Eye Tracking: Future in Tablets and Smartphones

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ABSTRACT:

Eye Tracking is a technology that is being increasingly employed to study usability issues in Human-Computer Interaction(HCI).In this paper,we take a quick look at the basics of the eye tracking technology and its advances over the years and various ways in which eye movements can be systematically measured to examine interface usability.It describes the issues related with eye tracking in mobile devies and their solutions.The paper also unfolds various opportunities for the eye tracking technology in the field of Smartphones and Tablets.

INTRODUCTION:

Eye tracking is a technique whereby an individual's eye movements are measured so that the researcher knows both where a person is looking at any given time and the sequence in which their eyes are shifting from one location to another.

Tracking people's eye movements can help researchers understand visual and display-based information processing and the factors that may impact upon the usability of system interfaces. In this way, eye-movement recordings can provide an objective source of interface-evaluation data that can inform the design of improved interfaces. Eye movements can also be captured and used as control signals to enable people to interact with interfaces directly without the need for mouse or keyboard input, which can be a major advantage for certain populations of users such as disabled individuals. We begin this Paper with an overview of eye-tracking technology, and progress toward a detailed discussion of the use of eye tracking in Mobile devices and usability research.

1.EYE TRACKING TECHNOLOGY:

The History of Eye Tracking

Many different methods have been used to track eye movements since the use of eye tracking technology was first pioneered in reading research over 100 years ago. Electro-oculographic techniques, for example, relied on electrodes mounted on the skin around the eye that could measure differences in electric potential so as to detect eye movements. Other historical methods required the wearing of large contact lenses that covered the cornea (the clear membrane covering the front of the eye) and sclera (the white of the eye that is seen from the outside), with a metal coil embedded around the edge of the lens; eye movements were then measured by fluctuations in an electromagnetic field when the metal coil moved along with the eyes. These methods proved quite invasive, and most modern eye tracking systems now use video images of the eye to determine where a person is looking (i.e., their "point-of-regard"). Many distinguishing features of the eye can be used to infer point-of-regard, such as corneal reflections (known as Purkinje images), the iris-sclera boundary, and the apparent pupil shape.

How Does an Eye Tracker Work?

There are two main types of eye tracker,both of which use a combination of a camera and in infrared light source that illuminates the eye with bursts of invisible infrared light.Some of this infrared light disappears into the pupil, and some of it bounces off the iris, the cornea , the eyelid or the surrounding skin.All these different parts of the eye reflect different amounts of infrared light, which is picked up by the camera. By analysing the reflections it is then possible to work out where the eye is looking.

Type-1 : Charting someone's gaze as gaze as they use a computer screen or watch television can be done using an eye-tracking device aimed at the user from as far as two meters away.In case of mobile devices, the front camera is used as the receiver and analyzer of the incoming infrared rays and a small transmitter is used to transmit these rays by connecting it to the phone(in-built in future and upcoming tablets) as shown in the Figure 1.

Type-2 : To track someone's gaze as he moves around, a special headset is needed, with extra forward-facing video camera*(C)* that records what the wearer is seeing.Light from an infrared source *(A)* bounces off the lenses of the glasses into the eye-tracking camera *(B)* picks up the eye's reflection in the lenses, rather than imaging the eye directly.The output from the eye tracker is then used to superimpose crosshairs or a coloured dot on the video from the forward-facing camera.

