

---

# EYE TRACKING USER MANUAL

---

## 1 Introduction

Welcome to your personal integrated eye tracking system! In this short guide, you will learn about how to use the hardware and the user interface to control your computer with your eyes. The eye tracking package shown in Figure 1 consists of the following items:

1. Frame mounted webcam headset (1).
2. Infrared lamp, up to 12 V<sub>dc</sub> (2).
3. USB 3.3 V converter (3).

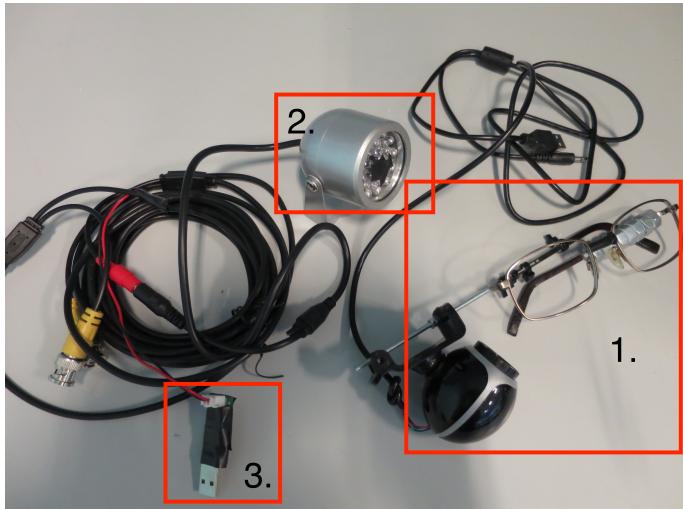


Figure 1: Eye tracking hardware package.

## 2 Package Prerequisites

In order to run the graphic user interface, the following packages must be installed. Please refer to the installation instructions for each package separately.

1. Python version 2 from <https://www.python.org/download/releases/2.7.3/>.
2. OpenCV version 3 from [http://docs.opencv.org/3.0-beta/doc/tutorials/introduction/windows\\_install/windows\\_install.html](http://docs.opencv.org/3.0-beta/doc/tutorials/introduction/windows_install/windows_install.html).
3. NumPy from <http://docs.scipy.org/doc/numpy-1.10.1/user/install.html>.

4. PyAutoGui from <http://pyautogui.readthedocs.org/en/latest/install.html>.
5. TkInter from [https://tkinter.unpythonic.net/wiki/How\\_to\\_install\\_Tkinter](https://tkinter.unpythonic.net/wiki/How_to_install_Tkinter).
6. PySubPub from <http://pubsub.sourceforge.net/installation.html>.
7. Mathplotlib from <http://matplotlib.org/users/installing.html>.

The system has been tested and runs on both Windows 7 and OSX 10 operating systems.

## 3 Hardware Setup

1. Place mounted frame on head and ensure that it is snug against the bridge of the nose. If required, adjust the nose pads.
2. Angle camera towards eye and plug into a USB port.
3. Power IR lamp by plugging the voltage converter into another USB port.
4. Wait until the necessary drivers are automatically installed, then GUI may be run.
5. Ensure that you are sitting comfortably and try to reduce head and body movement to a minimum before proceeding to the next steps.

## 4 Running the GUI

The GUI may be run in two different ways. In OSX, the executable application can be double clicked, or the GUI may be built from source in the Command Prompt/Terminal. The latter approach will be described in detail. It is assumed that the user is already familiar with using the Windows or OSX command line.

