Eye-Tracking Study of Navigation Behaviour on Mobile Devices for mLearning

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4.6 Eye-Tracking Study of Navigation Behaviour on Mobile Devices for mLearning

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Zusammenfassung
Die aktuellen mobilen Geräte bieten eine zunehmende Nutzbarkeit für Internet Anwendungen. Deshalb ist es immer wichtiger die Navigation für solche Geräte zu optimieren, um den Aufwand und die Zeit für einen Nutzer zu minimieren, Informationen die er benötigt, zu finden und abzurufen. Dies gewinnt an Bedeutung, wenn der Nutzer Lernmaterialien abrufen will. Der Nutzer will seine Zeit nicht für die Navigation verwenden, sondern will diese mit den Inhalten nutzen. Dieser Artikel beschreibt die Arbeit und die Ergebnisse der Navigationsoptimierung für mobile Geräte mit Hilfe eines Eye-Tracking Systems. Der erste Schritt hin zur optimierten Navigation war, herauszufinden, welche Faktoren eine Navigation benutzerfreundlich machen. Zu diesem Zweck wurde ein Eye-Tracking System eingesetzt. Ein solches System erlaubt es, die Augenbewegungen auf dem Bildschirm des mobilen Gerätes sowie die Zeitdauer, mit der ein Benutzer ein bestimmtes Wort fixiert, zu erfassen.

Abstract
The current mobile devices offer a growing usability for Internet applications. Therefore it is more and more important to optimise the navigation on such devices in order to minimise the effort and time for a user to find and access the needed information. This situation is becoming more and more important if the user wants to access learning materials. She/he does not want to lose her/his time with finding out how to navigate to the content. They rather prefer to deal with the content. This paper discusses the work and the results of the effort on optimising navigation for mobile devices with the help of an eye-tracking system. The first step towards the optimisation was to find out the facts which make the one navigation more usable than the other. For this purpose it was decided to use an eye-tracking system. Such a system allows to track the eye movement on the mobile screen as well as to measure how long a user fixates a word.

Introduction
The concentration on using eye tracking techniques in the research field of web usability has been growing rapidly in the last years. Such studies concentrate on how users interact with web pages [1], as where people start browsing on a page [2], where they look for navigation, and how they react to different text types [3]. However, using eye tracking as a tool for mobile usability research was introduced lately. Actually, the only public available attempt was in applying eye tracking techniques to evaluate several readability methods on mobile devices [4].

The eye-tracking system which was used for the tests is a head mounted device, equipped with a camera to record the user's vision and an infra-red light source and a camera, Figure 4.6-1. To calculate the user's eye focus, the Cornea-Reflex-Method is used by this system. The light of the infra-red light source, which is reflected by the cornea, is recorded by the infra-red camera. From the relative distance between the cornea reflection and the centre of the pupil, the viewing angle can be calculated. After a calibration, the gaze intersection with the surface of the examined object can be calculated. The recorded video of the user's vision is superposed with this calculated point of the user's eye focus.

Humans are not looking or reading in a steady way. While reading, the movement of the eyes is typically divided into fixations and saccades. The reader is fixating for a view milliseconds on a part of the content, before the eyes are moving fast, the so called saccades, to the next part. It is known that information is gathered during the fixation of the eyes and not the saccades. Therefore it is possible to discover the user's way of gaining information from the content by checking out the fixation points of his eyes [5]. An important advantage of this method is that it is possible to discover unknown fixation points which the user would not be able to express because he/she is not realising this action.

As a result of the eye-tracking study a statistical analysis can be made to generate gaze spots and gaze states. Another result which can be generated is a gaze trace. With gaze spots and gaze states visual attractive parts can be discovered. The gaze trace allows discovering of the eye movement on the viewed scene.

Preparation of the test
Before a test is performed initial considerations have to be examined, and some initial questions have to be answered as well.

One of the biggest challenges is the eye-tracking camera. In order to receive a good quality of the video stream the zoom factor has to be as high as possible. On the other hand, a high zoom factor makes the calculation of the eye focus more vulnerable to miscalculation. One solution is to fix the mobile device as well as the test person. The fixation of the test person will probably lead to wrong conclusions because the test person will change her/his behaviour as a result of the unusual situation. The fixation of the mobile devices was assumed to be less problematic. Because in such a situation a higher zoom factor was achievable, the decision to mount the device for the first tests, but not the test person, was taken.

