An Eye-Catching Study: Comparing Two Portable Eye-Tracking Systems

Mahmood, T., Prinsen, R., Ma, H., Pacificar, M., Hayward, D.A.
Department of Psychology, University of Alberta

Introduction

Gaze behaviour, recorded using **eye-trackers**, can be used to understand cognitive processes. Head-mounted eye-trackers provide opportunities for research outside of constrained lab environments[1].

In this research, two portable eye-trackers were tested to gain insight on the pros and cons of each eye-tracker, and to determine the settings in which they perform the best.

The purpose of this study is to explore what kinds of data we can collect in the real world while considering the impacts that external factors may have on eye-tracking accuracy. We did this by comparing the Pupil Core and the Pupil Invisible.

Methods

Two tests were conducted for each eye-tracker.

- Stationary test (sitting, free head-movement)
- In-Motion test (walking, free head-movement)

Other considerations include: lighting, people in our field of view, slippage, and adjustments. These factors can impact the users gaze and/or the performance of the eye-trackers.

Figure 1: Pupil Invisible and Pupil Core (left to right), made by Pupil Labs.

Pupil Core

Figure 2: Pupil Core.

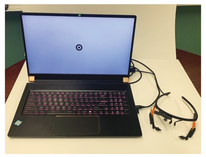


Figure 3: Pupil Core setup and calibration.

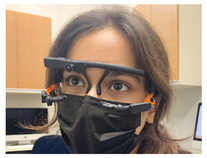


Figure 4: User wearing Pupil Core eye-tracker.

Pros	Cons
• Inexpensive. • Accommodates users with glasses. • Built-in head rest allows for stability. • Camera quality is crisp.	• Uncomfortable for users in public settings. • Multiple calibrations. • Drains battery of device connected. • Connection to laptop or tablet only. • Relies on darkness of pupils.

Pupil Invisible

Figure 5: Pupil Invisible.

Figure 6: Pupil Invisible setup.

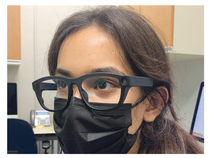
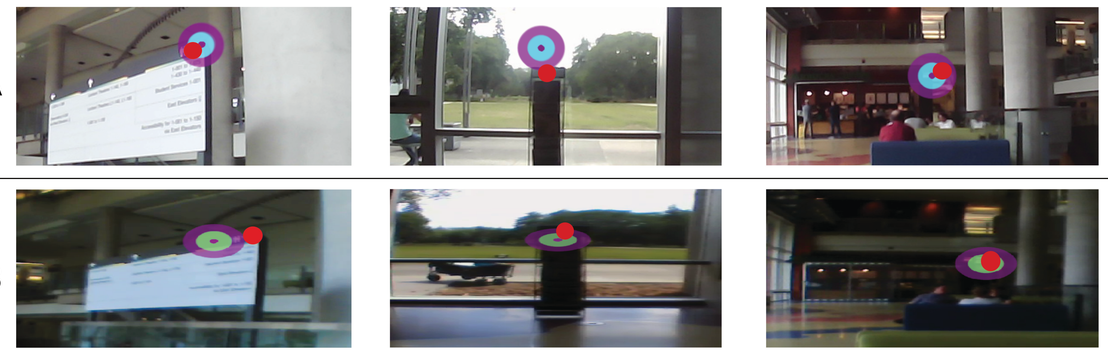


Figure 7: User wearing Pupil Invisible eye-tracker.

Pros	Cons
• Comfortable for users in public settings. • Convenient for moving tasks. • Reduced slippage design. • Calibration not required due to gaze estimation approach[2].	• Expensive. • Less compatible for users with glasses. • Camera quality is blurry. • Lighting has an impact on video visibility.

Legend: Core, Invisible, Point of fixation

Stationary Test Results



In-Motion Test Results

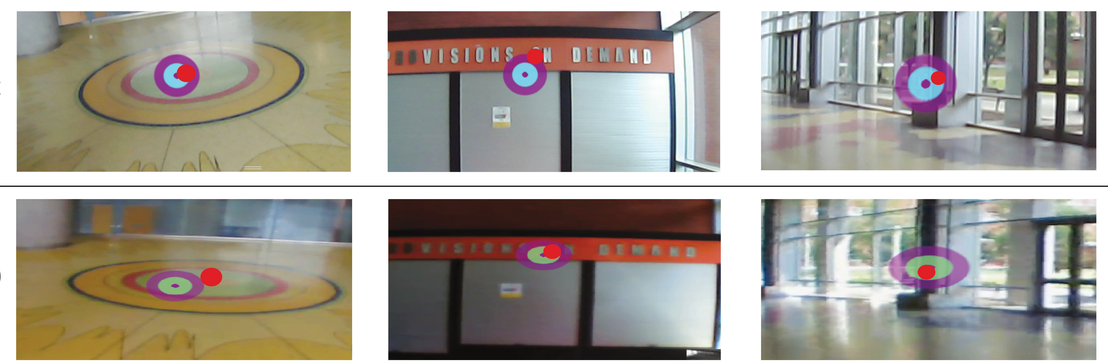


Figure 8: Results and accuracy of the eye-trackers during each test. Targets are shown close to far (left to right). A) Scenes from the Pupil Core stationary test. B) Scenes from the Pupil Invisible stationary test. C) Scenes from the Pupil Core in-motion test. D) Scenes from the Pupil Invisible in-motion test. Through the data, we can see that the Invisible was more accurate when the user fixated on targets at a further distance, whereas the Core performed better with closer targets.

Conclusion/Next Steps

The Core and the Invisible each thrive in different conditions and their limits will have to be heavily considered for future experiments.

- Researchers can identify which eye-tracker will best serve their research.
  - **Pupil Core** would work best for **stationary tasks** in which gaze targets are at a close proximity.
  - **Pupil Invisible** would work best for **in-motion tasks** in which gaze targets may be further away from user.

Through the identification of limits in current eye-trackers, we can make alterations in future eye-trackers to maximize data accuracy as well as other elements such as comfortability.

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References

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(2) Tonsen, M., Baumann, C. K., & Dierkes, K. (2020, September 1). A high-level description and performance evaluation of pupil invisible. arXiv.org. Retrieved July 29, 2022, from https://arxiv.org/abs/2009.00508