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Technical Report 2019-01: Pupil Labs Eye Tracking User Guide

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Technical Report 2019-01

Pupil Labs Eye Tracking User Guide

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September 07, 2019

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Introduction

The purpose of this document is to allow users to quickly set up and capture data from the pupil labs eye tracking glasses without any previous experience.



For additional resources, see the [Links and References](#) section of this guide.

Getting set up

To get started, you will need to set up the physical hardware for the glasses, as well as install the necessary software. More information on setup process can be found on this website: <https://docs.pupil-labs.com/#getting-started>

The Hardware

Included with the glasses, you should have the following:

- A USB cable
- 2 Orange extenders
- An additional nose pads
- An extra camera lens

The Pupil Labs glasses are relatively easy to set up. Simply connect one end of the USB cable to the computer, and the other end to the glasses.



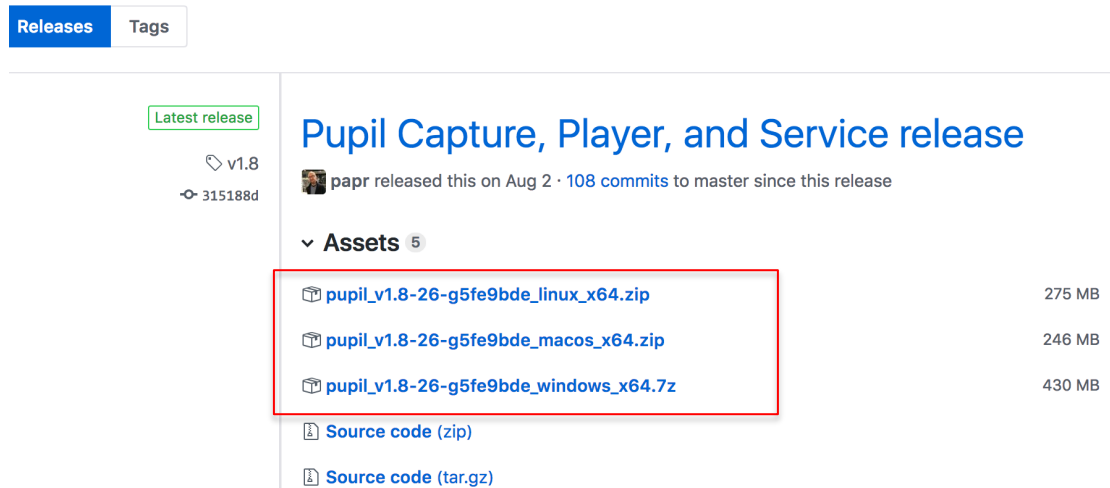
More information about how to adjust the glasses to properly capture the eye is in the [Getting Good Data](#) section. It is much easier to perform these adjustments once the software is installed.

The Software

To begin, download the companion software by clicking the following link:

<https://github.com/pupil-labs/pupil/releases/latest>
(At time of writing, the latest version of this software is 1.8)

A screen similar to the one shown in the image below should show up, and select the appropriate download for your operating system.



After the file is downloaded, unzip it and open it. In the unzipped folder, there should be three .dmg files that allow you to download the three Pupil-labs applications.

Using the software

Pupil Labs comes with three different applications, Pupil Capture, Pupil Service, and Pupil Player.



