Expert control system of convenience of User Interface

Mikhail Smirnov, Diana Ilina, Iliya Lysenkov
Nizhny Novgorod State University
Gagarin Ave, 23, Nizhny Novgorod, Russia
mishasmirnov@yandex.ru, ilina.diana@gmail.com

Abstract

Human-Computer Interaction researchers and phone vendors are continuously searching for new approaches to reduce the effort users exert when accessing applications on limited form factor devices such as mobile phones.

This work is devoted to assessing the convenience graphic interface of software for mobile devices. Score convenience GUI software is sufficiently complex and ambiguous challenge. There are many methods which help to overcome this issue such as measuring, registrational, organoleptic, calculated, expertise, and sociological. As a rule, all mentioned methods require participation of experts or testers [1].

In this article we propose the method of assessing the convenience graphical user interface (UI) that does not require the participation of third parties, i.e. process will be automated. To automate the process you can use the trajectory of user's eye movement over the test object. By analyzing this trajectory, we can draw conclusions about the most uncomfortable elements for user and decide to change them.

For mobile devices, this challenge could be solved by using the front built-in camera which is very weak today. So in the early studies used simple digital camera. But we believe the rapid development of communication technologies enable mobile devices to perform this task only from their own resources.

We present a prototype implementation our system on a Nokia N900[6], which is capable of tracking the position of the eye on the test image, mapping this position.

Index Terms: GUI, usability, eye - tracking, eye movements, saccades, mobile phones, machine learning.

I. INTRODUCTION

As smartphones evolve researchers are studying new techniques to ease the human-mobile interaction. We propose expert control system of convenience of UI for adaptation of it to a specific user, because this task is one of the most important in the development of software but implementation of this feature is complicated by people's wide range of interests, attitudes, and other variables. The solution can be realized by monitoring and analyzing the user’s eye movement.

Nowadays there are variety of methods for estimating the convenience of a graphical interface, such as measurement, registrational, organoleptic, calculated, experiences and sociological methods, some of them imply the existence of several qualified experts, the presence of testers, the rest working directly with the user but all of them takes a longer time and relatively high costs. Some methods are based on the analysis of attention, but the tools for it are also expensive.

We take a different approach than that found in the literature. Our system use the eye movement of the user captured using the phone's camera for analysis, adaptation of an interface and to trigger actions on the phone. The system uses computer vision and machine learning techniques for detecting the eye.

We implement our eyes-tracking algorithm using the camera Nokia N900 tablet and present experimental results in different settings. These initial results demonstrate that our system that our system is capable to adaptation of an interface and for driving the mobile phone.

The paper is organized as follows. In MAIN PART, we discuss the challenges encountered in the development of eye-tracking technology and we discuss about the physiological of eye movement. We present the design of the system followed by its evaluation. In CONCLUSION PART we present some concluding remarks and the future research direction.

II. MAIN PART

A. EYE–TRACKING

Eye tracking is the process of recording the fixation and movement of the point of gaze. It offers analyze the cognitive processes involved in user interaction with websites, physical products, and video, printed media materials and other

Nowadays tracking eye movements (eye tracking) is closely linked with the technology of infrared radiation [2][3]. Eye illuminates by harmless to view infrared beam and a special camera captures the reflected gleam of the cornea and the position of the pupil of the eye, passing the data to the computer, which, in turn, makes the necessary calculations, which give an indication on the status of the eye. Another way to study eye movements, including coverage of eye light source, receiving the video eyes on a computer screen, binarization of each recorded video frame, with subsequent analysis

However, those devices that operate reliably and with high accuracy using infrared cameras have a high cost. This increases the price of such systems and prevents their spread.

The aim of our study is to establish a system for monitoring eye movements, which could work with existing user cameras (digital camera, webcam, camera, built into a laptop or phone).Now we use camera Nokia N900 tablet for our experiment.

As part of this work, we create the algorithm, which takes into account the peculiarities of mobile devices. Algorithm determines the coordinates of pupil of the eye under the condition of fixed user's head and using the camera Nokia N900 tablet.

At the beginning of the experiment the user's head is fixed, and then the user ought to look at the screen or test image. The camera Nokia N900 tablet registers the displacement of the eye movement. The video save on the computer and analyzes with a computer program.

Our algorithm works with per-frame of video uses computer vision and machine learning techniques, after algorithm creates record the trajectory of pupil of the eye [3][4][5].

The results of the algorithm figure 1**.** A video of the demo can be found at site www.fruct.org[11].

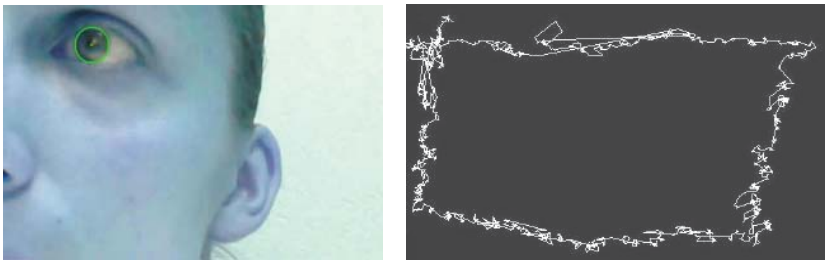

Figure 1. Eyes-tracking algorithm work, which using of the camera Nokia N900 tablet

B. PHYSIOLOGICAL RESEARCH

This part is devoted to the algorithm of analysis trajectory the eye movement. Our algorithm based on the physiological research of eye movement. After receiving the of eye movements trajectory, we may go to the next stage of the research — analysis of eye movements' trajectory (saccade).

A saccade (pronounced / sækad/, sa-KAAD) is a fast movement of an eye, head or other part of an animal's body or device. It can also be a fast shift in frequency of an emitted signal or other quick change. Saccades are quick, simultaneous movements of both eyes in the same direction [7][8][9].

The previous researches show that every person has their own pattern - saccades following pattern which is determined by three parameters: the interval between saccades, their amplitude and orientation [10].

There is the especial eye movement pattern when user looking on object or reading book. For example, when the text goes from left to right, the point of sight jumps along rows in the same direction with fast saccades. When the eye reaches the end of the line, it usually comes back to the beginning by the single saccade to the left.

During work on the study the physiological research of eye movement we create algorithm, which identified simplest non-physiological types of saccades:

- Return saccade - a logical transition from one area of interface to another with following return
- Multisaccade - moving between the two logical areas by more than one saccade

Also we can point out such phenomenon as unevenness of saccades' distribution (the density of saccades' fixation points over an image). Based on saccades' distribution it's able to identify the attention areas. The main modes of the program are presented in Figure 2:

- The main type of applications such as Document-View
- Opportunity to work with multiple copies of one image
- Opportunity to work with different image
- Construct transitions between areas of attention;
- Construct attention distribution map;
- Show of inconvenient saccades (multisaccades).

Figure 2. Application Interface analyzing the user’s eye movement

The aim of further research is developing an algorithm based on saccades' analysis which will be able to identify an inconvenient GUI element for a certain person automatically.

III. CONCLUSION

Usability is now recognized as an important software quality attribute, earning its place among more traditional attributes such as performance and robustness.

In this paper, we have focused on developing a system for adaptation of an interface to a specific user. The solution realized by monitoring and analyzing the user's eye movement (eyes-tracking technology solely using one of the phone's growing numbers of onboard sensors, i.e., the camera Nokia N900 tablet).

We presented the implementation of the proto-type our system. We are currently working on improving the algorithm definition of the boundaries the pupil of eye. Preliminary, our results indicate that our system is a promising approach to adaptation of an interface and for driving mobile applications in a hand-free manner.

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