Developing Gaze-based Map Interactions

A User Study of Eye-controlled Navigation

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Map interfaces are the provided interaction set which allows a user to connect with the information contained within maps. These interactions define and constrain our ability to explore and use the map. The computer mouse and keyboard are arguably the standard map interface used in a desktop setting, but their speed has physical limits. The viewer's eyes are faster, and has been used before for adapting map content based on viewing behaviour [1]. This work investigates the eyes' ability as a direct control method for map interactions. Specifically, this research aimed to find suitable ways to facilitate map navigation (panning and zooming) using explict eye behaviours.

INTERACTION CONCEPT

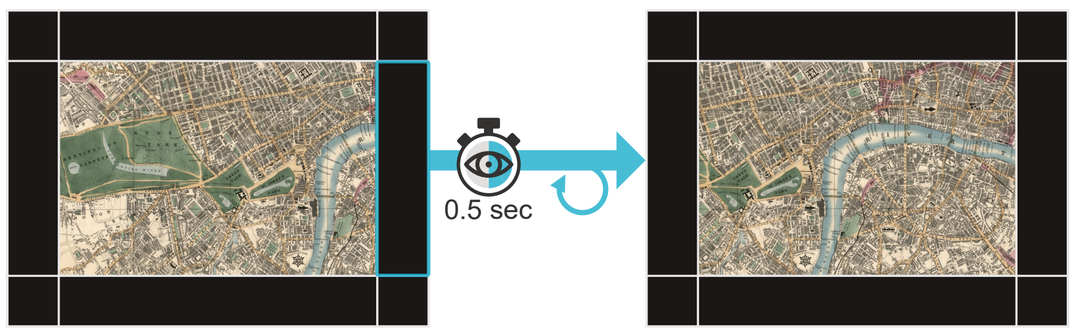
Out of the a set of expected cartographic interactions [2] Panning and Zooming were chosen as the focus for implementation. Identified was a model of interaction using a combination of a pointer and triggers was identified. This was common in both cartographic interfaces (mouse-based) and human-computer interaction research (eye-cursors). It followed that the gaze as a pointer coupled with a physical trigger would allow map navigation.

INTERFACE IMPLEMENTATION

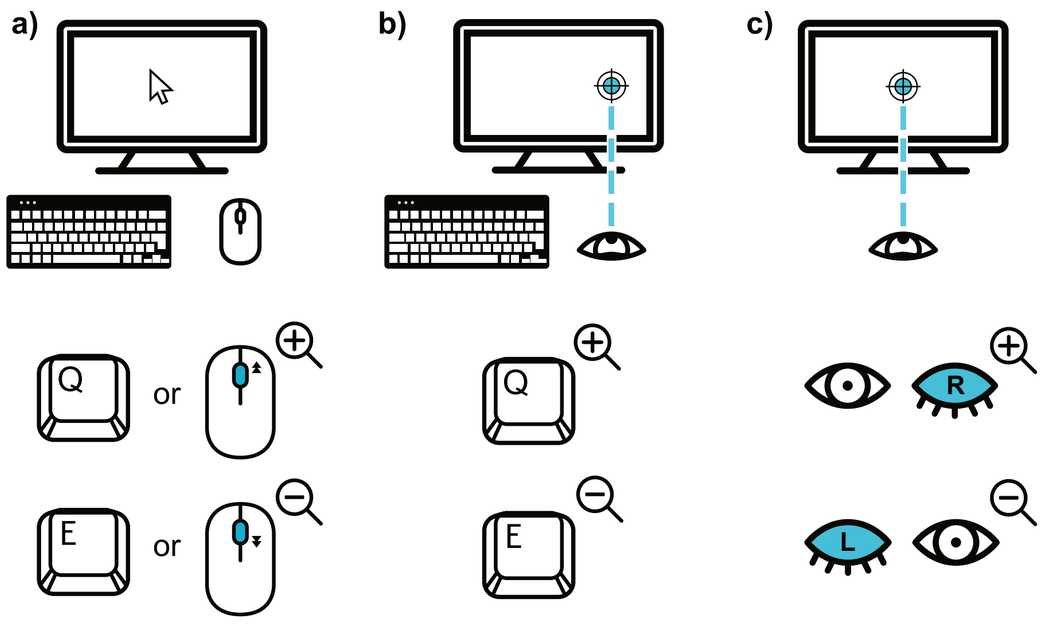
Three map navigation interfaces were created, in Python using PyGame and PyGaze [3] - (a) Mouse & Keyboard, (b) Gaze & Keyboard, and (c) Eyes-Only. User gaze location operated as the pointer, while either the keyboard or eye-behaviour were the interaction triggers.

USER TESTING

A total of 16 participants tested the developed interfaces and provided feedback on usability and user experience after each use. Tests involved timed search tasks (no time limit) for features described verbally to the user. After testing all interfaces, users provided feedback on their ranked preference of the interfaces, pan, and zoom interaction methods.



In the Eyes-Only interface, panning in a desired direction was triggered by staring at the black gaze-aware border regions of the map; panning would continue until the user's gaze left the border region.



The zoom interactions of the developed Interfaces: a) Conventional Mouse & Keyboard Interface, using the mouse scrollwheel for zooming or a pair of keyboard keys, b) Gaze-supported Interface, pressing the keyboard to zoom based on the viewer's gaze location, c) Eyes-Only Interface, where closing an individual eye would zoom based on the other eye's gaze location.

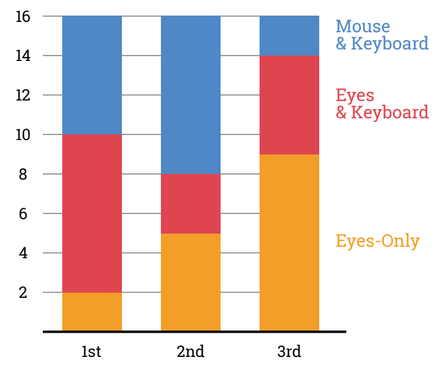
FINDINGS

Users were able to complete all tasks given to them using all of the interfaces developed. Users performed these tasks on average fastest with the conventional interface as expected, followed by the Gaze & Keyboard interface. There was a strong preference by users for this combination interface; users assessed it as somewhat less usable and more stimulating than mouse and keyboard. Some users were able to perform tasks more quickly, than with the mouse and keyboard.

The Eyes-only interface performed more poorly in usability and ease of use, but was more stimulating and exciting for users. However, it had severe issues: occasional erratic or inconsistent system behaviour, and some users' limited ability to wink. Eye-tracking interference due to overhead lights reflecting off of users' glasses also occurred in some tests.

CONCLUSION

Users positively assessed the developed gaze-based interfaces and successfully completed the navigation tasks, despite interface misbehaviour and user ability. Being more stimulating, there is strong potential for gaze-supported interaction to be beneficial to user experience and performance if made stable and reliable.



Post-Study Feedback of Users' Preferred Interface: Users showed an equally strong favour for the combined Eye and Keyboard interface, while the more troublesome Eyes-only interface was less well received. Such remarkably strong preferences for eye-based interfaces is good indication of potential user adoption and success.

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