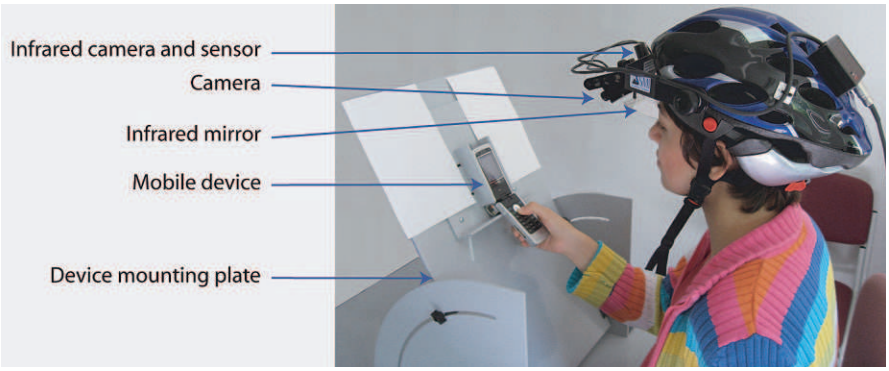

Fig. 4.6-1: *Eye-tracking system for study the interactions with mobile device*

Additionally, the camera was sensitive to changing light conditions. Therefore it is necessary to keep the light conditions unchanged. This can be guaranteed if only artificial light sources are used.

In order to gain meaningful results, statistical boundary conditions have to be observed. The more people are examined, the more accurate the results will be. Because of time and money reasons it is in most cases not possible to examine more than a low number of people. Therefore a target group has to be defined and examined. After the target group is defined and examined, the important differentiators of this group concerning the study criterion have to be defined. Some common differentiators are:

- male/female
- experienced/not experienced

Realising the test under the same conditions, the supervisor of the test has to be always at the same time at the same position. The supervisor had a kind of storyboard to perform always the same actions in the same order and time if possible. Also all information which had to be provided to the test persons were written down to the story board.

For the test, three different navigation scenarios with the same content were developed. In the first scenario, the navigation is on top of the page, in the second there exist a back, forward, and table of contents link, and in the third the navigation is on the bottom of each page. Figure 4.6-2 shows the three different navigation scenarios

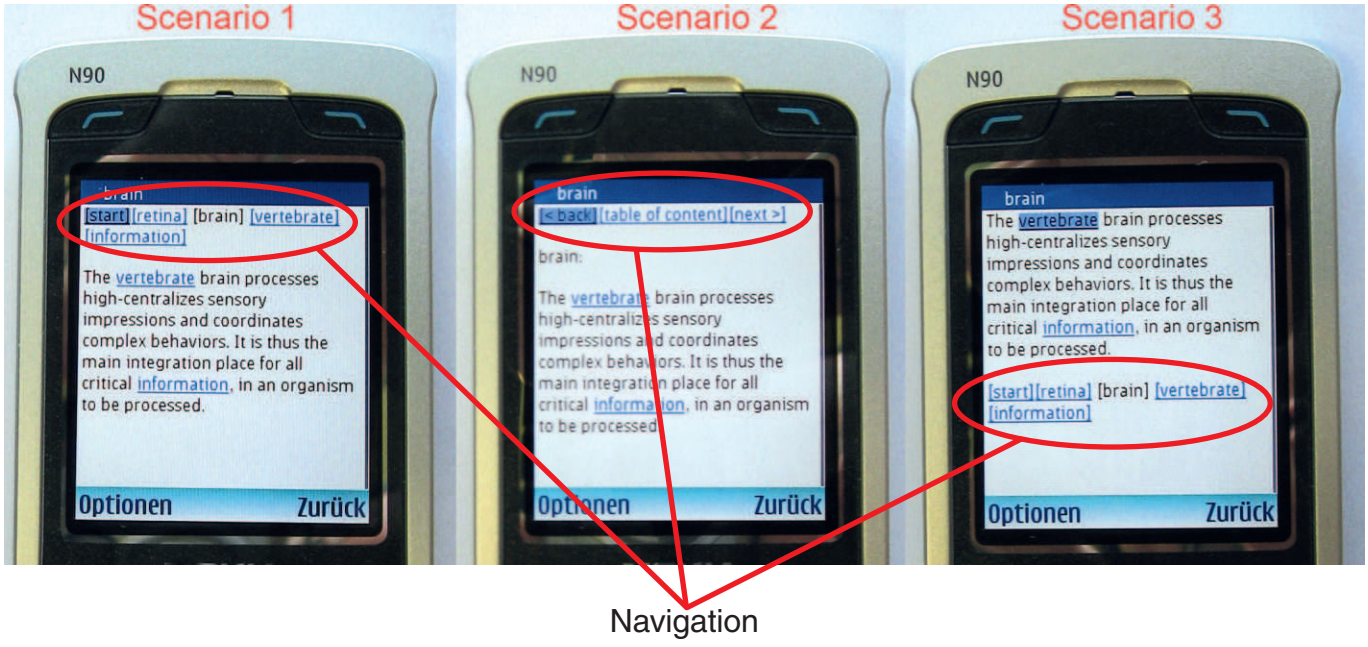

Fig. 4.6-2: *Investigated navigation scenarios: on top of the page (scenario 1), reduced navigation: back / forward / table of content (scenario 2), bottom of each page (scenario 3)*

