Expert Control System of Convenience of User Interface

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Abstract

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. In most cases, to solve the problem using various methods such as measuring, registrational, organoleptic, calculated, expertise, and sociological. As a rule, all above mentioned methods require the participation of third parties, such as expert or a tester.

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

For mobile devices, this problem can be solved by using the front camera. At the moment such camera are very weak, so in the early studies used simple digital camera.

But the rapid development of communication technologies, it is expected that mobile devices will be able to perform this task only from their own resources.

In the present paper presents an approach for determining the trajectory of eye movements (Eye Tracking) using mobile camera devices, as well as an analysis of the trajectory of eye movements to find inconvenient for human elements.

Index Terms: usability, eye - tracking, eye movements, saccades, GUI.

I. INTRODUCTION

Adaptation of an interface to a specific user is one of the most important tasks in the development of software. The solution of this problem is complicated by users' wide range of interests, attitudes, and other settings. The solution to this problem can be realized by monitoring and analyzing the user's eye movement.

Evaluation of comfort a GUI for mobile devices is a rather ambiguous task, because of the peculiarities of mobile devices, such as the small screen, rapidly growing capabilities of such devices.

A possible solution to the problem of assessing the convenience graphical interface is the automatic adaptation of the program interface to a user in the process of its work.

Nowadays to assess the convenience of a graphical interface using various methods, such as measurement, registrational, organoleptic, calculated, experiences and sociological, some of them imply the existence of several qualified experts, the presence of other testers, the rest working directly with the user everything takes a longer time and money costs. Some methods are based on the analysis of attention, but the tools for it are also expensive [1].

Currently there are no tools on the market analysis of the quality of graphical interfaces that are available to small and medium-sized companies. An inexpensive mechanism to evaluate the convenience of a graphical interface can be implemented directly on the device using the front of the camera, which would could capture eye movements and analyze them.

Determine the coordinates of the pupil (of the eye) of the first problem that arises in the course of the study. On this issue there is enough work, but these solutions do not work when using mobile phones. Moves eyes - saccades reflects people's reactions to what is happening on the screen. Each user has its own special way of eye movements, which is determined by three parameters: the interval between saccades, their amplitude and orientation [2]. Review and consider these options, you can adapt the interface for a specific customer.

Saccades - it is fast, strictly coordinated eye movements that occur simultaneously in the same direction. The largest number of saccades to be a 0,2-0,6 sec., The amplitude of saccades varies in a wide range of 2 arc. 15 min arc. deg; directed saccades in all directions (right, left, up, down), but usually their number is greater in the horizontal plane. Depending on the external and internal environment parameters are modulated by saccades. Saccades are ballistic: start, saccade to be completed regardless of whether it has changed its position point of fixation for the time elapsed since the beginning of saccades [3]. The aim of this paper is to review existing technology eye-tracking and description of our solutions in the analysis of saccades.

II. MAIN PART

EYE–TRACKING

Nowadays tracking eye movements (eye tracking) is closely linked with the technology of infrared radiation. Harmless to view infrared beam illuminates the eye, and a special camera captures the reflected gleam of the cornea and the position of the pupil, passing the data to the computer. He, 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 of the parameters of eye movement.

However, those devices that operate reliably and with high accuracy, using infrared cameras have a high cost [4]. This increases the cost of such systems and prevents their spread. The aim of this study is to establish a system for monitoring eye movements (eye-tracking), which could work with existing user cameras (digital camera, webcam, camera, built into a laptop or phone).

For this algorithm, which monitors eye movements should work with images in visible light. However, the precise fixation eye movements, such systems require the installation of additional equipment directly to the user, which prevents him comfortable work [5]. The system of which do not require installation of additional equipment at the current time, too sensitive to changes in lighting and work with sufficient accuracy, in addition, put restrictions on the movement of the user's head.

Thus, to date there is no quality system eye-tracking, which would be available to ordinary users.

Solving the problem of fixing the eye movements (eye-tracking) consists of two main sub-tasks:

First - find the center of the pupil of the eye on the image;

Second - the found coordinates to determine the user's point of gaze.

