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Navigation of Mobile Based on Eye Tracking Technology

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Abstract: ***This research looks at the navigation of the mobile using the technology of eye tracking to ease the human mobile interaction. This tracking system enables users to interact with the mobile application/functions and navigate without physically touching the device that is using only the movements of eyes and actions (e.g. Blink).This tracks the eye movements of the user to navigate the phones display using the front camera or sensor mounted in front of the phone, machine learning algorithms are used to: i) track the eye and gets its position on the mobile phone's display as a user views a particular area of the mobile or an application and ii) detect eye blinks that emulates touch events to perform the task or activate the target application under view. Using this user does not need to physically touch the phone for navigation purpose. Eye tracking systems have greatly improved, beginning to play an important role in the assistive technology field. Eye tracking relates to the capability of some devices to detect and measure eye movements, with the aim to precisely identify the user's gaze direction on a screen. The acquired data can then be exploited to provide commands to the Mobile or application running for various operations like scrolling and link selection, to be easily performed without using the hands.***

Keywords: eye tracking technology, mobile application, navigation mode

1. Introduction

Human Computer Interaction (HCI) researchers and phone vendors are searching for new approaches and technologies to reduce the efforts of the user occurred when accessing the applications and navigating through menu on some devices like mobile phones and other limited form devices. The most successful innovation of the past few years is the touchscreen technology introduced which was followed by all the other major vendors, such as Nokia and HTC.

The touchscreen has changed the people's interaction with their mobile phones because it provides an simple way to perform various actions and navigate through menus using the movement of one or more fingers on the display (e.g., pincha photo to zoom in and out, or panning to move a map).

The eye tracking navigation system uses eyes to perform various operations which have been performed by finger through touchscreen.

Eye tracking enables recording of eye position and movement based on optical tracking of corneal reflections, thereby making the analysis of eye movements and gaze positions in both 2D and 3D environments possible. It helps to analyse human processing of visual information for interactive and diagnostic applications. Early eye trackers were huge and cumbersome – trackers today can be as tiny as a pencil case, greatly expanding the possible use cases for a more flexible device. Eye tracking measures attention, interest and arousal, making it a great tool for any kind of human computer interaction.

2. Literature Survey

Users have been interested in various technologies on human and mobile or computer interaction. For the past few years, various technologies are being used for human and screen interactions like pointing device, touch screens, stylus, etc.

In 2015 Fu Jiuqiang created an application based navigation for mobile phones in his research he explained all the possible ways of mobile navigation modes and mobile application interface. His study summarized six basic navigation modes about mobile interface, analysed users' eye movement rules for different pages structure and found users' behaviour discrepancy of using navigation through experiment.

Tara Rudnicki in his study introduced a Tobii Technology, is the leading global provider of eye-tracking and gaze interaction-based Augmentative and Alternative Communication (AAC) devices that help improve the individuals with disabilities by making them to communicate and control their devices or mobiles through their eyes.

In 2010 Emiliano Miluzzo, Tianyu Wang and Andrew T. Campbell propose EyePhone, a novel "hand free" interfacing system capable of driving mobile applications/functions using only the user's eyes movement and actions. EyePhone could also be used to detect driver's drowsiness and distraction in cars. While car manufactures are developing technology to improve driver's safety by detecting drowsiness and distraction using dedicated sensors and cameras, EyePhone could be readily usable for the same purpose even on low-end
cars by just clipping the phone on the car dashboard.

3. Methodology

A. Modes of Navigation

There are the various modes of navigation used in mobile phone for navigating through eye tracking mobile interfaces which include making a call, changing some settings, navigating to various menus.
There are 6 navigations modes which are as follows:

a) **Vertical list mode**: The content of mobile phone screen is often vertically displayed, but text is shown in the landscape normally, so the vertically arranged table can contain more information. The length of the list can have no limit, therefore users could view more contents by sliding up and down. Vertical list mode is often visually artistic and neat, so many users are ready to select it, which often be used in showing side elements, including directories, categories, content, as shown in Figure (a).
b) **Horizontal boxes mode**: Horizontal box is a layout mode which can display element horizontally. Some common control, such as toolbar and Cover flow, just uses this mode. Restricted by the screen's width, this mode may display fewer content, but users can slide the screen or click on the arrows to view more content, which needs users to explore actively, as shown in Figure (b).
c) **Nine square mode**: Nine squares is a very classic layout mode, which owns simple appearance and is widely accepted by users, as shown in figure (c).
d) **Tab mode**: TAB layout mode is to display coordinate information through horizontal or vertical tab. Compared with the traditional way of hierarchical structure, the element of TAB mode does not exceed 6, and only has a single level, as shown in Figure (d).
e) **Multi-Layer border mode**: Multi-Layer boards layout mode commonly emerges in PAD terminals, and mobile phones relatively few use it. This mode is often used in traditional desktop software as navigation mode, looking much like a vertical title in screen, which can display more information and be suitable for classification and displaying content, as shown in Figure below(e).
f) **Sidebar Mode:** Sidebar is that page hides the contents first, and then expands as needed. This mode is more nature on the interactive experience and better integrates with original interface. Sidebar is often pulled from the left side of the screen, if it is pulled from the top or the bottom, we commonly call it as Message Manager Bar, as shown in Figure (f).