Pupil Capture



Pupil Player

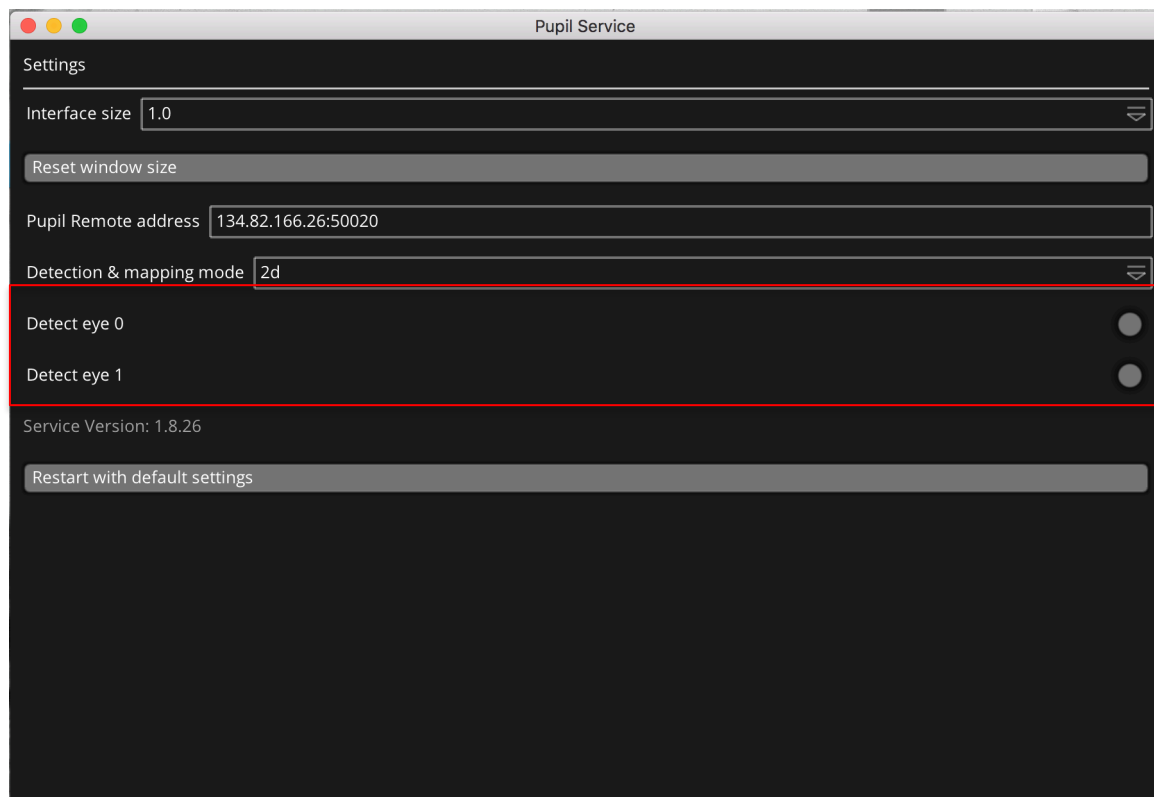


Pupil Service

Pupil Service

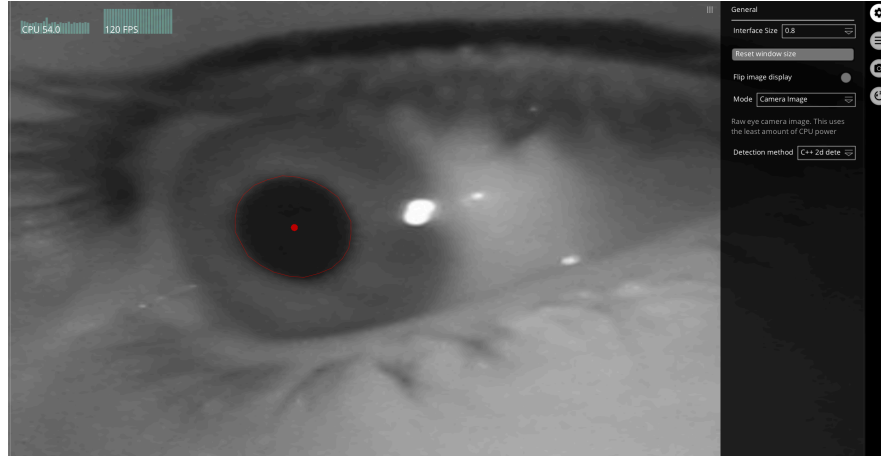
Pupil service lets you look at each of the eye cameras to make sure they are set up properly for capturing data later.

On launch, you should see a screen that looks similar to the following image:



Most of the stuff we actually care about is in the red box. Clicking on the grey circles on the far right will open up the camera feed from the respective eye. From here, we can start calibrating the cameras to get a good image.

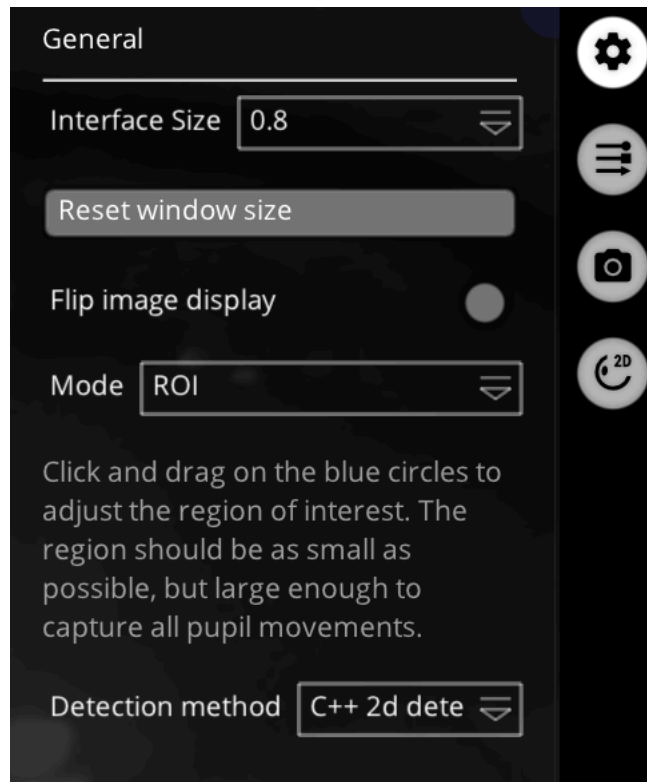
The window that pops up should look something like the following image:



More information on how to get a good image of your pupil is in the [Getting good data](#) section of this guide.

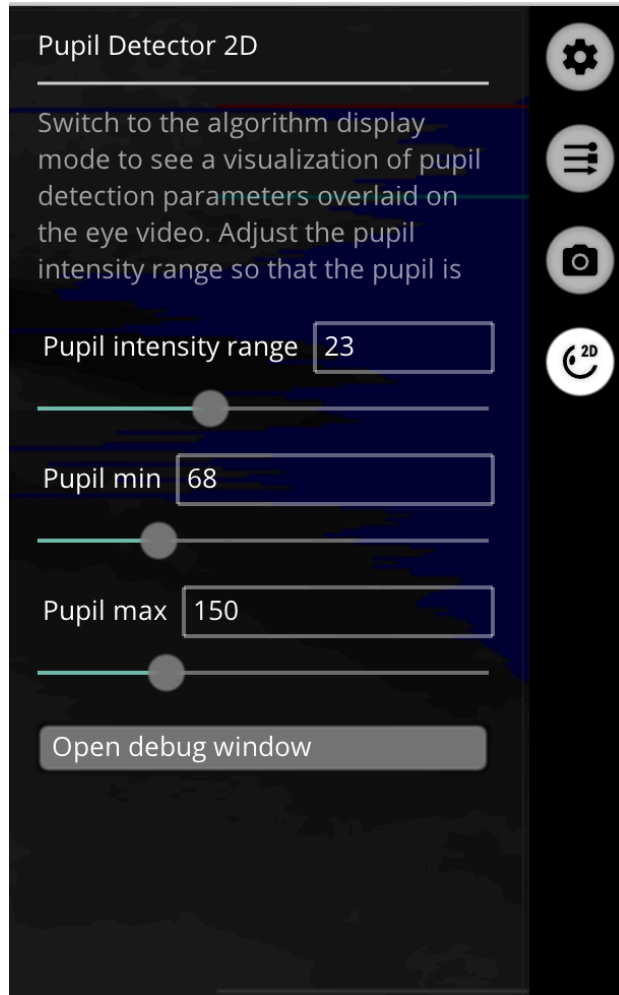
How to navigate this app.