To solve the first sub-problem can find the boundary of the pupil of the eye or iris, using the obtained abroad, to determine where exactly the center of the pupil of the eye is. As shown by experiments conducted during the study, this approach does not work. If you use the border of the pupil of the eye, it may not be sufficiently clear because of poor lighting or physiological features of the user, such as long eyelashes user.

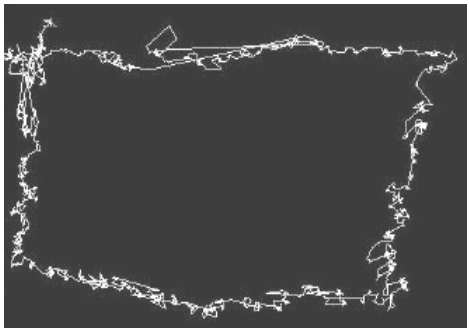
The algorithm, developed in the course of the study, working with the boundary of the iris, which stands out well against the background of the protein. However, there is a problem, his eyelids closing the border of the iris from the top and bottom.

Therefore, in determining the lower part and upper limits are ignored. Find the center of the pupil (of the eye) is complicated by the fact that not enough to determine the pixel, in which it is contained - it would be too rough estimate. The algorithm developed in this study, working with sub-pixel accuracy, that is, determines the coordinates of the center of the pupil of the eye within the found pixel. To determine the point of gaze using the simplest model of the camera, this provides an acceptable quality of processing. Point of gaze is determined by calibration of the system before its launch.

At the beginning of the experiment the user must look at the queue in the corners of the screen.
The experimental setup is as follows, the user's head is fixed in the stand. With the help of, for example, fluorescent lamps evenly illuminate the eyeball user.

The camera registers the displacement of the eyes in the sockets. The video image of moving pupil (of the eye)s remains on the computer and analyzed with a computer program. They carry out per-frame processing of video and record the trajectory of pupils of the eyes of his eyes, as well as their mathematical processing.

Results of the experiment with a slowly moving point (1 pixel / sec) on a rectangle of 20x20 pixels with a distance of 30 cm are shown in Fig.1.



The system stores the coordinates of the centers of the pupils of the eyes in the image, which correspond to the corners of the screen. A linear interpolation on both dimensions, we obtain the function to translate the coordinates of the center of the pupil of the eye in the coordinates of the point on the screen, on which the user is looking.

As part of this work is the algorithm determines the coordinates of the pupil (of the eye) when taking the camera with 4 x optical zoom, the user's head is fixed.

To determine the coordinates of the pupil (of the eye) is an analysis of existing solutions, as well as writing his algorithm, which takes into account the peculiarities of mobile devices. To use this algorithm on a mobile phone is expected to use the main camera and explore the static image attached to the holder.

The main purpose of the experiment to obtain the trajectory movement of the pupil (of the eye) using a mobile device camera without optical zoom.

PHYSIOLOGICAL RESEARCH

Receiving the point of fixation of sight - saccades, you can go to the next phase of the study - an analysis of the trajectories of eye movements. The standard approach is to identify areas of focus. Based on this principle all the existing commercial systems [4,6,7]. Analysis of saccades performed only in medical experiments or ophthalmic systems [5]. In previous studies it was found that every person is inherent in its own pattern of following saccades, which is determined by three parameters: the interval between saccades, their amplitude and orientation [2].

More, that these parameters vary for each person in the interaction with a certain type of information. In Fig. 2 shows the saccade when reading simple legkoponimaemogo text, but on Fig. 3 shows the process of reading a complex text with more specific terms. In the second case, notably a strong increase in the return saccades [8].

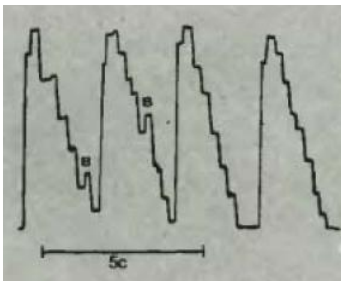
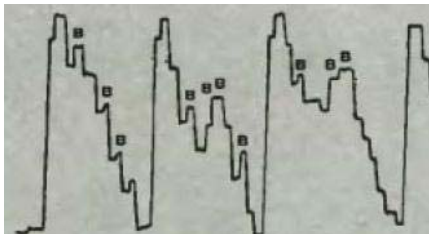


Fig. 2



The complexity analysis of saccades on mobile devices is not only the small screen size, but the principle of two-dimensional analysis. In most studies related to saccades analyzed the function of deviation of the pupil of the eye) from the center of the visual field over time (all directions are isomorphic).

