This file contains a list of all tags used for a tracking session.

These .csv files can be loaded into your favorite reporting application, such as Microsoft Excel, SPSS, or SAS, using each of these tool's import features for standard ASCII text files. The .csv files are column data, separated commas.

Example tasks that can be completed with such data include:

- Aggregating data from many participants of a multi-person empirical eye tracking study.
- Generating statistics, graphs, and reports for frequencies of visual fixations, tags, and eye gaze information.
- Analyzing temporal sequences and patterns by comparing the visual fixation and eye gaze data values with their associated timestamps.

WARNING

All hardware components should be powered off before connecting or disconnecting any cables.

This eye tracking technology has not been approved for medical diagnosis.

This eye tracking technology is designed to emit <10 mW / cm^2 of infrared light according to American National Standards Institute (ANSI) Z136-1-1993 and European Standard EN 60825-1 1994-1996 safety guidelines. Users should check that total infrared light is within safe limits for people wearing and near the eye tracker technology.

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