On the far-right side of the screen, there should be four tabs similar to the image below. Hover your mouse over the first tab, which should be labeled “General Setting”. Click to open the tab. When opened, the image below should display.



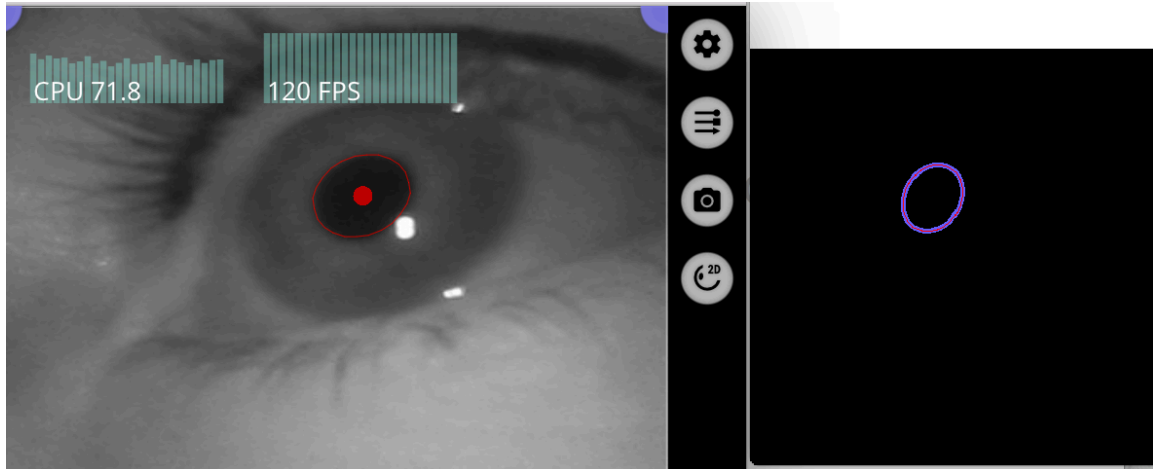
The most useful options here are the Flip Image display button and the Mode dropdown menu. The Flip image display button flips the camera image if it is upside down. The Mode dropdown menu on the other hand, has 3 options: Camera Image, ROI, and Algorithm. Camera Image will show the raw feed from the camera, and Algorithm is helpful when adjusting the filter parameters.

The next tab we will be looking at is the Pupil Detector 2D tab. It should be the bottom tab. Hover over it to confirm you are on the right tab (If your tab says “Pupil Detector 3D”, you are still on the right track. If you want to switch to 2d, go to the Pupil Service Menu opened on a different window on your computer and select 2d on the Detection and Mapping Mode dropdown menu). Click on the Pupil Detector 2D tab to open. You should now see the image below:



Note: If you do not have a 4th tab option or your tab says Pupil Detector 3D, go back to the main screen (which should still be open in a separate window) and make sure that under Detection & Mapping mode either 2D or 3D is selected.

This screen will either say Pupil Detector 2D or Pupil Detector 3D depending on what detection & mapping mode was selected, but since the menu differences between these two are minimal, we'll just look at 2D here. Here, you can fiddle with the minimum and maximum detectable size of the pupil as well as the contrast. It is extremely advantageous to be in Algorithm mode here, as it allows you to visualize how the pupil detection changes with the settings. Clicking Open Debug menu should display something that looks similar to the screen on the right in the image below:



