

In your last assignment you will explore Fitts' Law, a fundamental and widely used mathematical model in HCI, while conducting your own eye tracking study. Eye tracking is a common user study technique, and here you will have a chance to try two different eye trackers: the Tobii EyeX and a webcam eye tracker we have built. The readings we have done in class describe Fitts' Law principles and will help you measure the effect of different target shapes on pointing interactions, while examining the eye-gaze activity of participants. This is probably the most challenging assignment, so you ought to start early. The success of the study depends on many details; read this document several times until you feel comfortable carrying out the study.

You will find 3 participants and arrange an 1-hour session with them in CIT 408. It takes time to find unique participants and schedule them. Mark four 1-hour slots on this Doodle to book the room: <http://doodle.com/vprmnaqeuvu7tga9>, one for you as a pilot user and the rest of the 3 for your users. Make sure your participants have not participated in any other classmate's study. Prepare and have them sign an informed consent document before the beginning of the study, and make a note of their age and hand preference (right or left-handed).

Have your participant sit at the computer named FINN; they should be comfortable and relatively still throughout the study. Log in with the following credentials: the username is `finn\cs2300` and the password is `cs2300`. Once you log in, you should see four shortcuts on the desktop, as seen in Figure 1. You will be accessing them one by one from left to right according to the steps below. It's recommended that you run the full study on yourself to familiarize yourself with the study procedure before you start with your 3 participants. Perform the following steps for each participant:



Figure 1: The four tools you will use from left to right in order to complete the study.

Setting up the Eye Trackers

The first step is to calibrate the Tobii eye tracker. You will double-click the Tobii EyeX shortcut, and create a new profile for the participant by clicking the plus sign in the Eye Tracker tab, as seen in Figure 2. Specify if your participant has normal vision, wears glasses, or contact lenses. The calibration should be done for both eyes. After that, follow the instructions given by the interface to do the full calibration.

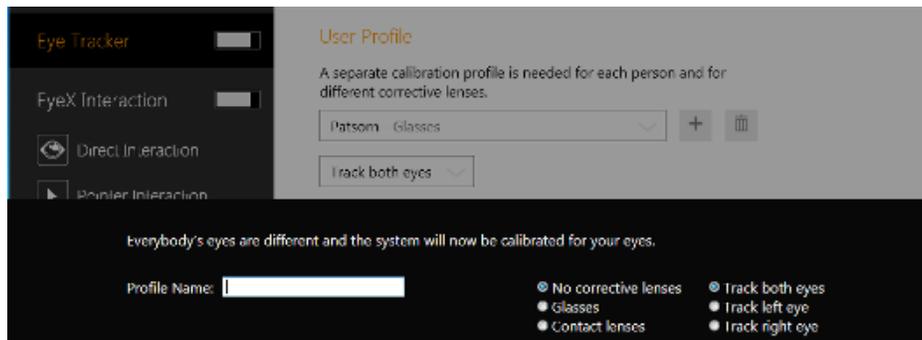


Figure 2: Tobii EyeX calibration. Add a new participant by clicking the plus sign, then specify their name and vision settings.

The second eye tracker you will use will be based on the images captured by the webcam located above the monitor. Double click the Logitech Webcam Software to make sure that the face of the participant is correctly aligned within the captured video (adjust the settings by using the tilt and zoom controls), but do not move the physical webcam. Your captured video should look similar to Figure 3.

