Hybrid Approach to Web Based Systems Usability Evaluation

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Abstract. This paper presents a concept for a design of a new, hybrid method for web systems usability evaluation. This method will combine various elements of other, well-known usability methods, and will be enhanced with a mechanism to evaluate the use of the system, by the users, against the model of its desired use. This way it will be possible to determine the usability of a tested system, using various metrics and techniques, during a single test.

Keywords: Usability, Human-Computer Interaction, Eye Tracking.

1 Introduction

Usability testing is one of the methods of software testing [10]. It is a dynamically growing field that is used to evaluate the quality of various types of interactive systems – from basic desktop applications, through websites to mobile applications. 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" [7]. Web systems usability testing dates back to the middle of the 1990's when people started to analyze their website designs. Since then many evaluation methods were created and many of them are constantly being improved and adopted to meet current website design trends and implementation technologies.

Conducting a complex usability audit of a given system, using various techniques, allows to increase its effectiveness, eliminate errors and increase user satisfaction. The main goals for usability testing of web systems:

- Enlarge the number of active clients
- Build clear and reliable message content for your website
- Enlarge satisfaction of your clients
- Provide qualitative feedback and helps improve your interactive experience
- Focus on the features that really matter
- Reduce costs by anticipating and eliminating potential user roadblocks
- Decrease user acclimation time and errors

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Conducting usability tests at every stage of the design process of the system, and also after its implementation, provides the possibility to perform rapid changes and eliminate usability issues.

In this paper, the following section presents an overview of various usability testing methods. In section 3 an idea of hybrid method and research methodology for its development is described. Section 4 presents completed research and section 5 - summary.

2 Usability Testing Methods

Currently there are many methods and tools that are used to perform web systems usability evaluation. However each method is constantly being improved and new methods are being introduced to match the evolution of user interfaces.

One of the most interesting usability testing techniques, which require user's participation, is eye tracking [5]. This method enables to track the movement of user gaze on the screen, using a special device called eyetracker. In the 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 may have however some disadvantages, such as head immobility during eye tracking, using a variety of invasive devices, a relatively high price of commercially available eye trackers and a difficult calibration [4]. 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. This technique is also dynamically evolving. New eye tracking solutions are created, using web cams or cheap infrared cameras [2].

In usability testing we also use other techniques like questionnaires, where users complete a survey regarding their experience with the system and also clicktracking - tracking and recording user's action while they browse the website (for example their clicks) using some dedicated tools and applications. It allows to gather information about how users worked with the systems, where did they click, which parts they did not notice and from where they have entered the system.

In modern usability testing, remote tests are becoming more and more popular. Because of lack of time and money, companies are looking for alternatives for standard tests with users. Those tests require a place to test, gathered users, moderator and equipment. This situation leads to idea of remote usability testing. Its main goal is to test users in their natural working place, without any sophisticated equipment. Users in their own environment are behaving more naturally, like they would normally use given website [9]. Moreover we do not need to gather all the users at one time, we can work with them when they want to. Also we can have participants from different cities or even countries that would normally not visit our laboratory. Furthermore remote tests can be performed automatically. There are various tools and applications that allow to gather the data from users while they are visiting our website. Most of those tools allow to perform clicktracking [10] – they record where users have clicked while browsing the website. This way we can see which elements of the website were not visible to users, which attracted the most attention etc. We can also track other

actions, like for example the mouse movement or the user's path, while working with the system, between various sites in our system.

Using those mentioned methods we can perform a full usability audit of a given system. However applying all those methods can be time and effort consuming. The solution to this problem is to create one method, which would combine particular elements of other methods – hybrid method.

3 Research Scope

In this doctoral research a new, hybrid, usability testing method is being developed. It will combine different elements of other methods. Moreover the method will be enhanced by a method for comparing the desired usability model for evaluated system against the data obtained from the usability test. The effectiveness of the proposed method will be verified by comparing it with standard usability testing methods.

3.1 Hybrid Method

The scope of this research is to create a hybrid usability testing method. It would allow to perform complex usability test much quicker and would allow to gather all sort of data regarding user's work with the system. Other advantages of such method are: low cost, it does not require moderation, it would allow to test a large group of users at once, and also it could be used to perform fast, iterative tests at each step of software development. Furthermore this method could be used in agile software development, where the emphasis is put on quickness of development, correct work of the system, the possibility to introduce dynamic changes and to react quickly to problems and errors. In addition this method will be extended by a mechanism that will allow to evaluate the system against its desired model. In this method, at the beginning we will determine the desired result parameters for tasks performed in the systems.