Note: this will look different if you are in Pupil Detector 3D

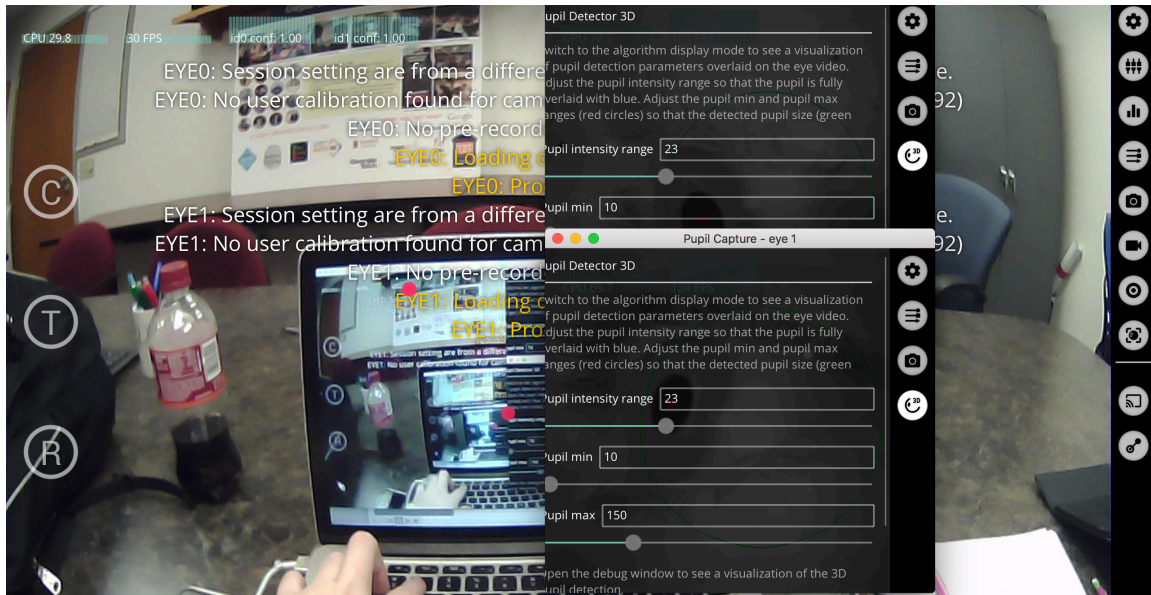
The debug screen is helpful for ensuring that the full range of motion of the pupil is able to be detected, and the movements of the pupil in the camera image and the tracked pupil should correlate.

Note: We won't be looking into the other two tabs but feel free to explore them on your own. They are useful for tinkering with the source image.

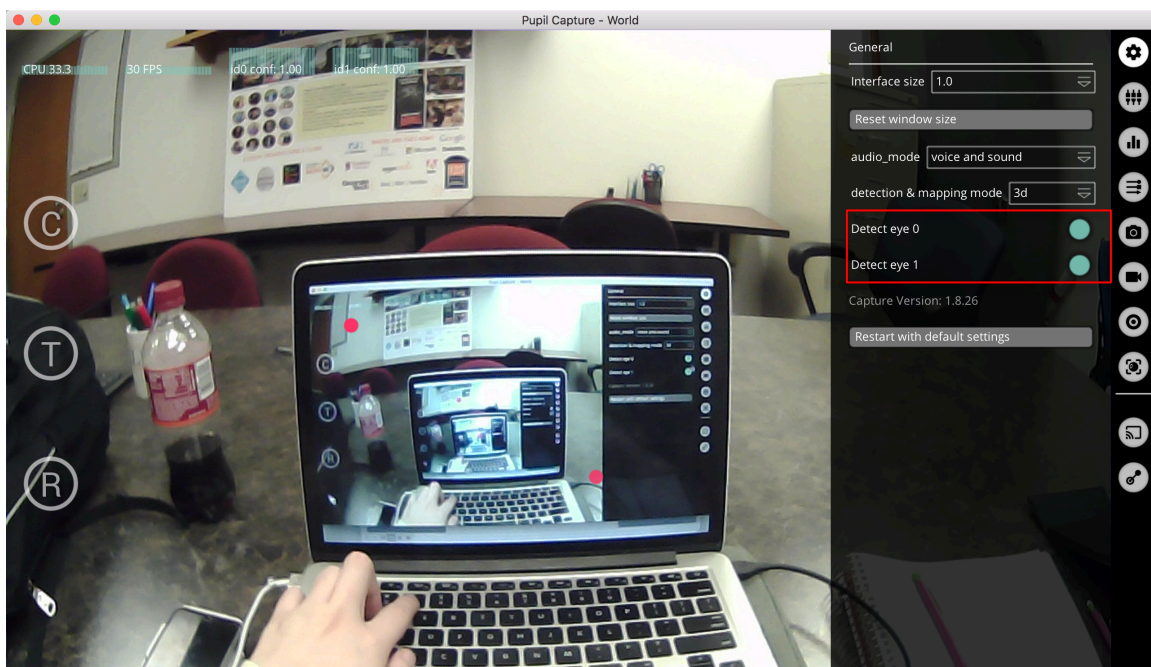
Once you have used pupil service on both eyes and ensured that both pupils are being tracked cleanly, you can start recording data with Pupil Capture. Refer to Getting Good Data to see if your pupils are tracked cleanly.

Pupil Capture

Upon opening Pupil Capture, you should see something similar to the following image:



It is normal (at least on a Mac computer) for the smaller Pupil Capture windows to pop up, one for each eye. If you accidentally closed one, just click the circle in the General tab to reopen the eye detection.



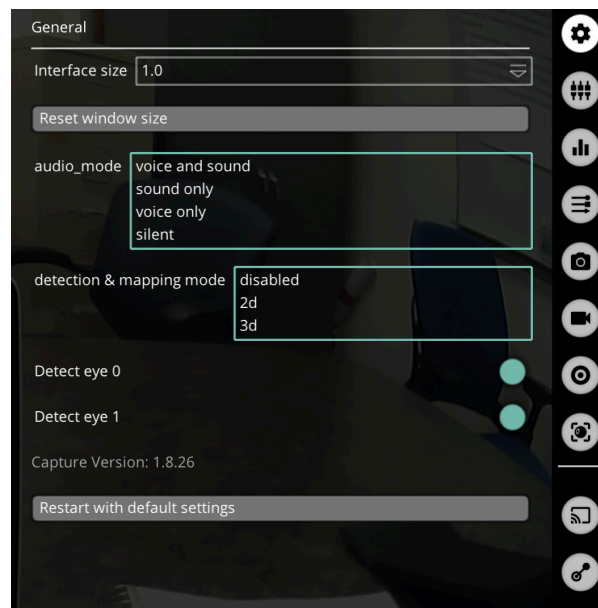
We start by calibrating. Click the circle with the 'C' on the left hand side of the screen and you should see a marker in the middle of the screen with a red dot. Look at the marker until the dot turns green, and repeat this process until all 5 markers have turned green.