### 4.1 Start up

1. Open the Command Prompt (Win) or Terminal (OSX) and navigate to the Filtering folder.
2. Type `python eyeTrackingMainGUI.py` and hit Enter. An example of this is shown in Figure 2. If any errors appear about missing packages in the command line, ensure that they have been correctly installed by referring to Section 2.

```
Last login: Sun Apr 24 16:34:24 on ttys001
Nadias-MacBook-Air:~ Nadias$ ls
19520-Eye-Tracker
Android Studio Projects
Applications
Desktop
Documents
Downloads
Dropbox
Kinect
Library
Movies
Music
Pictures
Public
eyeTrackingMain.py
opencv
opencv_contrib
unnamed.autosave
zeroForcingSolution.ipe.autosave
Nadias-MacBook-Air:~ Nadias$ cd 19520-Eye-Tracker/
Nadias-MacBook-Air:19520-Eye-Tracker Nadias$ ls
Accuracy
Calibration + Gaze Point
Filtering
Nadias-MacBook-Air:19520-Eye-Tracker Nadias$ cd Filtering
Nadias-MacBook-Air:Filtering Nadias$ ls
AllTogetherEdit.py
AllTogetherEdit.pyc
Eye.MOV
TestToplevel
VideoTut.py
VideoTutV2.py
VideoTutV3.py
VideoTutV3.txt
bi_level_img_threshold.py
bi_level_img_threshold.pyc
calibration9dotsBlinking.py
click_callback.py
color_img.jpg
edgeDetection.py
edgeDetection.pyc
eyeTrackingDemoGUI.py
eyeTrackingMain.py
eyeTrackingMainEdit.py
eyeTrackingMainGUI.py
eyeTrackingMainImage.py
eyeTrackingMainVideo.py
getCalibrationUnknowns.py
Nadias-MacBook-Air:Filtering Nadias$ python eyeTrackingMainGUI.py
```

Figure 2: Navigating to and running the eye tracking GUI.

- When the GUI starts up, you will see something similar to Figure 3.

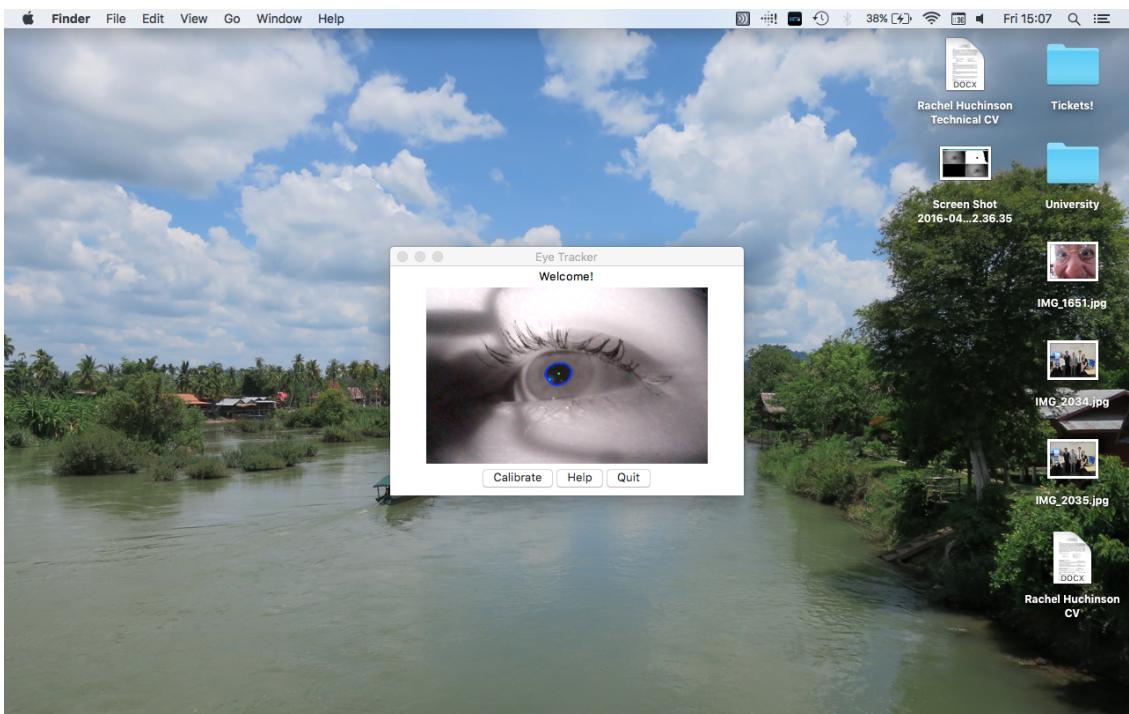


Figure 3: Welcome screen of the GUI.

