

Investigating Possible Mobile Device Interaction Approaches Through Combining User Gaze & Tracking Lateral Movement of Mobile Device Using User's Face as Reference Frame

CM50175 - Project Proposal

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1 Project Description

Current SHDs don't typically utilise additional modes of interaction that such devices have to offer. Most interactions with SHDs are performed through the touch-screen, with only specific apps/functions utilising additional modes of input¹. Though the touchscreen is intuitive and can accept gestures beyond finger-presses, it does face some limitations.

It is common for a user to hold a smartphone with one-hand, such that they interact with the screen with just their thumb. This is supported by the introduction/support for one-handed keyboards (keys pushed to the side closer to the hand), and one-handed modes (SAMSUNG, 2021).

There is also active research in developing techniques to allow the user to interact with the whole display, with just their thumb (HAKKA, IKEDA AND SHIZUKI, 2020), which they then followed-up with using non-standard hardware (IKEDA, HAKKA AND SHIZUKI, 2021).

An alternative approach to adding gestures to the thumb, or requiring new hardware, is outlined by VOELKER ET AL. (2020), which looks to use the user's head orientation to select the region within which to place a cursor, which the user can then move with their thumb. HUEBER ET AL. (2020) then extended upon this by providing a 'selection-wheel', which highlights a segment of the wheel based on the orientation of the head.

These techniques were developed with the aim to enhance the user's reachability to all parts of the screen. However with head-tracking there are other ways within which the user's interaction with the device can be enhanced.

Two ways the user experience can be further enhanced involve either: extending application functionality to support head gestures (LÓPEZ ET AL., 2012); or adapting the user interface to the user's perspective, with respect to the device display (FRANCONE AND NIGAY, 2011).

In the former, orientation and distance of the user's head, with respect to the display, is used to adjust hide and show application functionality (such as a bookmarks bar in a browser).

The latter making the interface itself 3D, and rendering the appropriate view based on the user's perspective, such that by moving their head they could either see more within an app, or 'preview' what is present on the next/previous page.

This project aims to build upon the works described above.

It shall involve investigating/developing techniques for tracking the lateral and rotational movement of a smart handheld device (SHD)², which could be combined with user gaze, to permit additional gestures with which the user can interact with the device.

We shall then build an interface for a SHD with which the interaction mode described above can be used to enhance the user's interaction with the device.

This interface can then be evaluated to determine if there is any gained usability to a SHD with the above interaction modes, how comfortable the interaction modes are, and to evaluate the performance of the head/gaze tracking capabilities (potentially comparing them with existing systems).

¹e.g. Map/Navigation Apps - Device Orientation/Movement, Smart Assistant Apps - User Voice, Parallax Wallpapers - Device Orientation

²e.g. smart-phones and tablets.

2 Objectives

2.1 Deliverables

1. An interface for an SHD which can be interacted with via head, gaze, and touch gestures.
2. A report detailing the research, design, development, and evaluation of the interface.

2.2 Requirements

These are the criteria with which the project success shall be evaluated:

1. Must have an interface that can be evaluated (e.g. something that a user can interact with).
 - 1.1. Could mock the interface (e.g. not a proper smartphone launcher, but an app/website representing a smartphone launcher).
 - 1.2. Should evaluate the interface with a usability study.
 - 1.3. Should permit user's to interact with device one-handed (e.g. head/gaze gestures should extend user reach while holding device with one hand).
 - 1.4. Could extend the display with 3rd dimension, adding depth to the interface from user's perspective.
2. Must have working head tracking.
 - 2.1. Should evaluate against similar techniques/systems
3. Should have working Gaze tracking.
 - 3.1. Should evaluate against similar techniques/systems

3 Project Plan

For the execution of the work required for this project an Agile development strategy will be employed.

As such milestones / deliverables will not have specific dates/times³. Instead the Project Plan will primarily indicate the order within which work shall be completed, with start/end dates provided with respect to when in the month it will be expected³.

The overlap between the end of the design sections, the start of their respective development sections, and the start of the write-up sections are to indicate that these can be performed to some extent in parallel. While researching a topic, the write-up can be started (documenting what is being researched), as can the development and testing of the relevant code.

This avoids scenarios where the next section is unable to be started while waiting for 'all' the research to be performed ahead of time. Research and development can be much more responsive, resulting in less wasted time, and allowing more flexibility in the order/effort work is completed in/with.

1. **Research - 2022/04/02 → Beginning of August 2022**
 - 1.1. **Head/Gaze Tracking research - 2022/04/02 → Beginning of July 2022**
 - 1.2. **Gesture Recognition research - 2022/04/02 → Middle of July 2022**
 - 1.3. **Head/Gaze Interfaces - 2022/04/02 → Beginning of August 2022**
 - 1.4. **Literature Review - 2022/04/02 → 2022/05/06**
*Dependent on: 1.1., 1.2., & 1.3.*⁴
1st Draft of the literature review
2. **Development - 2022/05/06 → Beginning of August 2022**
 - 2.1. **Head Tracking - 2022/05/06 → Middle of July**
Dependent on: 1.1.
 - 2.2. **Gaze Tracking - End of May 2022 → Middle of July 2022**
Dependent on: 1.1.
 - 2.3. **Gesture Recognition - Beginning of June 2022 → Middle of July 2022**
Dependent on: 1.2.
 - 2.4. **Interface Prototyping - Middle of June 2022 → Beginning of August 2022**
*Dependent on: 1.3., 2.3., 2.2., & 2.1.*⁴
3. **Testing & Evaluation - End of June 2022 → Middle of August 2022**
 - 3.1. **Evaluating Tracking and Gesture Recognition Performance - End of June 2022 → Middle of August 2022**
Dependent on: 2.1., 2.2., & 2.3.

³Unless a specified submission date/time has been provided for the course. These will be provided in YYYY/MM/DD format.

⁴Though dependencies can be finished later than this draft is submitted, they must be started prior.

- 3.2. Usability Study - End of July 2022 → Middle of August 2022
Dependent on: 2.4.
- 4. Writing the Report - 2022/04/02 → Beginning of September 2022
 - 4.1. Literature Review - 2022/05/06 → Beginning of August 2022
Dependent on: 1.
Final Draft of the literature review.
 - 4.2. Design Write-up - 2022/05/06 → Beginning of August 2022
Dependent on: 1., & 2.
 - 4.3. Development Write-up - 2022/05/06 → End of August 2022
Dependent on: 2.
 - 4.4. Evaluation Write-up - 2022/05/06 → End of August 2022
Dependent on: 3.
 - 4.5. Conclusions & Further Work - 2022/05/06 → End of August 2022
Dependent on: 3.
 - 4.6. Abstract & Introduction - End of August 2022 → Beginning of September 2022
Dependent on: 4.5.

4 Required Resources

4.1 Research

Institutional Paper Access In order to perform research into head/eye-tracking and gesture recognition techniques, access to papers in this field will be required. Through the university library/VPN/log-in, access to relevant papers should not be an issue.

4.2 Hardware / Software

Handheld Smart Devices Android smartphones should already be available, however if study is to evaluate interface on iPhone devices as-well, then an iPhone may be required.

If the study is also required to venture into the world of tablets, a tablet may also be required.

Mobile App Development Software This should be straight-forward for android devices as I should be able to obtain the Android studio without issue, but for iPhone / cross-platform development, I'll need to use Xamarin, as I do not have a MacOS machine.

4.3 People

Experts/Supervisor Time may be required from experts in the domains relevant to the project to aid in the development and evaluation of the techniques and interface.

Study Participants Participants will be required for the usability study that should be performed on the interface.

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