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Eye Movements and Visual Perception

Practical Session 1

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Introduction

The aim of this practical session is to introduce you to manipulating eye tracking data and performing basic eye movement identification.

Submit your answers to ILAS on a single folder using the **Upload Multiple Files as Zip-Archive** option. This folder should contain all items marked in this document with (Answer in: example.txt) . Name the file **exactly** as specified in this document with your answer inside. No file upload is required for items not marked as such. **Upload a single submission per group.**

Exercise 1: Group Identification

Add the matriculation number of all group members, **one per line**. (Answer in: group.txt)

Exercise 2: Eye Tracking Protocol Manipulation

1. Load the eye-tracking protocol (*data.csv*) and inspect it.
   Matlab tips:
   - You can read the data using the **importdata** command.
   - You can display help about a command using **help <command_name>**.
   - Given a matrix **m**, you can access the elements of the matrix using the syntax **m(row,col)**. E.g.:
     - **m(1,1)** gives the element at row 1, column 1.
     - **m(1:3,1)** gives the element from row 1 to 3, column 1.
     - **m(:,1)** gives the element from all rows, column 1.

2. Remove invalid data points and overlay the remaining data points on the stimulus image (*stimuli.jpg*) using different colors for each eye. (Answer in: eyes-overlay.jpg)
   Matlab tips:
   - You can load the stimuli using the **imread** command.
   - You can overlay the points using the **hold on; scatter(x,y); hold off;** commands.
   - You can use the **imsave** command to save an image.

3. The display used to collect this data has a width of $500mm$ and a height of $300mm$. What is the horizontal and vertical **millimeter per pixel** ratio? Assume that the axes of the screen and gaze are aligned and consider the white borders in the image. (Answer in: ratio.txt)

4. Assuming that the user's eye center was distant $600mm$ from the display, what is the gaze angle encompassed by $1000\ horizontal\ pixels$ approximately? (Answer in: angle.txt)

5. When we look at an object, our eyes must rotate around a horizontal axis to project the image in the center of the retina in both eyes. The resulting angle between the gaze vector of both eyes is known as vergence. Assuming that the user is gazing at an stereoscopic (3D) display $600mm$ away and that the horizontal distance between the gaze points *in the screen* is $10mm$, what is the depth (w.r.t. to the eye center) from the 3D point the user is gazing at? Assume the interpupillary distance is $64mm$. (Answer in: vergence.txt)

Exercise 3: Eye Movement Identification

For this exercise, consider that the time in the data file is given in *microseconds*.

- Implement the Velocity Threshold Identification (I-VT) algorithm. You can find the pseudocode for this algorithm in Figure 1. (Answer in: ivt.m (or .py, .cpp, etc depending on the language))
- Implement the Dispersion Threshold Identification (I-DT) algorithm You can find the pseudocode for this algorithm in Figure 2. (Answer in: idt.m (or .py, .cpp, etc depending on the language))

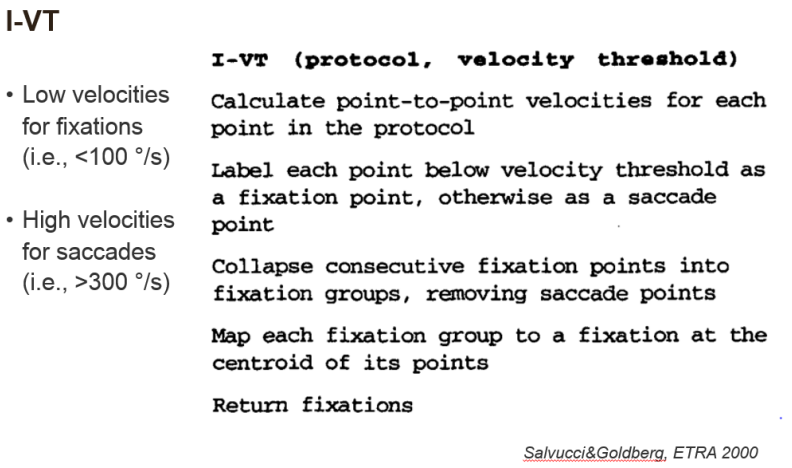

Figure 1: I-VT pseudocode

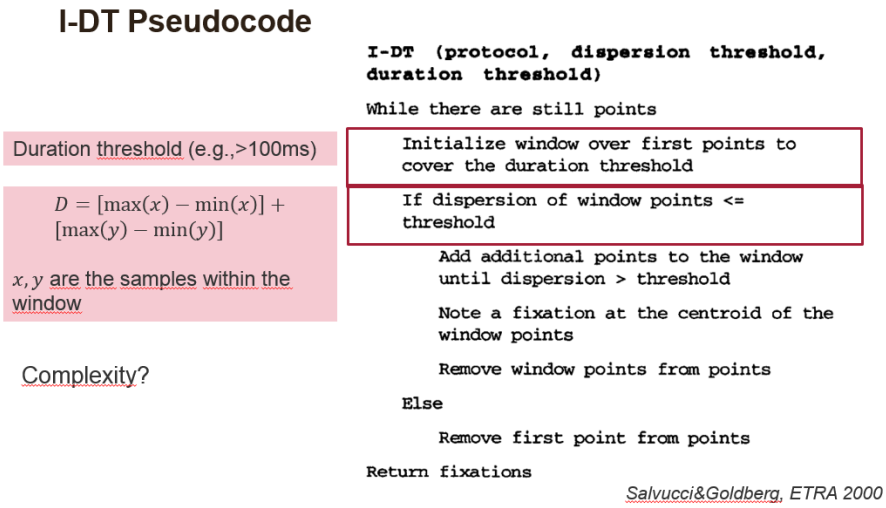

Figure 2: I-DT pseudocode.

Exercise 4: Critical Thinking

1. Choose *meaningful* parameters for I-VT and I-DT. Using these parameters, run the algorithms on the **left eye data**, and plot the resulting centroid for I-VT fixations in **red** and for I-DT fixations in **green**. (Answer in: ivt-vs-idt.jpg)

2. Are the fixations you overlayed in the previous item accurate or are they shifted? If shifted, what's a possible cause for such an inaccuracy? (Answer in: critical.txt)

3. In your opinion, is it better to work with the gaze in pixels (e.g., as given in the data file) or in angles (e.g., as calculated in the previous section) to identify eye movements? Why? (Answer in: detection.txt)