In this study important is the position of the pupil of the eye in the two-dimensional image, which makes the analysis more difficult.

Identify the characteristics of pupil of the eye behavior in a potentially awkward elements is an important task. In this paper we use the results of medical research in the analysis of eye movements [2], [9]. Many works are devoted to identifying common patterns of behavior saccades, but no specifics, nor for the application of the mole, nor for graphical interfaces.

Especially eyes naturally move during reading. When the text goes from left to right, the point of fixation jumps along rows in the same direction fast saccades. When the eye reaches the end of the line, it usually comes back to the beginning of the next single saccade to the left. The amplitude and frequency of saccades during reading depends not only on the format of the text (the size of rows, their breakdown, the type font), but also from an understanding of its readers. If the style of written text "heavy" or the content of a subtle, often observed reflexive saccades. Of course, when reading the Arab and Jewish texts saccades opposite to the direction of "western", and in the case of Japanese and Chinese vertical columns of text saccades directed downward. [1]

Include research in the first phase have been identified simplest nefiziologichnye options saccades:

• Return saccade - a logical transition from one area to another interface and instant return

• Multihopovaya saccade - moving between the two logical areas of more than 1 saccade

• Uneven distribution of saccades - the density of images covering the points of fixation saccades. Analysis of attention to elements

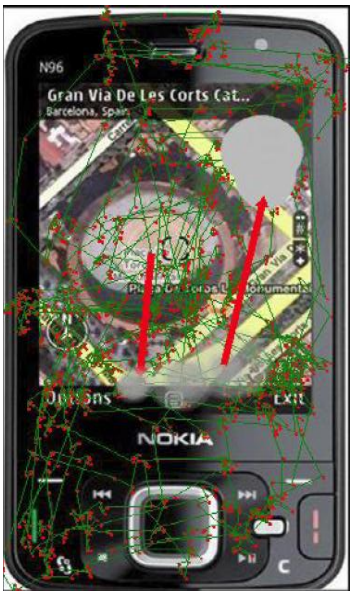


Fig.4

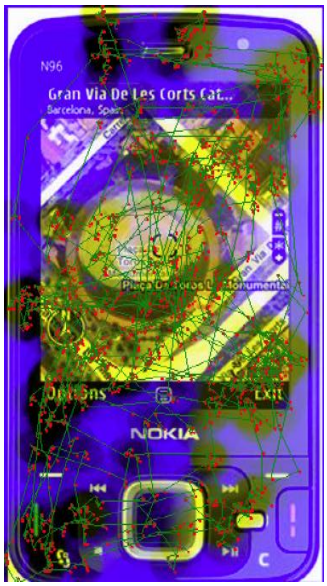


Fig.5

Fig.6

The main modes of the program are presented in Fig 4-6:

Fig 4 - transitions between bands of attention;

Fig 5 - Map the distribution of attention;

Fig 6 - Analysis inconvenient saccades (saccade multihopovaya).

The next step of this study will add to the program analysis capabilities to identify potentially embarrassing items:

Saccades analysis with main interface items

Use cases search-defined main succession moving between items

Dependency of eye coordinates from time

The aim of further research is to develop an algorithm by which, analyzing saccades, determined inconvenient GUI elements, for a specific person in the automatic mode.

III. CONCLUSION

Automated personalization of graphical interfaces can be realized using analysis sakkadicheskoy of the eye, as it is individual for each user.

While working on the algorithm of fixing eye movements (eye-tracking) found that to obtain acceptable for the analysis of a fairly simple to use camera with the ability to capture video 640x480 20 FPS.

Using these data during the experiments, certain simple saccades, showing the vulnerabilities interface:

- Return saccade - a logical transition from one area to another interface and instant return
- Multisaccade - moving between the two logical areas of more than 1 saccade
- Uneven distribution of saccades

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