Using Eyetracking in a Mobile Applications Usability Testing

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Abstract. In this paper we present general problems of a mobile application usability testing by means of eyetracking. The motivation for considering this problem is the fact that eyetracking is still one of the most advanced usability testing tool. We achieved that by performing two eyetracking tests with the participation of users. We tested mobile application on smartphone and PC emulator, to find out which method gives the most valuable results. Both tests showed that eyetracking testing of mobile applications gives valuable results but to make it really efficient professional equipment designed for mobile eyetracking is required.

Keywords: Eyetracking, Usability, Human-Computer Interaction.

1 Introduction

Modern information systems often suffer from many usability problems. Applications developed for mobile phones are no exception [11], [12]. The ISO9241-11 norm defines usability as “extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” [8]. There are several well known techniques for the usability verification (for example focus groups, interviews, observations, surveys, etc.). One of the most interesting usability testing techniques is eyetracking [4], [9]. This method enables to track the movement of user gaze on the screen, using a special infrared camera called eyetracker. In result of such test we receive graphical reports of where users were looking during performing tasks in the application. This provides data for effectiveness and efficiency analysis. It has few disadvantages, such as motionless head during eye tracking, using a variety of invasive devices, a relatively high price of commercially available eye-trackers and a difficult calibration [3], [9]. However, it provides very valuable information for usability studies. All of them are based on the eye-mind hypothesis that what a person is looking at, is assumed to indicate the thought on top of the stack of cognitive processes.

The main purpose of our study was to verify the known eyetracking method in the considerably new, mobile environment. ComScore study [7] shows, that Smartphone adoption in the U.K., France, Germany, Spain and Italy has grown 41 percent in the past year (2010). The importance of mobile phones is increasing in the everyday life,

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and the usability of mobile applications is becoming a critical factor. Nielsen Norman Group mobile applications usability studies conducted in 2009 showed that the average success rate on required tasks was only 59% [11], which is a very low percentage in terms of proper functioning of the application.

We decided to undertake research on the real mobile phone, with users using an existing application. The chosen mobile application should enable testing on both types of users, those who are familiar with it or its web equivalent, and those who are completely new to mobile applications. We have selected the mobile, touch screen version of facebook.com[1] web service, which is one of the most popular mobile applications, but while using it we found several usability issues in it.

2 Tools Used in the Experiment

Experiments were conducted in the Software Quality Laboratory, at the Wroclaw University of Technology. The main equipment used during this research was ASL 6000 eyetracking module [1]. It consists of two computers, Head Mounted Optics module (HMO) with camera, and ASL module with monitor. Study was performed using a chosen smartphone, a computer emulator and second camera for recording the phone screen. The brief description of the equipment and software is presented below:

1. ASL Eye-Trac 6000 Head Mounted Optics. The head mounted eye tracker accurately measures a person eye line of gaze with respect to their head. It is attached to the head by mounting on a headband (Fig. 1). The headband is light and adjustable to user head size [2]. One of the eyetracking cameras is using infrared to detect pupil and cornea reflections. The control unit processes the eye camera signal to extract the pupil and reflection data and computes both pupil diameter and line of gaze [1], [2].

Fig. 1. Testing environment

[1] http://www.touch.facebook.com

2. Web Cam Logitech Quick Cam Pro 9000. This camera was used to record the screen of the smartphone and operations made by users during interaction with the application. It was mounted as an additional element of HMO headband to assure closest angel to user's field of vision (Fig. 1). We used this camera, because parameters of the standard camera mounted in HMO were too low, to enable recording of the smartphone screen in the descent quality.
3. YouWave Android. This application was created by YouWave LLC. It is one of the easiest to use and most advanced Android emulator for PC. It enables emulating applications in APK format (Android application package file), features portrait and landscape mode, makes possible to browsing the Web and provides other specific functions of Android platform [6].
4. Smartphone LG GT540[2] with Android operating system. It has TFT resistive touch screen, which enables usage of an ordinary stylus as the pointing device. Screen size in this smartphone is 3 inches and the resolution is 320x480 pixels. The phone was fixed to the adjustable handle, to ensure proper position and stability.

Fig. 2. YouWave Android emulator and LG GT540 smartphone showing the tested mobile touch screen facebook version

3 Experiments

The aim of our study was to investigate mobile application usability testing using eyetracking. In order to test this method we conducted usability study of social network service facebook.com in its mobile version, using the eyetracking equipment. For this purpose we have prepared several tasks, intended to demonstrate whether the

[2] http://www.lg-optimus.com/

use of this application may evoke problems, and if so what was their cause. The tasks were partly based on the principles of creating usability testing scenarios [5]. Before the experiment, several fictitious user accounts were created and combined in a small network of friends, which enabled better monitoring of user actions in the service. The shortened content of the tasks which were given to users is presented below:

1. Organize your birthday. Create an event scheduled for March 20, at 7 PM in the "Tawerna club”. In the description write "no gifts". Invite your two friends to this event.
2. Create fan page site called "Mobile Eyetracking". Change the settings so that it will be only available to people over 18 years of age.
3. You want to call your friend "Peter Eyetracking" but you do not know his phone number. Find it on facebook.
4. Add a comment to your friend’s photo and click "like" next to it.
5. Check your recent notifications.