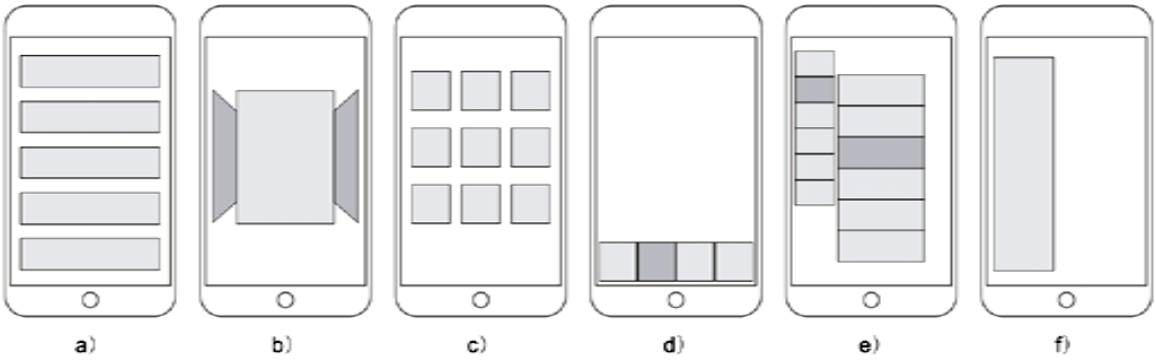

Figure 1.1: Various Modes of Navigation

Here is an example of one type of navigation mode which is nine square mode figure below:

Figure 1.2: Example of Nine Square Navigation mode

B. Working of the navigation sensor

This navigation system uses invisible Infrared light to illuminate the eyes. From there, two extremely high quality camera sensors capture the refection off of the retina and the cornea of the eyes, commonly referred to as “red eye” and the glint, respectively. The eye tracker then uses these two points to build a 3D model of the user’s eyes to determine two things: where the user is looking (gaze point) and where the user’s eyes are in space, relative to the location of the computer (track box). This information is then paired with some algorithms and processes to allow the mobile phone to know exactly where the user is looking with an accuracy of 1cm. The mobile phone can then track the user’s gaze point and, ultimately, tell the phone where their eyes are looking at all times. By knowing where the user’s eyes are looking, the eye tracking device then can control the mobile, similar to the way in which u use fingers to use touch screen for navigation on mobile phone. Movement of the eyes acts as navigation system and blinking of eyes acts as the selection or click events to perform some tasks on mobile phone.

The below image illustrates how infrared sensor detects the eye:

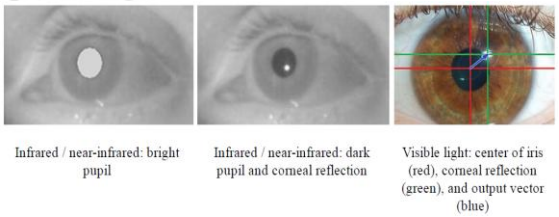

Figure 1.3: detection of eye by Infrared Sensor

This below image illustrates various eye movements for navigation of mobile phone:

Figure 1.4: Ways of navigation through eyes

Eyes represented by camera using algorithms is as follows:

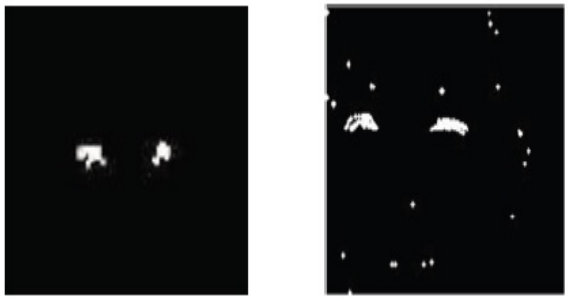

Figure 1.6: Eyes represented by camera

4. Conclusion

Here the infrared sensors or cameras are used to track the position of eyes and send commands by moving the eyes for navigations and blinking for the purpose of selection the menu or item on mobile device. This Eye tracking navigation technology will help users to access the mobile and operate without physically touching the device's screen. Thus solving the problem of many users using their devices in crowded areas for making an urgent call, playing music, surfing the internet, going through mails, and navigating the mobile phone for other purpose. This will allow the user to use their mobile devices where user cannot use both their hand to operate the device.

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