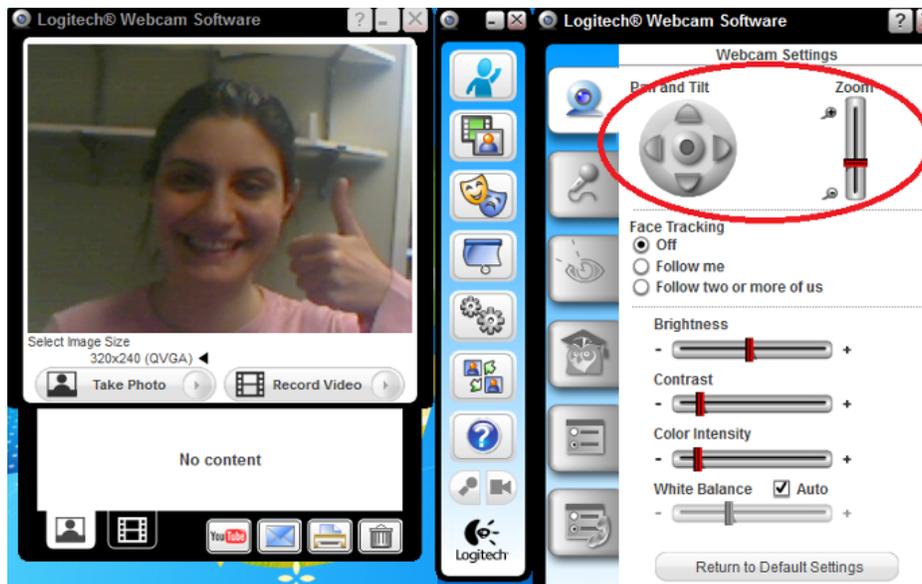


Figure 3: Webcam settings. Use the zoom and tilt controls to correctly aligned the face as seen here. Do not move the physical webcam.

You’re ready now to move on with logging the data captured by the Tobii eye tracker. Double click the eyeTrackerLogging batch file to start recording eye-gaze data in the tobii_eye_tracker_log_file.txt file (can be found in your Downloads folder). When you are done with the study don’t forget to close the cmd window that will have opened when you ran the batch file, email yourself the log file, and remove it from Downloads.

Once you complete these steps, open the last shortcut: Google Chrome. You will automatically land on this page: http://cs.brown.edu/people/alexpap/hci/fitts_law_assignment/.

Now calibrate the webcam eye tracker. Press Ctrl+F1 to show a video and a window with a threshold option. Your goal is to capture the iris of the eyes of your participant by tweaking the threshold parameter

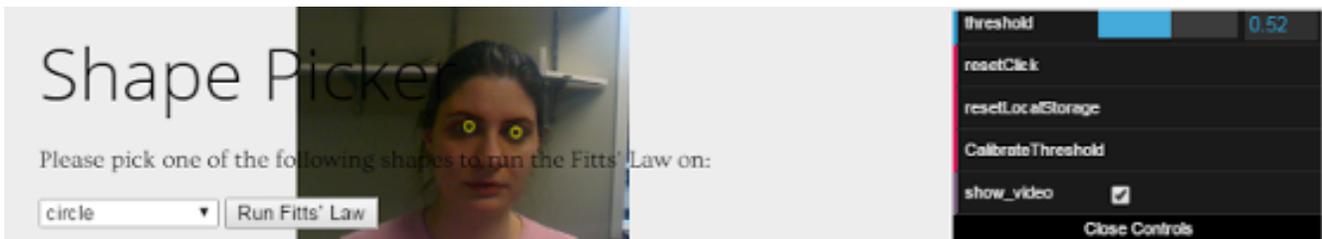


Figure 4: Webcam calibration. Start the threshold at 1 and keep reducing it until you no longer have unequal circles. If the eye tracker does not respond to small movements you should increase it.

until you feel confident that the eyes are located correctly, as in Figure 4. Start by shifting the threshold to the maximum value, that is 1. As long as you see that the two eyes are captured unequally, you should reduce the threshold. At the same time, ensure that the eye tracker captures the eyes when they make small movements. If it stops responding, increase the threshold value. Once you are satisfied, hit Ctrl+F1 again to hide the video, and make two clicks: one in the top-left corner of the window and one in bottom-right. This makes the eye tracker compute the distance between the participant and the monitor.

Fitts' Law Study

Now you can finally begin the study! Note the following parameters: 10 shapes, 3 amplitudes (256, 384, 512), 3 widths (24, 64, 94), and 10 trials per combination of shape, amplitude, and width. You will ignore the first 3 clicks in your analysis.

Back on the the webpage, you will notice there is a drop-down menu with 10 shapes. This is a within-subjects design where the order of the targets are randomized. Each of you has been randomly assigned a specific sequence of targets. The sequence of the shapes for each of your participants is here: <http://goo.gl/dy6k5Z>

You will always start with the circles layout. Give a couple of minutes for your participant to try hitting the red targets until they feel comfortable with the mouse. Remind them that their goal is to click the red target as fast and as accurately as possible. Once they understand how the study works, close this tab and move on to your first shape. You will not use this data.