The final version of the proposed hybrid method will gather data from the users, such as:

- Time of task completion
- Task success rate
- Events during performing a task
- Users' path (visited pages)
- Eye tracking data

3.2 Research Methodology

After the implementation of the system that will allow to perform tests using the hybrid method, this method will be evaluated by performing a tests with users on real and benchmark web systems. They will be the point of reference to check the accuracy, completeness, cost and time required to complete the test with this method. In those systems, users and user interaction is going to be modeled, and tasks for users will be

created. The number of users will be selected in such way to ensure the statistical significance of the results.

The effectiveness of the created method will be verified by performing tests with this method and standard usability testing methods on the same systems and comparison of the results. For the purpose of this evaluation we can assume that properties of each method can be written as:

$$W = <D, K, c, t>,$$

where D is the accuracy of the technique (whether only big usability problems have been found, or has the evaluation using this technique showed also smaller usability problems), K is the completeness of the technique (number of usability problems found), c is the cost of such method and t is the time that we needed to perform a test with the given technique. We say that a usability problem has occurred when the usability rules provided in the definition are broken in the evaluated system, for example where the system or its part is not effective, or there are some errors in it.

This will allow to compare usability problems found during the tests, cost of such tests and time that they took. While verifying the created method we should obtain the following dependency:

$$D_s \approx D_h,\ K_s \approx K_h,\ c_s >> c_h,\ t_s >> t_h,$$

where index s stands for standard usability testing methods and h index stands for hybrid method.

For further verification of the proposed method statistical verification of found usability problems can be performed, using for example Fisher's exact test [11].

3.3 Validation Mechanism

First of all the desired parameters for tasks performed in the system will be determined. Each task consists of:

- Purpose, for example send a message to specified user
- Starting point, for example main page of the website
- End point, for example displaying on the screen "message was send"

To determine the desired parameters we can use:

- Distance in the graph of transitions between pages
- Fitt's law, which enables to predict the time, that user will spend on choosing a particular object with the pointing device [8]
- Optimal list of events for completing the task
- Number of steps for optimal task completion
- Design patterns for particular types of systems

After that a comparison between the desired parameters with the results obtained from the usability tests will be performed. For that purpose for example the "Lostness" measure [13] can be used which is defined as: N – number of unique visited pages,

S – total number of visited sites, R – desired (optimal) number of pages that user should visit, and then we can calculate it:

$$L=\sqrt{\left[\left(\frac{N}{S}-1\right)^2+\left(\frac{R}{N}-1\right)^2\right]} \quad (1)$$

A perfect Lostness score would be 0. Smith [12] found that participants with a Lostness score less than 0.4 did not exhibit any observable characteristics of being lost. On the other hand, participants with a Lostness score greater than 0.5 definitely did appear to be lost. For example, if user is given a task to find some contact information on a website, the optimal number of visited pages (R parameter) should be 1. If during the test user has visited for example 4 pages (S parameter) and 3 of them were unique (N parameter), before managing to find the contact information, we can calculate that the Lostness measure will be equal 0.71 (L>0.5), so there are some usability problems for this particular task and user's might get lost.

3.4 Research Problems

The first encountered problem was to formally define what a usability problem is. It was described as violation of rules presented in the usability definition [7].

Another problem was how to evaluate the effectiveness of the hybrid method. It was solved by formal definition of properties of each usability method and by introduction of calculating its efficiency for the given system [1]. Moreover, another way of verifying the hybrid method will be an implementation of systems that will have specific usability problems. They will be used during tests with users and they will work as a benchmark for evaluation the efficiency of each method used in those tests.

4 Completed Research

So far a simple application that enables to perform remote usability tests using eye tracking was created and presented at the Interact 2011 conference [3]. It uses simple web camera and modified Opengazer software to track the users' gaze movement. Using remote desktop software and an application to communicate with user, for example Skype, we can perform a remote usability test, knowing where user is looking at the screen all the time (it is shown by a blue square on the screen that is following the users' gaze). The data (coordinates of the points on the screen that user has looked on) is recorded during the test and can be used to generate a heat map, that shows the areas on which users looked, and with what intensity.