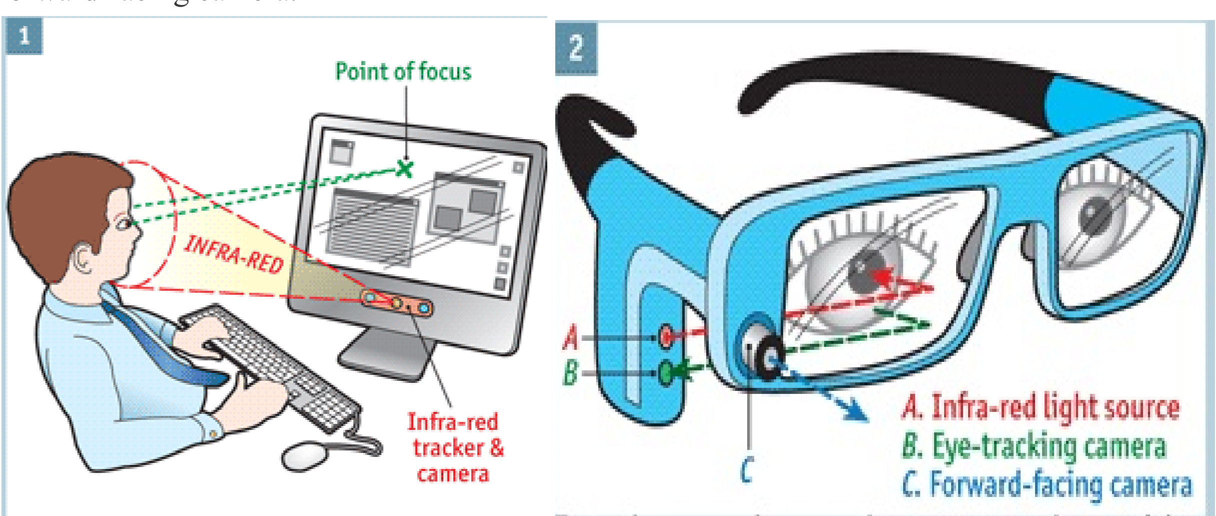

Figure 1: Types of Eye Trackers

2. TRACKING OF EYE MOVEMENTS:

There are several different techniques to detect and track the movements of the eyes. However, when it comes to remote, non-intrusive, eye tracking the most commonly used technique is Pupil Centre Corneal Reflection (PCCR). The basic concept is to use a light source to illuminate the eye causing highly visible reflections, and a camera to capture an image of the eye showing these reflections. The image captured by the camera is then used to identify the reflection of the light source on the cornea (glint) and in the pupil (See figure 2). We are then able to calculate a vector formed by the angle between the cornea and pupil reflections – the direction of this vector, combined with other geometrical features of the reflections, will then be used to calculate the gaze direction.

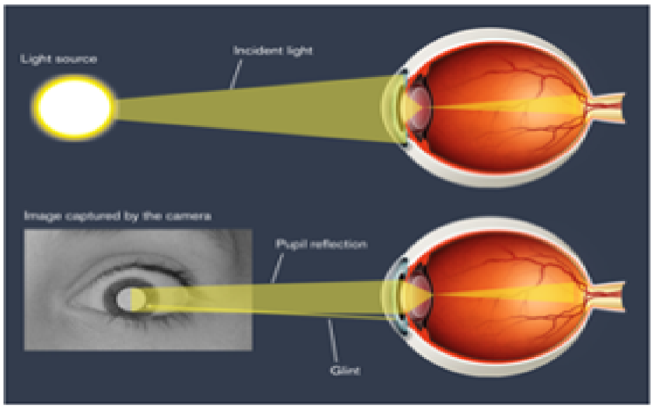

Figure 2: Pupil Cntre Corneal Reflection Technique(PCCR)

Near infrared illumination is used to create the reflection patterns on the cornea and pupil of the eye of a user and two image sensors are used to capture images of the eyes and the reflection patterns. Advanced image processing algorithms and a physiological 3D model of the eye are then used to estimate the position of the eye in space and the point of gaze with high accuracy.

Dark and Bright Pupil Eye Tracking:

There are two different illumination setups that can be used with PCCR eye tracking: bright pupil eye tracking, where an illuminator is placed close to the optical axis of the imaging device, which causes the pupil to appear lit up (this is the same phenomenon that causes red eyes in photos); and dark pupil eye tracking where the illuminator is placed away from the optical axis causing the pupil to appear darker than the iris.

There are different factors that can affect the pupil detection during remote eye tracking when using each one of these two techniques. For example, when using the bright pupil method, factors that affect the size of the pupil, such as age and environmental light, may have an impact on trackability of the eye. Ethnicity is also another factor that affects the bright/dark pupil response: For Hispanics and Caucasians the bright pupil method works very well. However, the method has proven to be less suitable when eye tracking Asians for whom the dark pupil method provides better trackability.

What does eye tracking data tell us?

Eye tracking analysis is based on the important assumption that there is a relationship between fixations, our gaze and what we are thinking about. However, there are a few factors that need to be considered for this assumption to be true which will be discussed below.

First, sometimes fixations do not necessarily translate into a conscious cognitive process. For example, during a search task one can easily fixate briefly on the search object and miss its presence, especially if the object has an unexpected shape or size (commonly called change blindness). This happens because our expectation of what the object (or scene) should look like modulates our visual attention and interferes with the object detection. This effect can be eliminated from a test if you give clear instructions to the participant, and/or follow up the eye tracking test with an interview to assess the participant's motivations or expectations.

Second, fixations can be interpreted in different ways depending on the context and objective of the study. For example, if you instruct a participant to freely browse a website (encoding task), a higher number of fixations on an area of the webpage may indicate that the participant is interested in that area (e.g. a photograph or a headline) or that the target area is complex and hard to encode. However, if you give the participant a specific search task (e.g. buy a book on Amazon), a higher number of fixations are often indicative of confusion and uncertainty in recognizing the elements necessary to complete the task. Again, a clear understanding of the objective of the study and careful planning of the tests are important for the interpretation of the eye tracking results.

