Master’s Thesis Engineering Technology

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Research on the optimal setup for eye tracking and optimization of instruction set with eye tracking

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CONTEXT

This master’s thesis is carries out in cooperation with Arkite, which is a company that transforms workstations into a digital and interactive environment by providing Operator guidance systems. Their main product is called the HIM (Human Interface Mate). Via a projector placed above the workspace, the HIM visually shows real time picking and assembly instructions for a given assembly line and where to find different objects that are necessary inside the workspace. One way to possibly speed up this process is by using an eye tracking sensor.

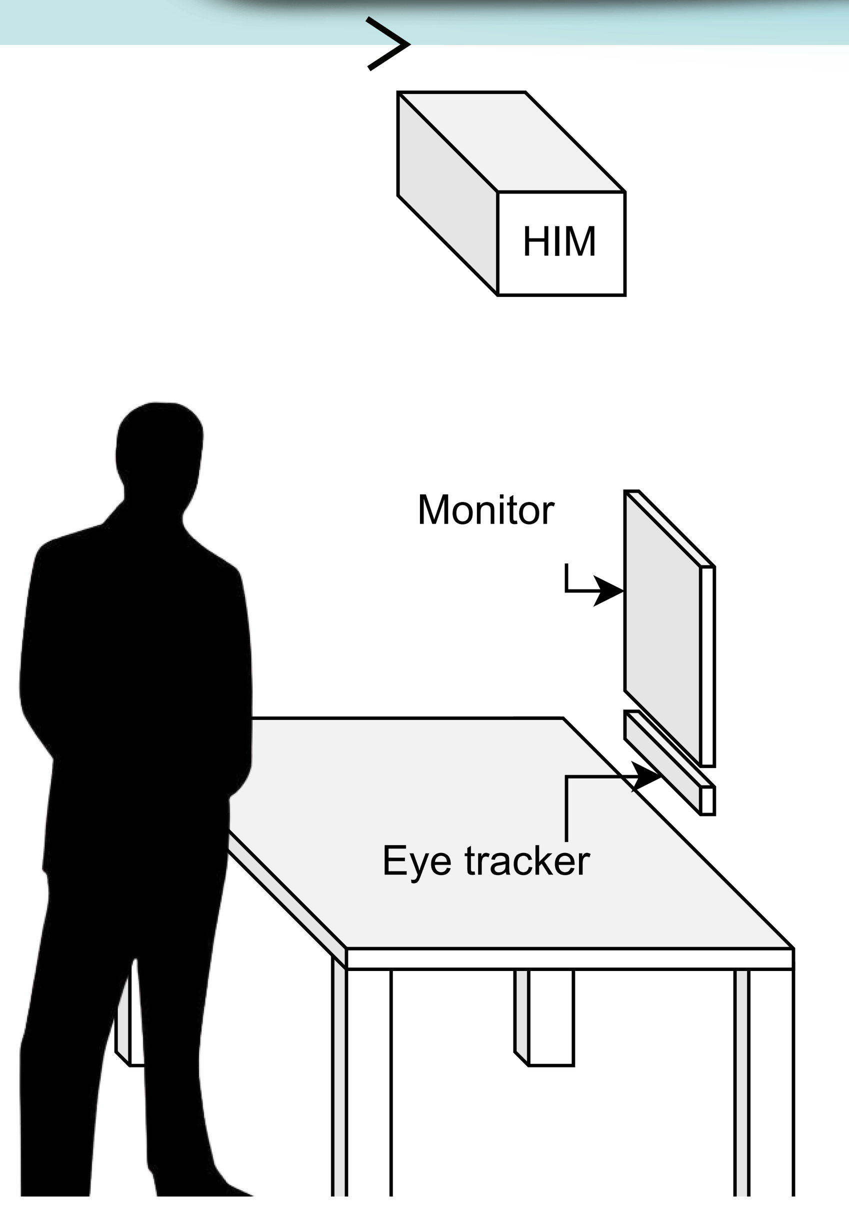
figure 1: HIM from Arkite [1]

A demo application is made to illustrate the use of an eye tracker on an instruction set. These instructions can then be cycled through by only using the eyes. Since the HIM will be used in different kinds of environments, finding the optimal way to use this eye tracker is necessary.