The window in the middle shows the live camera feed. The feed will allow you to adjust the IR light source, such that you see a consistent blue circle around the pupil and the corneal reflection (white dot). This means that a pupil and corneal

reflection have been successfully detected.

## 4.2 Calibrating

1. On the GUI start page, there are three options available – **Calibrate**, **Help** and **Quit**. **Help** will take you to this User Guide and **Quit** will exit the program. To begin calibration, ensure that pupil and corneal reflection have been detected and click **Calibrate**. You will be presented with the calibration screen – a  $3 \times 3$  grid of points, shown in Figure 4.

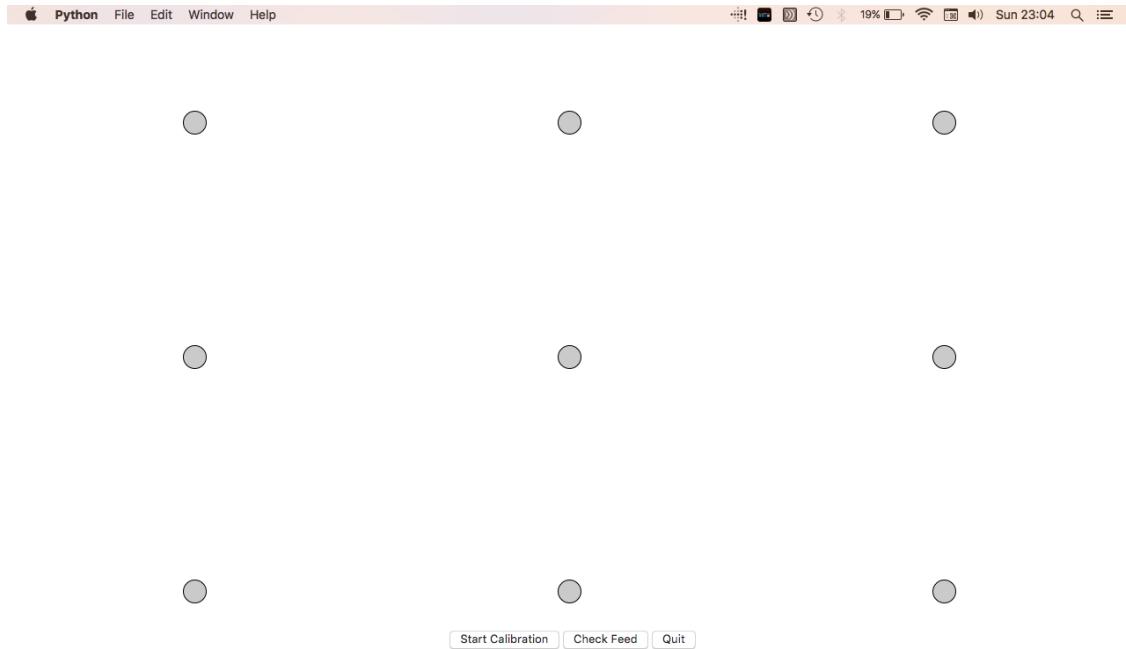


Figure 4: Calibration screen.

2. Once again, there are three options available. **Check Feed** will show the live feed as it was seen in the start screen. This is to check if the pupil and corneal reflections have been detected. **Quit** will present you with a warning dialogue if you wish to quit at any time, shown in Figure 5.