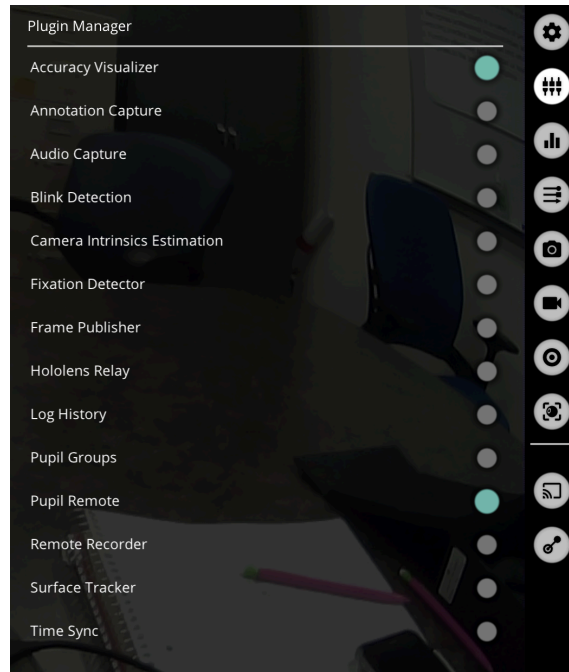
Now that the calibration is completed, the red dot in the middle of the screen should correspond to where in the environment the pupils are focused. If this is not the case, try re-calibrating or clicking the “T” in the circle to preform an accuracy test.

There are several tabs on the far right of the screen, and ‘General’ is typically opened on launch. There are 8 icons from top to bottom, and then a horizontal line followed by 2 more icons. Any icon below the line is a plugin, and there is a tab specifically for adding and removing these plugins from the tab bar. I will give a brief overview of the tabs, however most are relatively self-explanatory or can be learned by briefly playing around with their features.

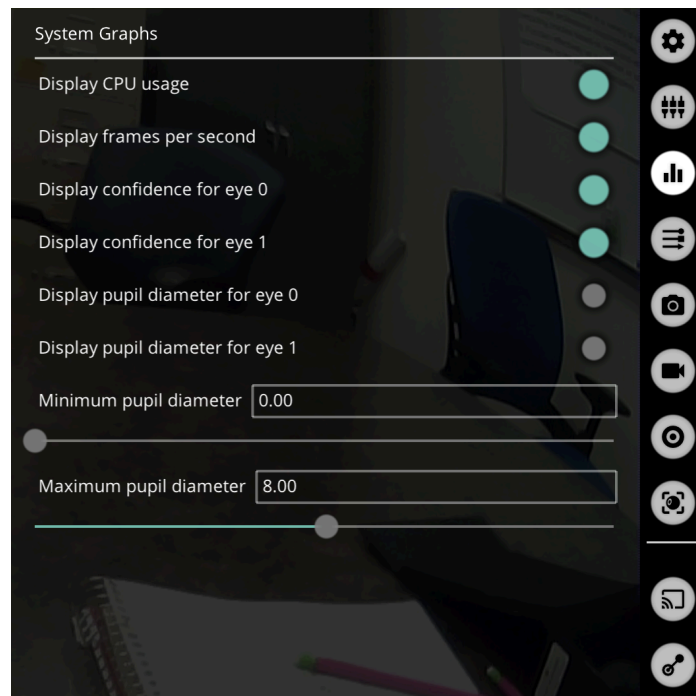
The general tab functions similarly to the tab of the same name in Pupil Service, with the exception of audio-mode allowing the user to change what kind of audio will be played during calibrations and recordings.



The next tab is the Plugin Manager, which allows the user to turn on or off icons for specific plugins. There are quite a few options and I encourage playing around with some, but I will go into certain plugins later.



System Graphs dictates what information is displayed on the top left portion of the screen.



The next 2 tabs are for image settings, which I rarely used and won't go over since they are pretty intuitive. The Recorder tab allows the user to change the settings for how videos are saved during recordings.

Recorder

Pupil recordings are saved like this:
 "path_to_recordings/recording_session_name/nnn" where "nnn" is an increasing number to avoid overwrites. You can use "/" in your session name to create subdirectories.

Recordings are saved to "~/pupil_recordings". You can change the path here but note that invalid input will be ignored.

Path to recordings

Recording session name

Request additional user info ☐

Compression
 smaller file, more CPU

Recording the raw eye video is optional. We use it for debugging.

Record eye ☒

The Screen Marker Calibration tab allows for different kinds of calibration that may or may not be easier to perform depending on what setup is being used. Selecting one of these options will give a brief blurb into what they are and how they work. The user can also change calibration settings here.

Screen Marker Calibration

Calibration Method
 HMD Calibration
 HMD Calibration 3D
 Manual Marker Calibration
 Natural Features Calibration
 Screen Marker Calibration
 Single Marker Calibration

Calibration only considers pupil data that has an equal or higher confidence than the minimum calibration confidence.

Minimum calibration confidence

Calibrate gaze parameters using a screen based animation.