SETUP

The Tobii 4L is a USB-based eye tracker that connects to a host PC. This tracker is meant to be mounted on a screen. When using this tracker, the developer has full control over the software / firmware during the development stage.

To have full access over the software / firmware of the Tobii 4L eye tracker, the Tobii Platform Development Kit (PDK) is needed. This PDK is provided with the tracker. It consists of two important parts, the Tobii Platform Runtime and the Tobii Stream Engine.



METHODOLOGY

During the calibration phase, stimuli points are displayed that gradually get smaller in order to get the focus on one point. In the measurement phase, there are nine stimuli points displayed at specific validation locations. The accuracy and precision of the eye tracking data were determined for the following parameters:

- Number of calibration points,
- Luminous intensity,
- Horizontal, vertical and operating distance,
- Head rotation,
- Different types of glasses and lenses.

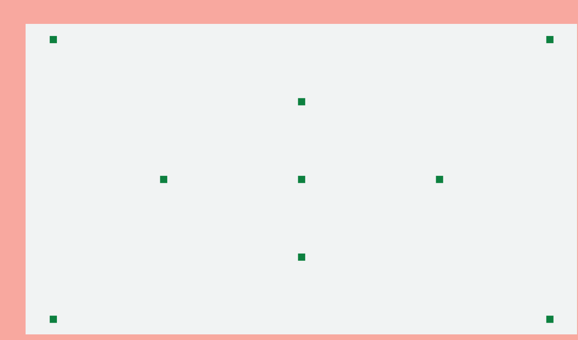


figure 2: Example of 9 point calibration

MEASUREMENTS

The accuracy is calculated as the mean of the distance between the gaze points and the stimuli points in millimeters.

The precision is calculated via the Root Mean Square (RMS) from the distance between successive gaze points. Another way to describe the precision is by using the standard deviation precision (SDP).

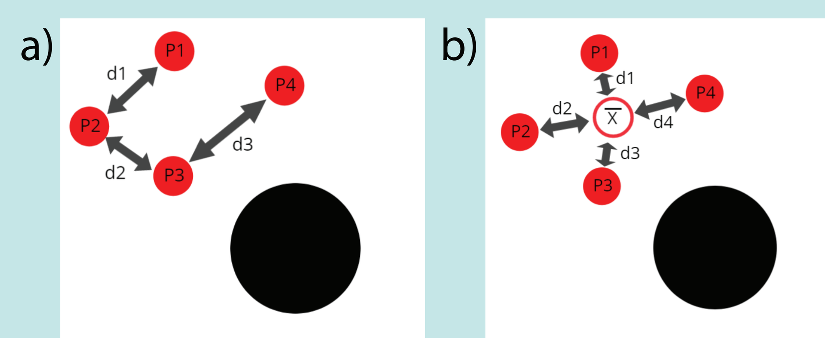


figure 3: Illustration of the distance between a) successive gaze points to calculate precision via RMS. b) the gaze point and the mean of all gaze points to calculate the SDP via SD.

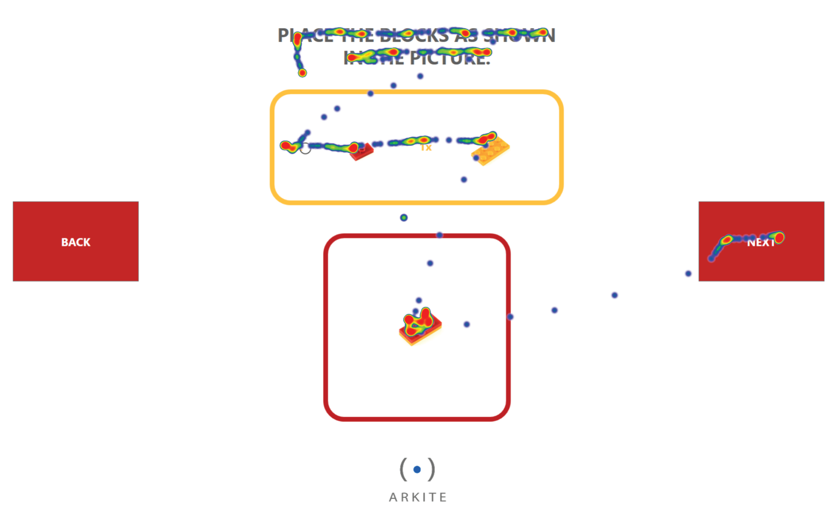


figure 5: screenshot of demo application instruction screen with interactive buttons left and right with heatmap generated by the instruction demo.