In this test case the target group were students, because these are the persons which are expected to use such a system later on. The test concentrates on female and male students in the age between 20 and 30 years. In addition, the first test was performed with German multimedia students. Therefore it was assumed that these students are familiar with the mobile device technology. Nevertheless the students were as well categorised according experience in using mobile phones.

Performing the test

The test with the German test persons was performed with the help of a student project group as part of their study program [6]. In the first test many other factors were eliminated in the examination in order to simplify the result preparation. This was the reason to examine only one device at the first stage as well. The goal was to work out the main differences between the three navigation methods concerning a few varying parameters as far as possible with human beings. The first test was performed with two groups. A first group were experienced users, consisting of a female and a male and second group of inexperienced users, also consisting of a female and male test person. Both groups had to perform three different navigation scenarios. This leads to an overall group size of at least 12 persons (2 groups with 2 persons, 3 navigation). In order to have some basic statistical meaningfulness, 36 persons were invited to the test. At the end 35 usable results were gained out of the first test.

The test of a person was performed in the following way:

- Mounting the eye-tracking system to the head of the test person
- Calibrating the eye-tracking system
- Starting the "official test" with the first question
- Repeat asking questions until all 4 questions were answered
- At the end filling out an additional questionnaire

Results

A deep analysis is still in process. Nevertheless the results from the questionnaire and the first results of the data analyses are available. Figure 4.6-3 to 4.6-5 show the results of the questionnaire.

The supervisor of the test had to write down the answer as well as the time, the answer was given. Therefore a first rough result is obtained of how long a test person needed to answer the question and if the answer was correct or not. With the questionnaire it was possible to gain a subjective result of the test person. The following questions were asked:

Did you find the navigation simple and user friendly?

1. Has it been easy for you to concentrate on the content or does the navigation attract too much attention?

2. Could you imagine, using mLearning? (Read lectures; learn; make lab appointments, etc.)

a) In case yes, what advantages do you expect?

b) In case no, why not?

3. How much would you be willing to pay for mLearning?

The results allows to answer the following important question.

- Is there any difference between a male and a female test person?

- Is there any difference between students with and without experience in using mobile phones?

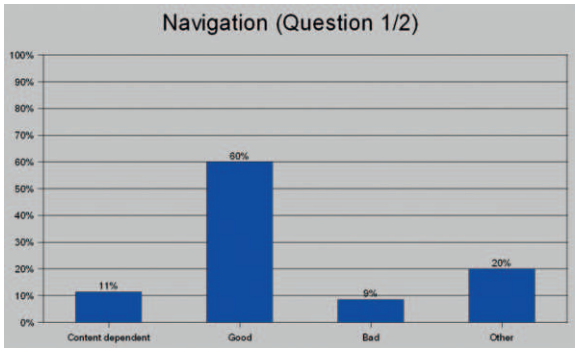

Fig. 4.6-3: *Navigation evaluation*

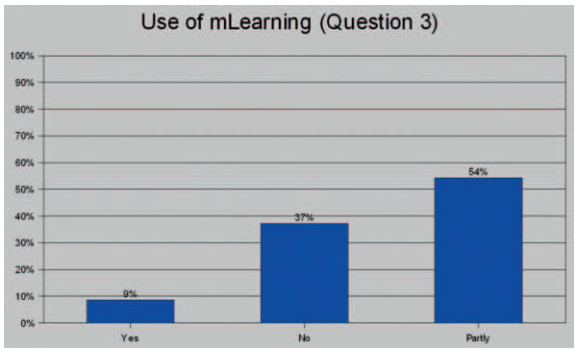

Fig. 4.6-4: *Use of mLearning*

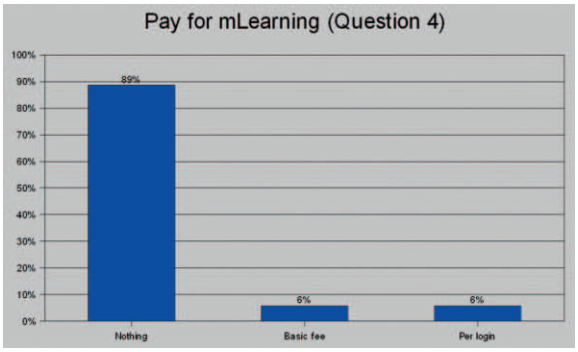

Fig. 4.6-5: *Pay for mLearning*

The answers of these questions are important for the next test, because in case, one or both questions can be answered with no, the test groups can be simplified.