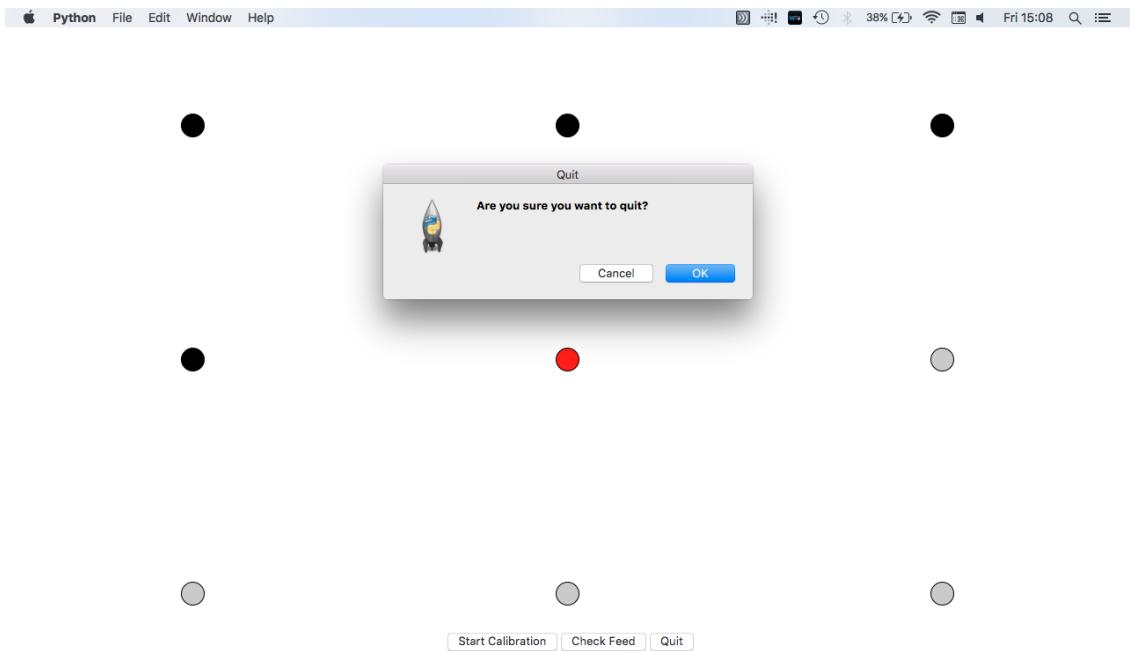


Figure 5: Quitting calibration.

To begin calibration, click on **Start Calibration**.

3. When calibration starts, you must look at each point in turn, from top left to bottom right. The required point will be coloured red as shown in Figure 6. Once the calculation has been performed, the next point will become coloured in red and the previous will become black.