We conducted two series of experiments. One with the real phone placed on the handle, second using YouWave emulator shown on the PC screen. Each of them was carried out with five different users. They all were students of the Wroclaw University of Technology. All of them were quite experienced users of different web applications, but their knowledge and time spent on the facebook service was varied.

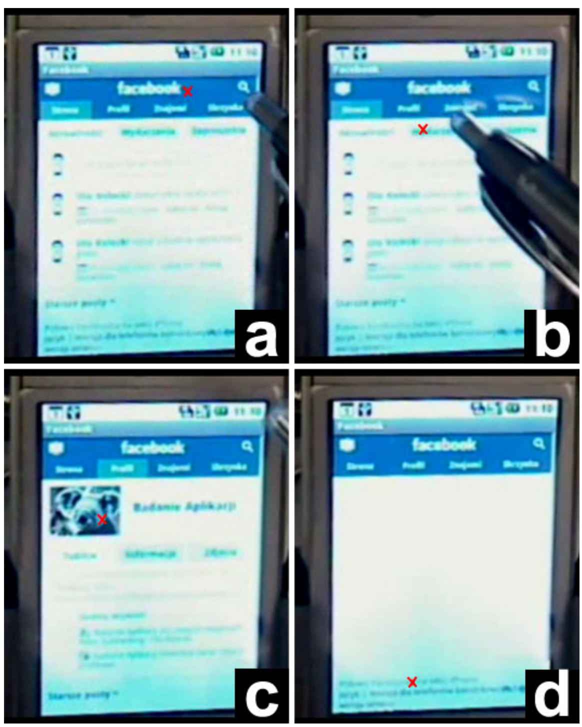

Fig. 3. Sequence of images with a superimposed "X" indicating an actual gaze point of the user: a) notice of the menu element b) pressing the chosen menu element c) brief look on koala bear face d) quick look at the text that shows up

Every participant was wearing the eye tracking HMO headband. Calibration was done for each one of them. The HMO test procedure allows gaze tracking on the PC monitor, so that part progressed as planned. Developing testing environment for eye tracking for mobile devices was one of the challenges which we had to face during researches. We attached a web camera to the headband, so it would record the screen of the smartphone. In the meantime we ran GazeTracker software[3], on the computer screen (over notepad application), calibrated to the size and position of the phone. The eyetracking data (red "X" sign) was than extracted and placed on the images recorded by the webcam (Fig. 3).

After presentation of the test rules each participant was asked to fill out the "before test" questionnaire. Questions concerned identification data, current occupation, education, interests, but also the experience of using a touch phone, mobile applications and knowledge of web page version of facebook.

The test consisted of execution of the five tasks presented above, read by the moderator. During the experiment, time, directories and overall success or failures were recorded. Also notes about specific behavior and mistakes made by users have been taken.

Fig. 4. Example of the sequence of gaze points with fixation times

3 http://www.asleyetracking.com/Site/Products/SoftwareSolutions

After the experiment users were asked to fill post-test questionnaire concerning their feelings about the test. They also had the possibility to express their thoughts on the tested applications. However we focused our analysis on material obtained from eyetracker software. For emulator test we got all the data provided by GazeTracker software, such as gaze plots (Fig. 4). For smartphone we had video files with imposed gaze points (Fig. 3).

4 Results of the Experiments

The results of both tests are presented in Tables 1 to 4. They present detailed results and comparisons between real phone and emulated facebook application tests.

Table 1. Time results of completed tasks on YouWave Android emulator

	Familiar with Facebook mobile version	Task 1 Time [s]	Task 2 Time [s]	Task 3 Time [s]	Task 4 Time [s]	Task 5 Time [s]
Person 1	Yes	58	85	64	76	11
Person 2	No	124	137	66	145	40
Person 3	No	65	147	19	71	37
Person 4	Yes	60	141	40	50	20
Person 5	Yes	73	47	8	46	5

Table 2. Time results of completed tasks on touch screen smartphone

	Familiar with Facebook mobile version	Task 1 Time [s]	Task 2 Time [s]	Task 3 Time [s]	Task 4 Time [s]	Task 5 Time [s]
Person 6	Yes	35	62	6	28	10
Person 7	Yes	57	68	63	75	35
Person 8	No	94	75	95	80	45
Person 9	No	92	59	20	37	7
Person 10	Yes	41	65	22	46	9

