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Applying Eye Tracking in Information Security

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Abstract

In this paper, we are considering the possibility of using eye tracking technology in the context of information security. We expect that this novel technique will have a very effective impact in this field. Eye tracking technology is widely used to investigate user behavior when working with a computer. This technology allows to obtain analysis in the form fixation point (location of a user's eye gaze), scan-path (gaze trajectory), heat maps (areas of interest), salient picture components. Eye tracking research has been widely used to improve the design and usability of web pages, as well as to explore an understanding how users are guided by them. Moreover, this technology is widely used in the protection of information.

Keywords: eye tracking; data security; gaze tracker; identification; electronic documents; security policy.

1. Technology of eye tracking

Eye tracking is the technology to highlight the eye movement. The device of implementing the eye tracking is an eye tracker. The techniques to obtain the eye movement data can be conceived in two types: to measure the eye position relative to the head, and to measure the eye orientation in space, namely "point of regard", in which the latter type is widely used for interactive applications. Nowadays, the current most widely adopted eye trackers are designed to detect the point of regard on the basis of the corneal reflection [1].

The video-based method is one of the four broad categories of eye movement measurement methodologies i. e. the Electro-OculoGraphy(EOG) tracking, the eye-attached tracking, the optical tracking, and video-based

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combination of pupil/corneal reflection mentioned above.

The EOG method once was the main stream method around 40 years ago. It relies on the electric potential of the skin surrounding the ocular cavity. Therefore, the eye trackers based on the EOG measurement were usually designed as embedded and wearable devices. This method demands low computational power and it can as well monitor the eye movement while the tester is sleeping. The main disadvantage of this method is the low accuracy thus it can hardly provide precise eye movement data about the gaze direction [2].

Fig. 1. Example of an EOG measurement device.

The eye-attached tracking i. e. to attach scleral contact lens or search coil to the eyes is a precise method to measure the eye movement [3]. The attachment such as a contact lens with an embedded mirror or magnetic field sensor are quite sensitive to record the eye movement, however certainly the attachment will cause discomfort to the tester.

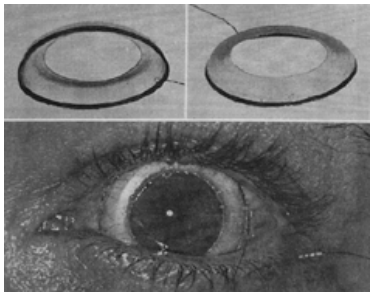

Fig. 2. Example of a search coil adopted for eye movement measurement.

The optical tracking includes Photo-OculoGraphy(POG) and Video-OculoGraphy(VOG) methods, adopts reflected light source (typically infrared light) from the eye and sensed by a video camera or some other particular optical sensor. Occasionally this method demands the testers to keep their head fixed [3].

Fig. 3. Example of an infrared reflection measurement.

The video-based combined pupil/corneal reflection method provides two key features i. e. the corneal reflection (a.k.a. the Purkinje reflections [4]) and the pupil center to monitor the regard point. This method is adoptable for low-priced cameras to compute the regard point in real-time, which offers the potential promise to be available to generalize the application.

Fig. 4. Example of the usage of a video-based eye tracker.

2. Eye Tracking in research works

In the research sphere, the use of eye tracking dates back to the first half of the 18th century. Some of the earliest devices relied on putting a plaster of Paris covering over the eye with sticks attached pointing outward. The sticks indicated the position of the eye relative to what the participant was looking at. Later eye trackers still used eye coverings but utilized devices similar to today's contact lenses.

Nowadays, eye tracking is extensively used in studies of psychology, in the field of marketing, web design to improve and optimize the webpage. It is also used as an auxiliary interface device for people with disabilities.

Eye tracking has come a very long way from its earliest years of being highly invasive for users and extremely complex to use, to a nearly unobtrusive and researcher-friendly technology. The last 10 years have been a golden age for eye tracking in user research.

Eye trackers are now being widely used to understand how users interact with a variety of devices and software from websites to video games. They can also be used to gain deeper insights into how certain audience groups view and interact with interfaces differently, and help researchers identify and address issues that affect the usability of their solutions.

The chapters that follow provide a more in-depth exploration of how eye tracking is used in the user experience (UX) field at large. The fundamental capabilities of eye-tracking hardware and software provide a highly accurate, objective understanding of the patterns of eye movement and what grabs and sustains the user's attention. Currently, eye tracking technology is widely used in the field of e-learning. Eye tracking technologies can support several types of perception processes and verbal/visual user performances. Eye tracking methods have opened many new possibilities in examining cognitive processing and providing a comprehension of reasoning and mental imagery, so additional research in this area is fully justified. In paper «Integration of Eye Tracking Technologies and Methods in an E-learning System» examines an e-learning environment where eye tracking technologies can be used to observe user behaviour in order to adapt content presentation in real-time, to identify a method by which real time psychopathological response data can be collected, analysed, and implemented without compromising the learning experience.

There are many advantages to combining learning systems with eye tracking technologies. In the article, the authors proposed 7 recommendations for the improvement of e-learning systems with eye tracking technologies:

- Learning style identification.
- User interface usability
- Tracking a learner's course progress
- Identifying important teaching areas.