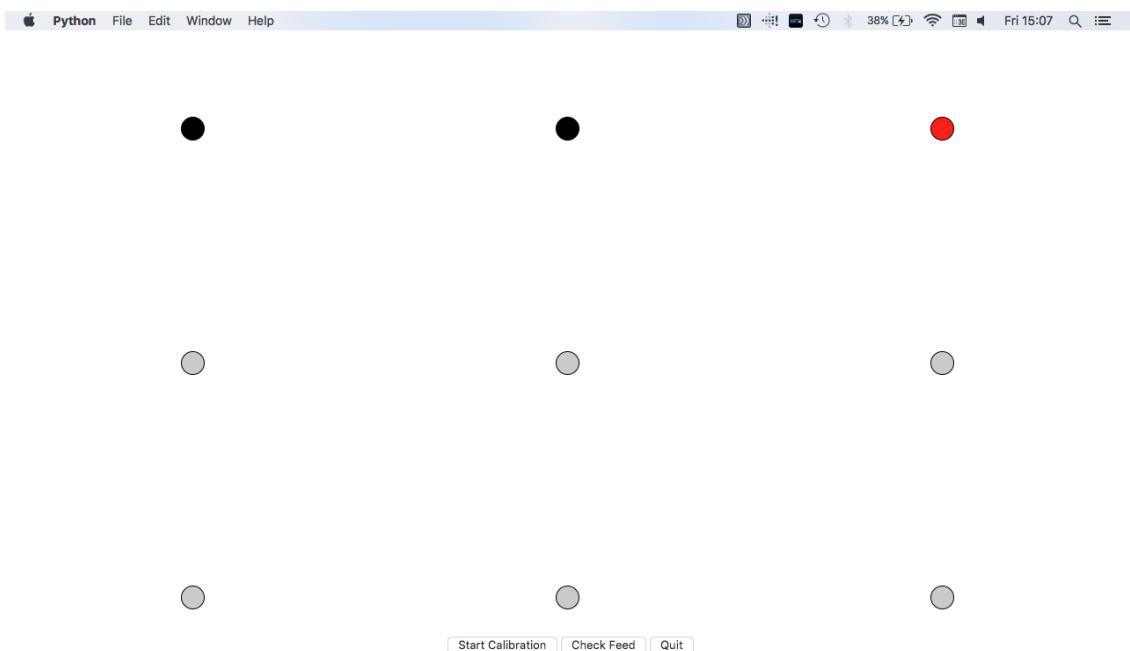


Figure 6: Performing calibration.

- If at any point, the algorithm no longer detects a pupil or a corneal reflection during calibration, the current point will be paused and attempt to detect again. If this fails, the current point will turn orange and the live feed will pop up to allow adjustments until a pupil and a corneal reflection are detected. Once this happens, the window will automatically disappear and calibration will proceed as before. This is illustrated in Figure 7.

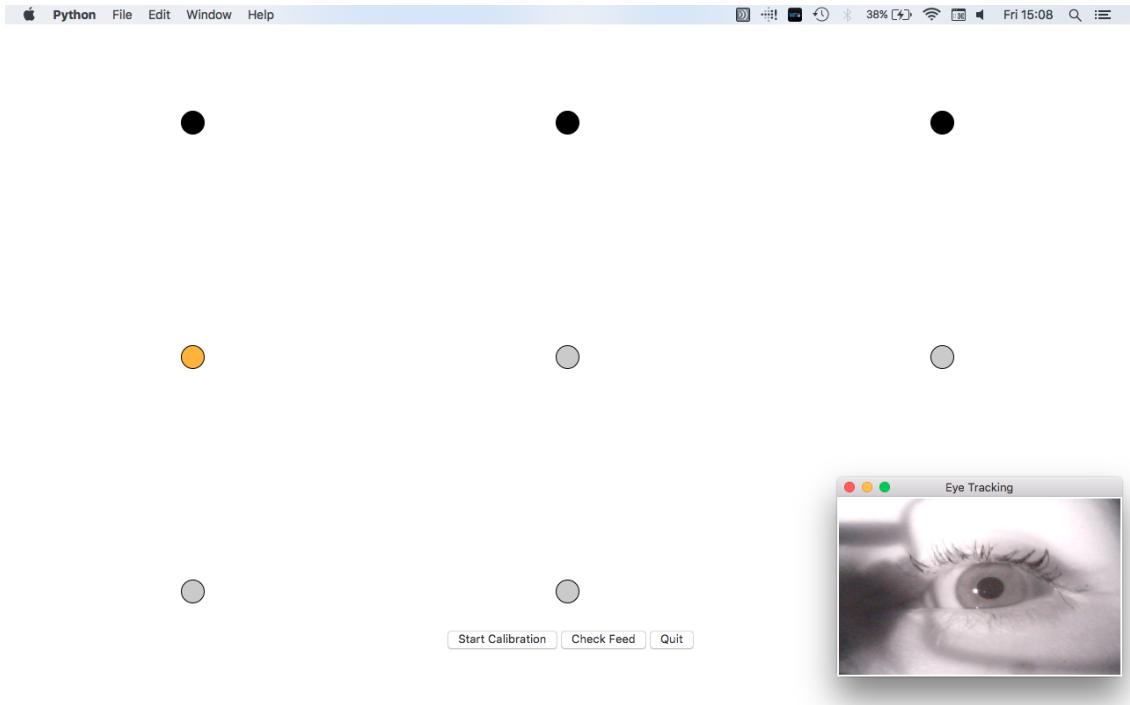


Figure 7: Problem with detecting pupil or reflection during calibration.