And third, during the processing of a visual scene, individuals will move their eyes to relevant features in that scene. Some of these features are primarily detected by the peripheral area of our visual field. Due to the low acuity, a feature located in this area will lack shape or color detail but we are still able to use it to recognize well known structures and forms as well as make quick, general shape comparisons. As a result, we are able to use the peripheral vision to filter features according to their relevance to us, for example, if we generally avoid advertisement banners on webpages, we might also avoid moving our eyes to other sections of the webpage that have a similar shape simply due to the fact that our peripheral vision "tells" us that they might be banners. The current eye tracker technology will only show the areas on the visual scene that the test subject has been fixating at and the jumps between them (i.e. not the whole visual field). Thus, to fully understand why a test person has been fixating on some areas and ignoring others, it is important that the tests should be accompanied by some form of interview or think-aloud protocols.

3.EYE TRACKING IN SMARTPHONES AND TABLETS:

The popularity of smartphones and mobile apps is exploding. In the increasingly competitive race for market share, every software or hardware interface modification that delivers better usability could make a difference. Eye tracking can help usability professionals decisively select and recommend appropriate, effective designs. Effective mobile interface designs can help product and service companies to better serve their customers and leverage the capacity of mobile marketing.

Eye-tracking systems for desktop computers have been around for decades—for instance, to conduct laboratory experiments and to help disabled people control their machines. But these systems often require bulky external hardware and complex algorithms that demand ample processing power. So there are huge challenges when trying to adapt the technology for mobile devices.

One of the challenges include overcoming instability.As the device is mobile, the user is not expected to sit in fornt of it stable all the time. As a result, the eye tracking software should be able to differentiate between movements of the eye and movements of the user.Due to recent developments, there are now softwares which are able to achieve this by pulling the data from a smartphone's various sensors, including its gyroscope, accelerometer, and compass. The system then combines the results with image data to filter out unwanted information.

Another problem is of computing resources. Eye tracking needs to be something that can run almost invisibly in the background of any application. Three years ago, when Umoove, a Company working on eye tracking software for smartphones, began pursuing mobile eye tracking, its engineers thought they could borrow many of the algorithms used in PC-based systems. They ran their first program on a Nokia smartphone, because it was one of the only models with a front-facing camera.Within about 3 seconds, the phone crashed.That's when they realized, those algorithms were not feasible for smartphones and they needed to built new ones and start from scratch as eye tracking in phones and in PCs are two completely different things.

FUTURE IN SMARTPHONES AND TABLETS:

Until now, the eye tracking technology has been used in mobiles to analyze viewing patterns on a website.It allowed to track which elements of the website have been noticed and for how long.

We believe, the eye tracking technology has much more to offer in the field of mobile devices. Active applications involve device control, for example aiming in games, eye activated login or hands-free typing. Passive applications include performance analysis of design, layout and advertising.A company named,EYE TRIBE ,now sells a complete Eye Tracker SDK toolkit for developers to create applications involving this technology.It has also created a prototype version of the game FRUIT NINJA where the fruits are cut as one looks at them. Also SAMSUNG's flagship phone ,Galaxy S4 had included this technolgy in the form where videos would stop playing it the user looks elsewhere.The technology is slowly evolving in this field and could very be the backbone of future smartphones and tablet pcs.

CONCLUSION:

Our contention is that eye-movement tracking represents an important, objective technique that can afford useful advantages for the in-depth analysis of interface usability. Eye-tracking studies in Mobile device interfaces are beginning to burgeon, and the technique seems set to become an established addition to the current battery of usability-testing methods employed by commercial and academic researchers. This continued growth in the use of the method in Smartphones looks likely to continue as the technology becomes increasingly more affordable, less invasive, and easier to use. The future seems rich for eye tracking and Smartphones and Tablets.

More robust experiments for different subjects, different phones and different environments are essential for these techniques to be employed routinely in smartphones and tablets.

GLOSSARY

Eye tracker: Device used to determine point-of-regard and to measure eye movements such as fixations, saccades, and regressions. Works by tracking the position of various distinguishing features of the eye, such as reflections of infrared light off the cornea, the boundary between the iris and sclera, or apparent pupil shape.

Eye tracking: A technique whereby an individual's eye movements are measured so that the researcher knows where a person is looking at any given time, and how their eyes are moving from one location to another.

Fixation: The moment when the eyes are relatively stationary, taking in or "encoding" information. Fixations last for 218 milliseconds on average, with a range of 66 to 416 milliseconds.

Gaze: An eye tracking metric, usually the sum of all fixation durations within a prescribed area. Also called "dwell", "fixation cluster", or "fixation cycle". **Regression:** A regressive saccade. A saccade that moves back in the direction of text that has already been read.

Saccade: An eye movement occurring between fixations, typically lasting for 20 to 35 milliseconds. The purpose of most saccades is to move the eyes to the next viewing position. Visual processing is automatically suppressed during saccades to avoid blurring of the visual image.

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