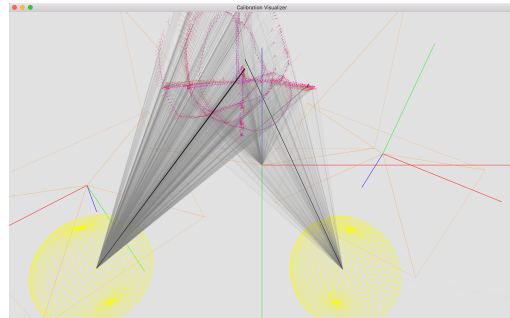
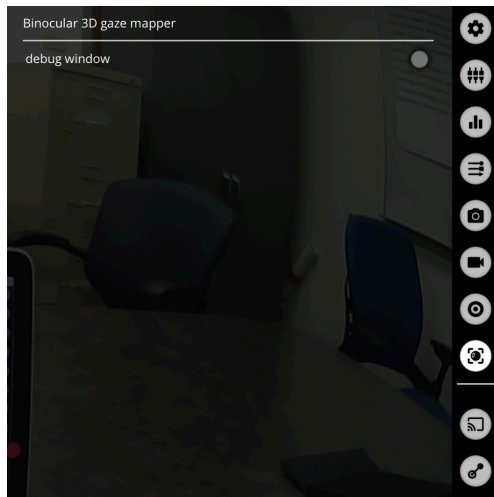
Monitor

Use fullscreen ☒

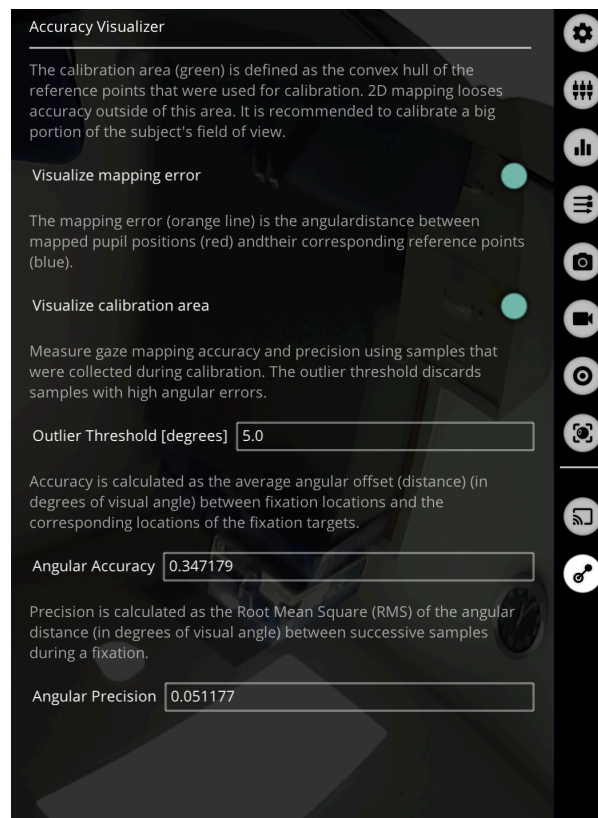
Marker size

Sample duration

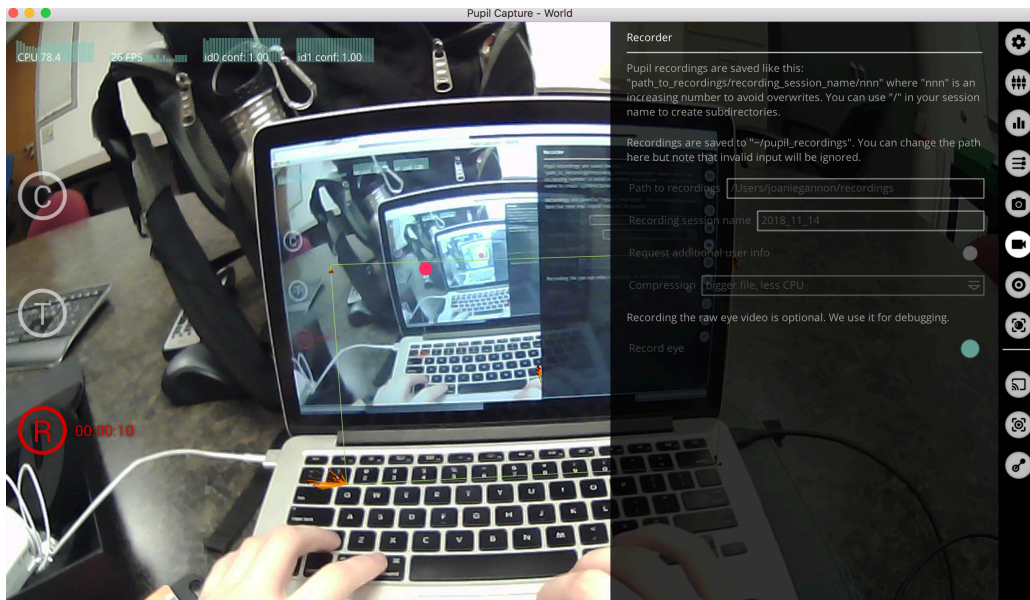
I'm not really sure what purpose this tab has other than debugging, but it looks cool.



As far as the plugins are concerned, most of them are features that may or may not be helpful depending on what the user is attempting to accomplish.



When you are ready to record, hit the 'R' button on the left side of the screen. Clicking this button again will stop the recording. Recordings can be viewed using the Pupil Player.