- Continue to focus on each point in turn until all 9 have been completed. Eye tracking will then automatically begin. If another user wishes to use the eye tracker, they need to calibrate beforehand.

### 4.3 Eye Tracking

- Once all 9 points have been calibrated, the unknown coefficients will be calculated and eye tracking can begin. Figure 8 illustrates the screen after successful calibration.

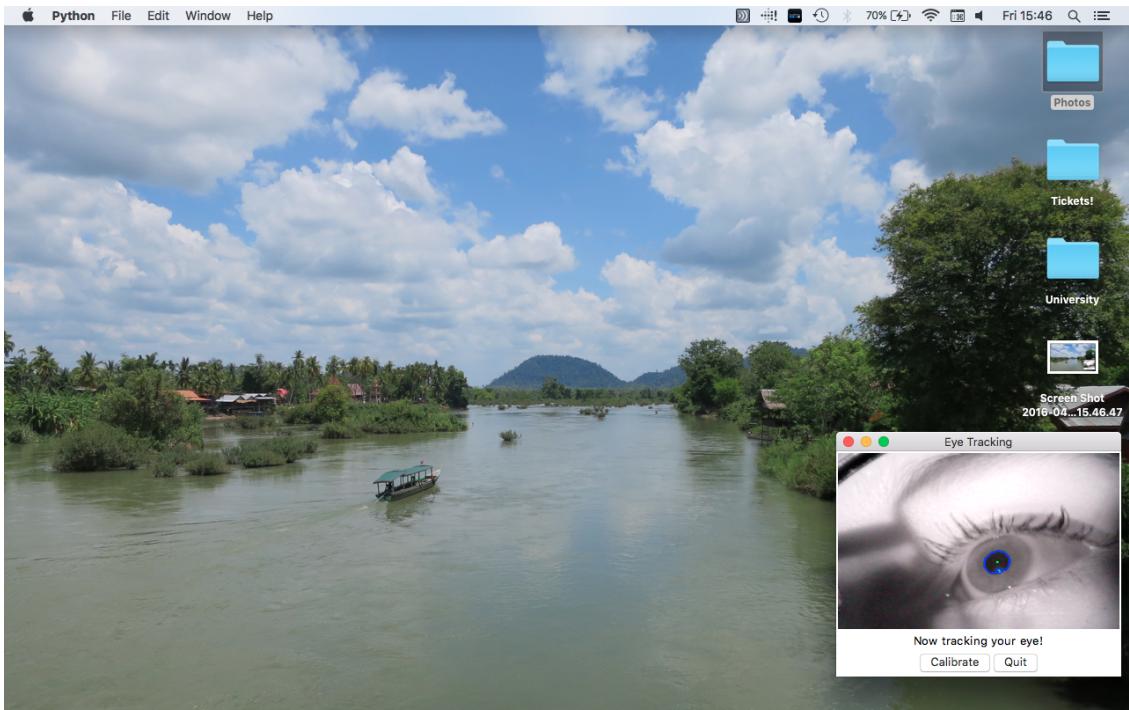


Figure 8: The user now has control of the cursor with their eyes. Note, cursor is not shown on this screenshot.

2. Single and double left mouse button clicks have been enabled for this eye tracker. In order to invoke a click, focus on an icon for approximately 1 second. For a double click, focus for approximately 2 seconds. Before using this feature, it is recommended to increase icon size to compensate for accuracy tolerances. Please note double clicking does not work on OSX.
3. Scrolling functionality has also been implemented. However, on Windows machines scrolling is only implemented on certain programs such as Notepad++, as each program has a unique interface. To scroll, simply look at the top or bottom of the scroll thumb as shown in Figure 9. The scroll only moves a couple of lines up or down the page.