The tests show no significant differences in using the navigation between male and female test persons. But the tests have shown that people without much experience in using a mobile phone or who have an old mobile phone needed more time in average to answer the questions. The mix between male and female is not as important in contrast to the criterion of experience as in using a (modern) mobile phone.

A positive result is that more than the half (60%) of the students found all navigations good and, according the first analysis, the third navigation type was preferred. Nevertheless, only 9% of the test persons could imagine using mLearning on their mobile phones. This fact causes another question:

- Are there any differences because of the cultural background?

In order to clear this fact a second test with international students has been started. From the 6 examined test persons all replied to the third question with yes. Because of the statistically small number of test persons, this result has to be used at the current state very carefully. Nevertheless this result shows a difference in attitude to the topic of mLearning. How much this more negative attitude of the German students in contrast to the more positive attitude of the foreign students influences the behaviour is yet unclear.

Another interesting result was that almost all students felt stressed during the test. The supervisor told them several times that the navigation is the test object. Nevertheless, almost all reported at the end of the tests that because they wanted to do their best, they got nervous.

Most of the students used, beside the navigation links the back button key from the mobile phone. In the interview they reported additionally that this key was very important for them, because they felt safe. "You know that you can find always back" said one of the test persons. In the recorded videos it was also possible to see that a lot of the test persons tried to navigate through the web pages with the same keys they are normally using with the phone.

Although the test was designed to concentrate on the navigation, a content related fact was discovered. Because the navigation is a tool to access the content, the test scenario made the assumption that the faster the test person can access content the better the navigation is. Of course the time to access the content is additionally dependent on the test person. Therefore, the content will be included in the test. A lot of the test persons reported that they found the links inside the content very helpful, because they were able to immediately access the information behind.

Future Work and Conclusion

For the first tests it was assumed that mounting the mobile device in front of the test person will not affect the behaviour. This assumption is unproven up to now. This assumption has to be either verified or falsified. Therefore a new test scenario has to be generated in order to examine the behaviour of test persons with or without mounted mobile devices, respectively.

Another influence of the test is the task the test persons have to solve. Every test person has to answer four questions after each other. Currently it is not clear, what kind and how much the task influences the navigation behaviour. In order to clear this situation, a test with different tasks and the influence on the navigation behaviour has to be performed. Also the influence of the different mobile devices is currently not worked out. Because of the importance of this influence this will be the first of the future tests. Only if it is clear in which way and how much the mobile devices influence the navigation behaviour, it is possible to develop a mobile device independent navigation.

Nevertheless, the first results of this test discovered already unexpected coherences. Therefore the results will help to improve navigation and users like or dislike navigation on mobile devices, respectively.

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References

[1] Jay, Stevens, Glencross and Chalmers, How People use Presentation to Search for a Link: Expanding the Understanding of Accessibility on the Web, Proceedings of the 2006 international cross-disciplinary workshop on Web accessibility (W4A), 2006, http://aig.cs.man.ac.uk/people/jayc/eye-tracking-final.pdf, May 2007

[2] Manhartsberger, Zellhofer, Eye tracking in usability research: What users really see, 2006 http://www.usability.at/ueberuns/EyetrackinginUsability.pdf, May 2007

[3] Pan, Hembrooke, Gay, Granka, Feusner, and Newman, The Determinants of Web Page Viewing Behavior: An Eye-Tracking Study, Proceedings of the 2004 symposium on Eye tracking research & applications, 2004 http://www.hci.cornell.edu/projects/pdfs%20of%20pubs/ETRA04.pdf, May 2007

[4] Öquits, Evaluating Readability on Mobile Devices, Acta Universitatis Upsaliensis, Studia Linguistica Upsaliensia, 2006

[5] Eye-Tracking Manual, 2005, University of Applied Sciences Offenburg, Eye-Tracking Manual, 2005

[6] Christmann et al., 2007, University of Applied Sciences Offenburg, Documentation of project work, 2007