Table 3. Comparison of average times of tasks

	Average time [s]				
	Task 1	Task 2	Task 3	Task 4	Task 5
YouWave Emulator	76	111	55	78	23
Smartphone	64	66	41	53	21

Table 4. Comparison of the test methods for mobile eyetracking testing

	Comparison of the test methods	
	YouWave Emulator	Touch screen smartphone
User comfort	Big screen in front of user, good angular view, very comfortable.	Small screen and interaction using stylus, phone was far from users, so they had small angular view on it, not to comfortable.
Eyetracking data precision	Very precise.	After merging gaze points with recorded images, the data was slightly imprecise.
Calibration	Easy calibration, same as for normal web page usability tests.	Difficult and long calibration, we needed to transform calibration points to the size of the mobile device screen.
Interaction	Users used mouse to interact with the application, so it did not fully simulate the way they would work with the mobile application.	Interaction using stylus, identical to the way most people use smartphones
Other remarks	The keyboard in the emulator was very poor, and users had many problems with typing text using it.	Application was tested in its natural environment.

After the experiments we gathered all the results and observations, and analyzed them. Our tests showed that the tested application has many usability issues and users were responding negatively to it. Most of the problems with using this application could be found using standard user testing without eyetracking, however data obtained from those tests allows us to benefit from all the information that we get from eyetracking testing. We are able to determine where users look while doing specific actions in this application. During the processing of the eyetracking data we came to some interesting results, for example most of the time users were scanning the application with f-shaped pattern [10]. Furthermore generated reports have clearly shown the problems that users had with particular tasks. For example in task nr 5, when users got to the photo, they had troubles with finding the comment box, because it was hidden under the photo (Fig. 5). The times of the task completion has varied between users who were familiar with this application and those who used it for the first time. Experienced users coped with the tasks faster than new ones (Tables 1 and 2). Generally users completed tasks on smartphone faster than on the emulator (Table 3). Such result is probably caused by the method of interaction used in both cases. Performing actions by touching closely aligned buttons on small screen is probably faster than using computer mouse on bigger PC screen.

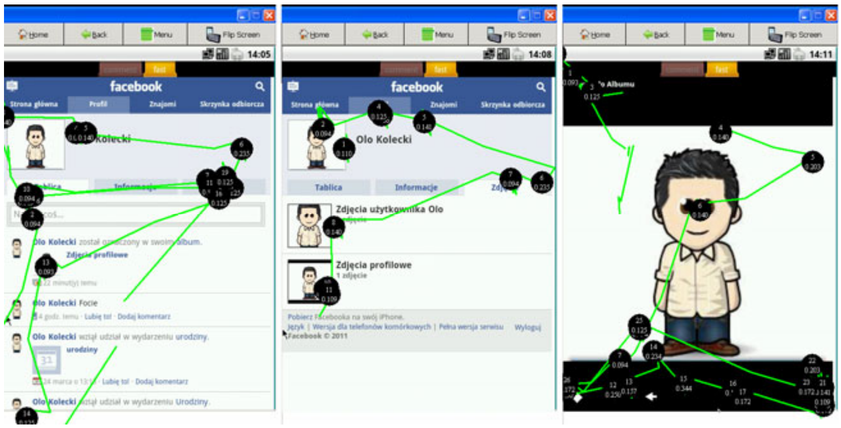

Fig. 5. Task 5 fixation map showing user performing consecutive steps of getting to the profile picture and searching for the comment box

5 Summary

Our experiments have shown that eyetracking is also a very useful method in the mobile devices testing.. In our experiment we used emulator and smartphone application. Both of those methods of interaction had some advantages and disadvantages (Table 4) in the usability testing. Because of that we recommend to perform usability tests using PC emulator and smartphone to get the best results. Smartphones are the target environment for those applications, so we should always use them in the usability tests, however the PC emulator testing together with bigger displays gives better perspective of the application and allows to obtain more visible and clear eyetracking data. Moreover our emulator test was performed on a normal screen with mouse interaction. It would be better if such tests were conducted on a touch screen to make the interaction the same as on mobile device.

We had many troubles with setting the testing environment with standard eyetracker, so to perform fast and effective eyetracking tests on mobile devices it would be recommended to obtain a professional mobile eyetracker with advanced camera and software, that would allow easy and fast calibration and analysis for objects outside of the computer screen. Application developers should also perform usability tests on different smartphones, because they have different parameters such as screen size and buttons.

It is obvious that the mobile application will be more and more popular, so surely mobile applications usability testing will become an important factor, and mostly used web usability methods such as clictracking and eyetracking will be adapted to mobile environments. Moreover we could for example try to analyze the eyetracking data with collaborative intelligence methods, like data mining, to get some interesting dependencies between the users. It could provide us with information about the regions of the application that particular group of users is mostly interested in or create some graphs showing the route for given task for those groups of users. There is still plenty room for research in this area.

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