This system will be used as part of an application that performs a hybrid method usability testing.

Another research milestone was a method that was created and published on ISAT 2012 conference [1], which allows to compare the efficiency of various methods of usability testing. Proposed model of presenting each usability method properties was enhanced with fuzzy logic. To all of those parameters we will assign a value from 0 to 1.

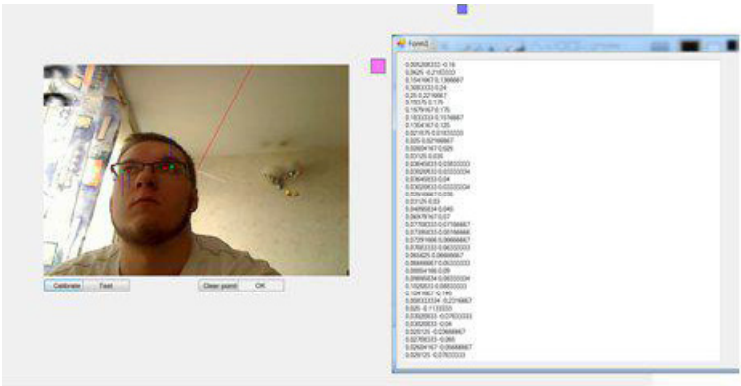

Fig. 1. Application after the calibration process. Blue square shows where the participant is looking and in the background we have a window that shows the coordinates of the gaze.

The 1 value will be assigned to the parameter of the technique that had the better results in the usability test, for example if using a technique we would found more usability problems than with using the other one, the K parameter of the first one will be 1, and the K parameter of the second one will be calculated in proportion, base on the number of usability problems found. We can also attach weights to those parameters, depending on which parameter is the most important for us. The weights should sum up to 1. If the cost is the most important we can give it the highest weight, so even though another method turns out to be more accurate and complete the final effectiveness for the cheaper technique will be higher. At the end the effectiveness of a technique can be counted as:

$$E=D*weight_1+K*weight_2+c*weight_3+t*weight_4 \quad (2)$$

This method will be used to evaluate the efficiency of the hybrid method and compare it with standard usability testing techniques.

Furthermore, a paper describing application of the intelligent data analysis to the eye tracking research was published on HCI 2013 conference [2]. It presents a method for evaluating how the standard data analysis, which is usually made manually by experts, may be enhanced by application of intelligent data analysis. We applied well known expert system, which is using fuzzy reasoning. To build such a system we should first define a model of "desired" eye tracking record for a given poster, or more general web page or the whole application. We have presented how we can enhance the process of gaze tracking data analysis by application of fuzzy reasoning. The most important advantage of this method is that it may be used to analyze the data gathered for single user, several users or even hundreds of users, which will give the statistical significance. However one of the drawbacks of this method is necessity of definition or redefinition of set of rules for the different experiments. This problem may be solved by application of determining fuzzy rules out of experimental data [6]. The presented method will be used in the final version of the hybrid method as well, for analysis of the eye tracking data obtained from the tests with users.

5 Summary and Future Work

To sum up, this doctoral research is focused on creating a new, more effective method for web systems usability testing. There are some steps that need to be taken to achieve that. First of them is the introduction of additional usability measures for hybrid method. There are many usability measures in the literature and it is possible to design some new once. The next thing to do is the creation and selection of existing web-based systems that will serve as a benchmark to evaluate the effectiveness of the method created, modeling of users and interaction in these systems, the development of tasks for these systems. Moreover determination of desired parameters for those tasks is needed. This will allow to fully prepare the testing environment for the hybrid method. After that there is the most important step - design and implementation of a system for usability testing with the hybrid method that will enable to perform tests with users and gather all the necessary data from them. When this system will be ready the next step will be to conduct tests with users. It will have to be an adequate amount of users to achieve the statistical significance for such tests. On the basis of the data received a mechanism that will allow to identify the problems with the usability of the evaluated systems will be developed. The last thing to do will be to verification the designed hybrid method with the existing methods. It will be achieved by performing tests on the same systems as with the hybrid method using, using standard usability methods, and comparing the results. This will allow to determine the effectives of the proposed method.

Different types of systems will also be evaluated using this method, like for example touch screen applications. In the future it is also possible to use this method for mobile applications usability testing.

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