CONCLUSION

The following can be concluded from the research. To obtain the best result, the operant should be at the middle of the eye tracker, 34.5 cm above and with an operating distance of 85 cm. The operant should be looking straight to the middle of the screen, and a luminous intensity of 250 lux is recommended.

Comparing the eye tracker version and the mouse-only version, it canbe seen that the eye tracker version scores better for all scales, with an exception of dependability.

DEMO APPLICATION

The Demo Application is conducted with and without an eye tracker. A User Experience Questionnaire (UEQ) compares both experinces with each other.

RESULTS

It is noticeable that direct sunlight (+- 29000 lux) on the tracker or eyes of the test subject makes the measurement impossible. When the calibration is done with glasses, the best results are obtained when these are kept on.

Test	Best result (in pixels)			
	Description	Accuracy	Precision	SD Precision
Gaze calibration	8 point calibration	11.36	2.41	16.66
Light condition	250 lux	16.08	2.62	17.88
Distance (x-axis)	0 cm	14.95	2.54	16.91
Distance (y-axis)	34.5 cm above eye tracker	12.18	2.49	19.84
Distance (z-axis)	65 cm operating distance	16.40	3.10	16.76
Head rotation (horizontal)	0 deg	16.87	2.34	21.03
Head rotation (vertical)	0 deg	15.85	2.74	18.68

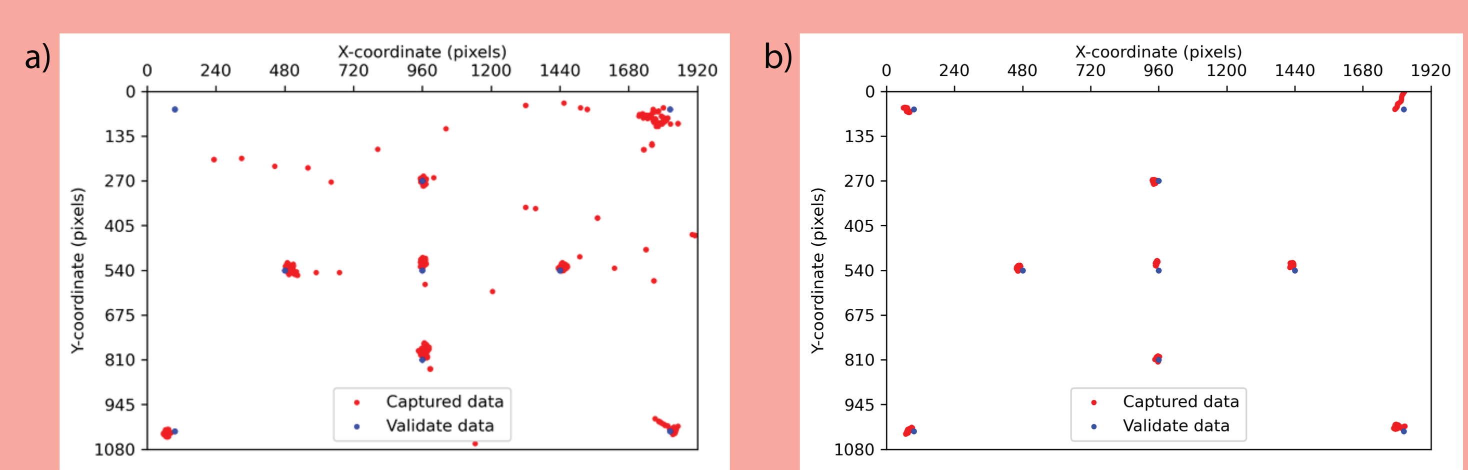


figure 4: a) eye tracking results of correct test by eight point calibration b) eye tracking results of incorrect data by direct sunlight on tracker.

Supervisors / Co-supervisors / Advisors

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