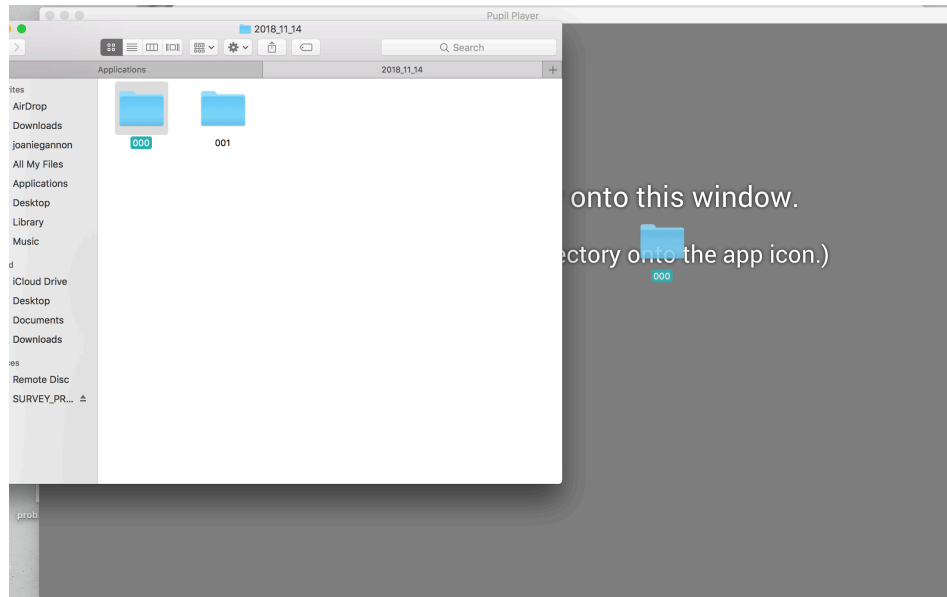
Pupil Player

After using Pupil Capture to record data (by hitting the R button on the left side of the screen), the recorded data should be located at the directory specified (by default: Users/yourUser/recordings)

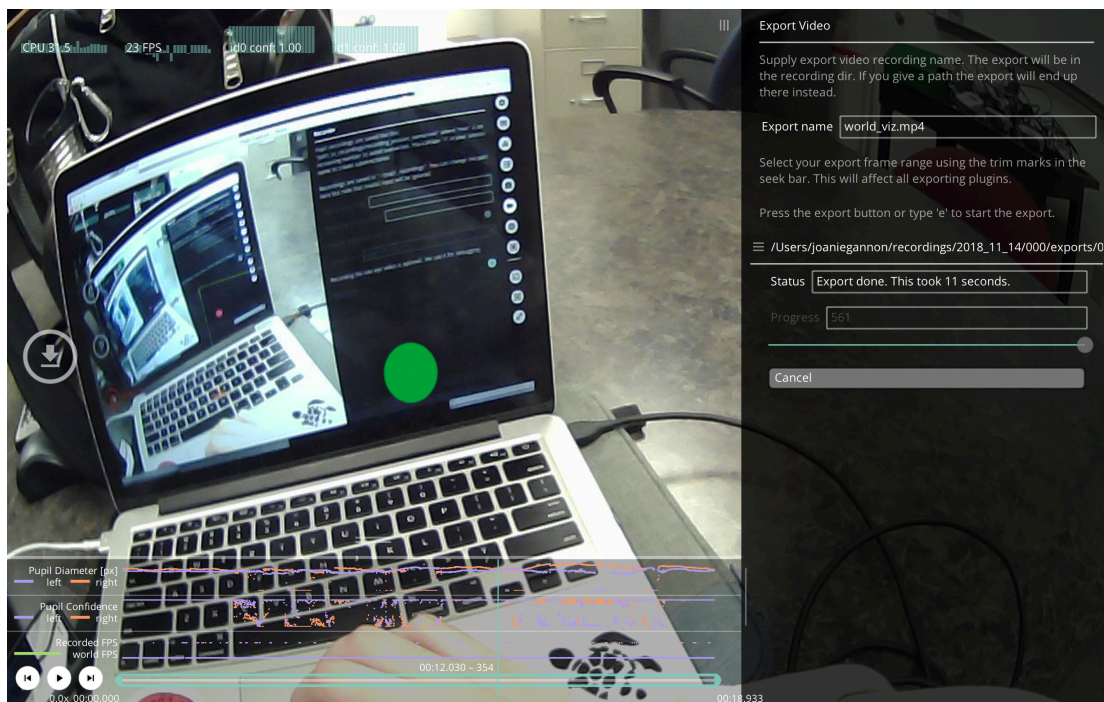
Opening the app shows the following screen:



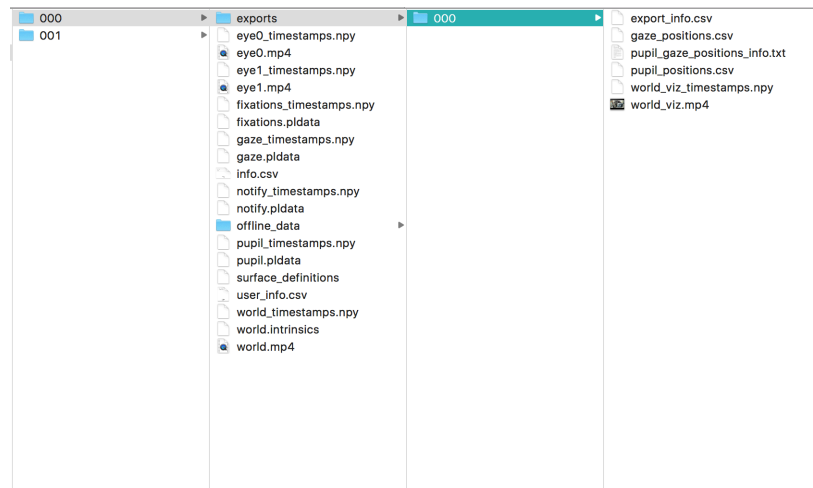
Located the saved recording file you wish to play, and drag it onto the window.