The combinations of width and amplitude will be picked randomly by the webpage. Your participant should get through all 9 of them for each shape (note that in total you will have $10 \times 3 \times 3 \times 10 = 900$ trials per participant). Once a participant has gone through all combinations of amplitudes and widths for a specific target shape, you will be notified by a pop-up menu to continue to the next shape. Before you go back to the shape selecting page by closing this tab (it should still be open) you should not forget to create and download the two log data files for **each** target shape (or you will have to repeat the shape again), as seen in Figure 5. This will give you 20 log files for each participant, plus one for the Tobii eye tracker. All of them will be found in the Downloads folder. As with the `tobii_eye_tracker_log_file.txt`, don't forget to get copies of them at the end of the study, email them to yourself, and remove them from the Downloads folder.

Analysis

By 1pm on April 8 (midpoint), you should have already run the study with at least two participants, uploaded their data to Canvas, and have found the third participant. The analysis should only be done

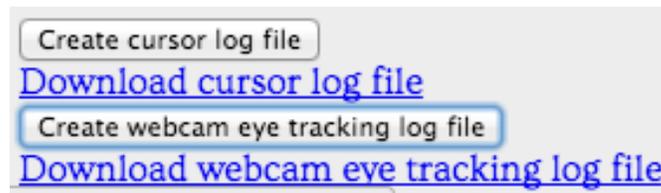


Figure 5: Be sure to create and download these two files after each shape.

after the midpoint. We will release everyone's midpoint data by the end of day on April 8 so you can perform the analysis with a moderately-sized dataset. We recommend using python and/or Excel, but however you do the analysis is fine.

The `cursor_log_file_[shape].txt` file that will be created includes the timestamp of moving and clicking activity of the cursor, along with the success/failure information. You will use these log files for your analysis. Follow the procedures recommended by Soukoroff and MacKenzie. Use the Shannon's formulation of Fitts' Law to calculate the MT , ID , W_e , a (intercept), b (slope), and error rates. Fit a linear regression to your data in order to create the classic regression plot of ID vs MT for each target shape. You can use Excel's Trendline to do the plot and compute the best-fit regression/correlation. Were the regression plots what you expected? Does Fitts' Law "work"? Compare the throughputs (according to the formulation specified in Soukoreff and MackKenzie) between different target shapes. Also include some descriptive results: plot distance from target vs time for one or two representative trials, what were the percentages of error and average times for each condition?

The `webcam_eye_tracker_log_file_[shape].txt` contains the eye-gaze coordinates captured by the webcam eye tracker. Be aware that the webcam eye tracking data will be only within the `fitts.html` page, excluding the tab bar. You should take that into account when comparing with the data captured by the Tobii EyeX in the `tobii_eye_tracker_log_file.txt` file.

Finally, do at least one creative analysis. Choose from one of the following, or come up with your own (check with Alexandra first): How does user pointing relate to their eye-gaze (e.g. to they look first and then point, or look at different places they could point to and choose where to aim)? How did the accuracy of the eye trackers compare, and how do you know if one is accurate? Does Fitts' Law fit the data best or does a two-part model (like Welford's law) or a power law fit better? Which of Grossman et al.'s targeting models is most accurate, or can you come up with a better one? Basically, try to discover something new and interesting!

Final Words

Once you have completed this assignment, you will understand Fitts' Law and eye tracking better than even many HCI researchers. As usual, keep a journal (lab notes) of your work as you go. Describe everything you did, and what you found. You will submit a final short report to Canvas that includes your journal notes, plots, and any other files you generated. You will also upload the log files you have gathered for each participant (you can combine the cursor and webcam log data into 3+3 separate files). Contact Alexandra for help this assignment, but don't wait until the last few days because she will be traveling.

The assignment grade will be based on correctly running the user study and avoiding pitfalls (5 points), performing a reasonable analysis of the Fitts' Law study data (6 points), trying a creative analysis of the final data (5 points), quality of the report and conclusions (2 points), and midpoint progress (2 points).