- Automatic tagging.
- Lesson progress.
- Determining a learner's mental state.

Use of eye tracking technologies in e-learning environments provides an opportunity to unfold learner activities in real time. The data collected with eye tracker devices gives a significant amount of information about a learner's cognitive state. The most important measures are responsible for information about the learner's level of attention, concentration, tiredness, relaxation, stress, as well as successfulness in learning and task solving. To achieve this, it is necessary to consider both the way learning activities are carried out and the eye signals that can be related to the user's "emotional states". In order to do that, we considered all of these measurements and rules listed together and compared them in order to find similarities and differences, as well as determine new directions for future research. In this paper we emphasised the most important opportunities that eye tracker can provide [5].

Usually eye trackers are used for desktop applications, in article [6] the authors used a cheap device to develop a system that would be used in a car without a monitor. In collaboration with Automotive Safety Center (ASC) of Vairano di Vidigulfo (Pavia, Italy), whose track is the official trail used to test cars reviewed by the Quattroruote Italian magazine, they have implemented a low-cost eye tracking system that can provide significant information about the driver's gaze. This information can then be exploited by instructors to explain to novice drivers how to behave in different situations. The authors were able to calibrate and use an inexpensive eye tracking system that can detect and record driving while driving.

A partial drawback of the current implementation is the limited width of the virtual screen, that constrains the usable windshield area within which the driver's gaze can be detected – rightward glances are not sensed if the eyes are outside the eye tracker's range. The use of two eye trackers could extend the horizontal size of the virtual screen, although further challenges would need to be considered (e. g., the management of the two devices and their synchronization). Another possible improvement of the developed system could be the use of voice commands instead of the key/button press. Also, it would be interesting to test the system on other car models, with different curvature angles of the windshield and different distances between eye tracker and driver.

3. Use eye tracking in data security issues

Tracking of the eyes is also widely used in the field of information security. In the article "Setting safety precautions: a long-term research of habitation through the problems of fmri, eye and field experiments", it is described a research in the field of information systems and human-computer interaction. The study showed that addiction – reducing the response to re-stimulation – is a serious problem and lead to warnings about safety with effectiveness. With the help of several experiments, the authors solved two problems: the habituation in neurobiological housing, and when habituation negatively affects actual safety compliance.

"We added to past research by examining habituation longitudinally, both via fMRI and eye tracking, as well as through a field experiment involving security warning adherence. Our results illustrate that habituation occurs over time at the neurobiological level. We also demonstrated that exposure to repeated warnings results in diminishing security warning adherence. Finally, we showed that polymorphic warnings are effective in reducing habituation over time, manifested as both attention at the neurobiological level and in actual security warning adherence" [7].

Studies have also been carried out on user habituation in everyday life. Users are usually accustomed to closing warning windows without reading them, when installing third-party programs, thereby violating the simple rules of security and privacy of a personal computer. The authors of the article "Look Before You Authorize: Using Eye-Tracking To Enforce User Attention Towards Application Permissions" attempted to force users to activate the consent button only after reading the dialog box before clicking on it [8].

In the work "Preventing Lunchtime Attacks: Fighting Insider Threats With Eye Movement Biometrics" the possibility of the behavior of the eyes of users as a new biometric basis is considered.

"In a controlled experiment we test how both time and task familiarity influence eye movements and feature stability, and how different subsets of features affect the classifier performance. These feature subsets can be used to tailor the eye movement biometric to different authentication methods and threat models. Our results show that eye movement biometrics support reliable and stable identification and authentication of users. We investigate different approaches in which an attacker could attempt to use inside knowledge to mimic the legitimate user. Our results

show that while this advance knowledge is measurable, it does not increase the likelihood of successful impersonation. In order to determine the time stability of our features we repeat the experiment twice within two weeks. The results indicate that we can reliably authenticate users over the entire period. We show that the classification decision depends on all features and mimicking a few of them will not be sufficient to trick the classifier. We discuss the advantages and limitations of our approach in detail and give practical insights on the use of this biometric in a real-world environment" [9].

4. Planning further research work and conclusion

The above words allow us to understand that eye tracking has a wide application. Tracking the eyes of users in the field of information security will provide us with additional useful information for the analysis and identification of vulnerabilities in management systems by electronic documents.

For carrying out our experimental works we have chosen a tracker "Eyetribe". Despite the modest price tag, in certain situations, it has very satisfactory accuracy and can produce good output data.

In the planned automated environment for working with electronic documents, the introduction of an eye tracker will be effective for the following purposes:

- Analysis of the user when working with a computer to create a personal user profile as a specific method of identification. If the behavior of the user changes, the system will request an additional identification method again (electronic key, password).
- Additional metadata when creating, changing, sending and receiving an electronic document. Metadata will help to influence when a conflict situation occurs in the system.
- Analysis of the electronic document to improve security and integrity. The analysis will affect the improvement of the structure of the electronic document with the help of thermal maps on the document. Will help understand what parts are often interesting to users.

Thus, summing up it can be said that the application of eye tracking technology can affect the electronic workflow. By doing an analysis of user behavior, you can understand what aspects are of interest to users, which parts of the document are more susceptible to the interests of intruders.

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