The player will show a playback of the recording that looks similar to the following screen:



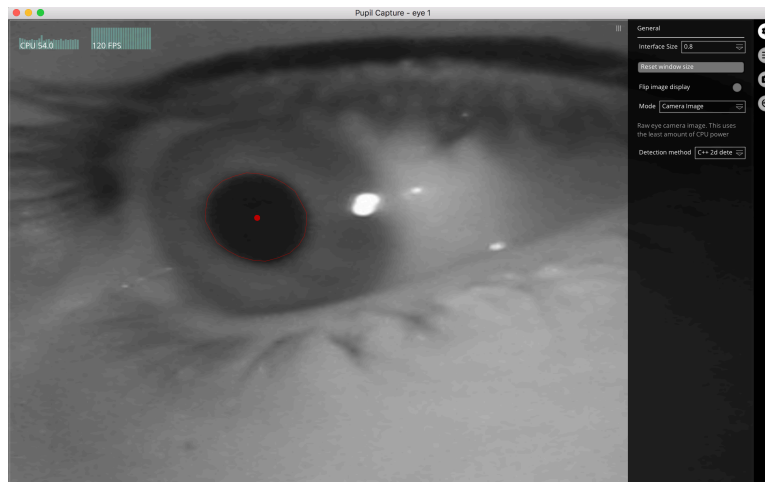
Click the buttons in the bottom left corner to control the video. The button on the far left will export a .mp4 version of the video, as well as raw data in the form of .csv files. After the export successfully completes, navigate back to the original file, and look in the 'exports' folder within that directory to find the exported data and video.



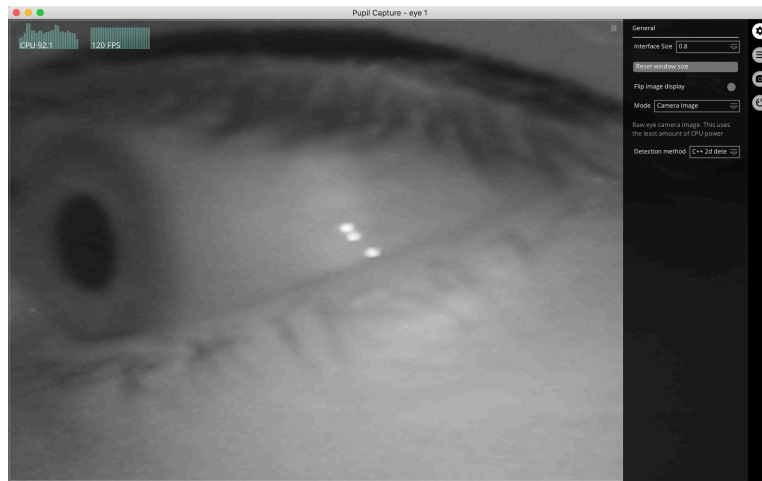
Getting good data

Good data starts with a good pupil images. To get good pupil readings, make sure the camera is set up such that:

- The full range of motion of the pupil is visible. Make sure that the pupil can still be detected from most if not all angles of vision.
- The eye is in the center of the screen
- There is nothing else in the view of the camera (such as eyebrows).



Good: the full range of motion is visible



Not good: The full range of motion for the pupil is not visible

To get better feedback on whether the eye is properly positioned in the Pupil Service app by using the algorithm view and the debug option. There, parameters such as pupil size and lighting threshold can be adjusted.

Additionally, the hardware itself can be adjusted to provide a better view of the pupil. The easiest adjustment is to gently pivot the pupil camera with your fingers. If the camera is not pivoting, you can loosen the screw on the outside of the camera until it is able to move freely while still being tight enough to hold its position while being used.



If these adjustments are still not enough to properly frame the eye in the view of the camera, then the orange extenders can be used.



To attach the extenders, slide the extruding camera out of the side of the glasses, and insert the thin end of the extender into the slot on the camera, like in the image shown below.



Then, slide the extender back onto the glasses where the camera was removed from, as seen in the image below.



Troubleshooting

Here I'll run through some of the issues I've encountered and how I resolved them.

I'm getting frozen images/a grey screen in Pupil Service

Don't worry, you probably didn't break anything, the camera connection probably just came loose. The most likely candidate is the small port that connects the pupil camera to the glasses (seen in the image below), which can sometimes get pulled loose when reorienting the glasses. Gently push the connection back together with your fingertip.



If this did not work, there might be an issue with the USB cable. Otherwise, there might be a loose wire somewhere else on the glasses.

Pupil Capture's calibration is not working

This can be a handful of issues. Firstly, if you are not even able to complete the calibration because the targets don't turn green when looking at them, check to make the pupils are both able to be properly read in Pupil Service. If they are, make sure the head camera is both in focus and is able to see the calibration marks.

If you are able to make it through the calibration, but the calibration still fails, Pupil Capture usually prints out an error message that can be helpful. Make sure both eyes are being detected and are set up properly to be read.

Links and References

Pupil Docs (official documentation):

<https://docs.pupil-labs.com/#getting-started>

Pupil Labs' Github

<https://github.com/pupil-labs>

Pupil Labs' Applications

<https://github.com/pupil-labs/pupil/releases/latest>