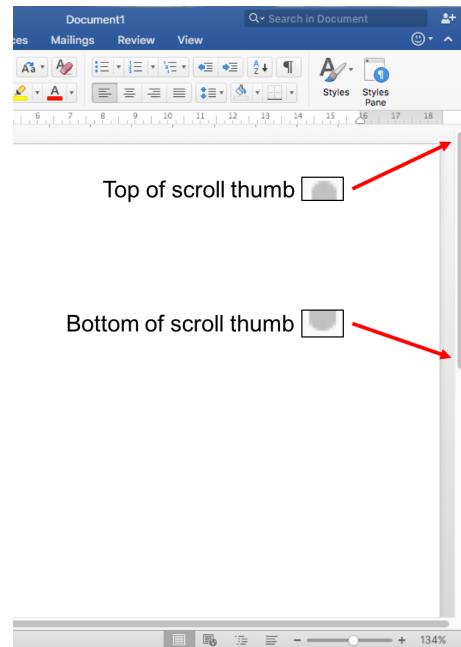


Figure 9: Look at top or bottom of scroll thumb to invoke a short scroll event.

4. To quit eye tracking all together, click **Quit** in the small window which shows the feed and click **Ok** in the warning dialogue as shown in Figure 10.

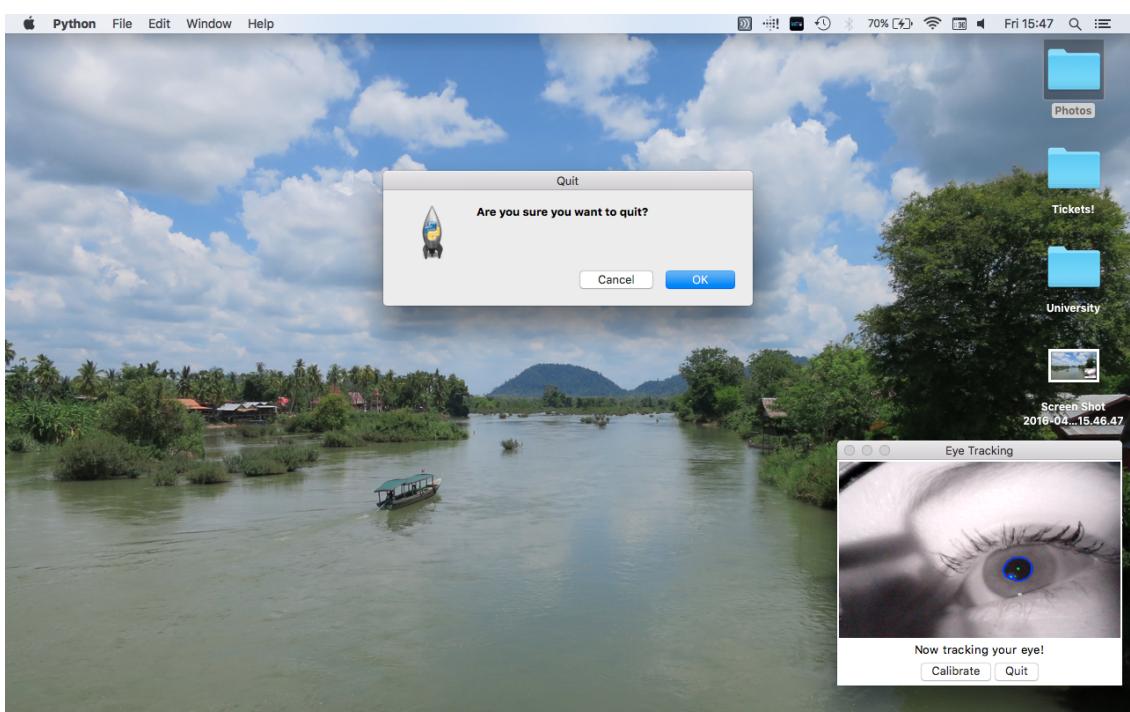


Figure 10: Quitting eye tracking.