An ergonomic user interface supporting information search and organization on a mobile device

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ABSTRACT

In this paper we describe the development of a user interface for a mobile search application. The interface is connected to an information retrieval system in order to allow mobile searching and personal information organization by using clustering algorithms. By making use of novel interaction techniques like multi-touch, users are supported in refining their information need. In addition users are provided with a tag cloud of past queries in order to offer a personalized initialization of the search process. We have conducted several user studies during the entire development process. In order to follow a formative evaluation process also a final usability test was conducted, which reveals a high usability of the concept.

Categories and Subject Descriptors

H.3.3 [**Information Storage and Retrieval**]: Information Search and Retrieval; H.5.2 [**Information Interfaces and Presentation**]: User Interfaces; H.5.3 [**Group and Organization Interfaces**]

Keywords

personalization, information retrieval, user interface design, mobile search, information organization

1. INTRODUCTION

The number of people using their mobile devices for searching the Internet is increasing and as such mobile search is becoming more widespread. Since users are interested in being supported in their mobile search activities, personalization, automatic categorization of search results and ergonomic user interfaces are needed. This contribution documents exemplary the development of a user interface for a mobile device, more specifically for a smartphone manufactured by Apple known as the iPhone. The interface allows the user to retrieve and organize data in an ergonomic fashion. In order to provide users a more simple entry in search initialization and resumption of past research tasks, users can choose whether they like to enter a new query into a classic input field or whether they like to select a past query out of a automatic generated tag cloud. Special features of the mobile device, like the small display size and novel interaction methods were taken into account. The Context Adaptive Retrieval System Architecture (CARSA, shown in Fig. 1) [4] is responsible for processing user queries and returning personalized results to the user. CARSA uses search engines like Google, personalize the initial search results by using user profiles and structures the result sets based on different classification and clustering algorithms.

2. RELATED WORK

While examining existing search result visualization techniques like presented in a survey by Carpineto et. al. [5] issues of web clustering engines are discussed. One of these issues is the visualization of the clustered results. Here, the different visualization methods implemented by current web clustering engines are examined. Several user studies proved categorization of information can improve the user experience in retrieval tasks. More precisely user interfaces that provide categories are more effective than simple listings for showing and exploring information [6]. In [6] the effectiveness of several interfaces for search result organization were evaluated. Since they were 50% faster in finding information from categories, users preferred these interfaces. Similar results are presented in [12]. Furthermore in [9] their paper a search interface is presented, that has been designed for improved navigation and visualization of result sets on mobile devices. Other surveys like from Church et al. [7] are focusing on adapted screen characteristics in order to provide mobile search users. In our work we go on by replacing inadequate visualization methods with graphical cluster representation or small lists of text were appropriate.

3. METHODS

In order to follow a user centred design process [2] like proposed in Usability Engineering by Nielsen [3] we made use of questionnaires [13] based on sketches, informal design reviews, thinking aloud protocols [10] and paper prototyping [17] and Fig. 5 in order to improve the concept in each development phase. Furthermore we follow a formative evaluation process. So results of user tests and interviews were taken into account from the early beginning of development.

4. ANALYSIS

During the analysis phase the project goals, user group and the use context were identified. According to [3] we sub-classified the analysis into several specific analyses: a user analysis, task analysis and a competitive analysis.

4.1 User Analysis

Since searching on smartphones is more similar to searching on personal computers than searching on regular mobile phones [11] it was decided to focus on users of smartphones. In particular statistics by The Nielsen Company and by comScore were examined: ComScore [14] states smartphone users are relatively young (51.4% are under 35, see also Fig. 2). The statistics published by The Nielsen Company [8] paint a similar picture as to age distribution with most users between the ages of 25 and 34 (29%) or 35 and 44 (24.5%). Smartphone users were found to be predominantly male with 59%. Users were also found to have a high income with 35.1% of users having an annual household income of more than $100,000. While 52% of users keep their phones for personal use, 48% use their phones for business.

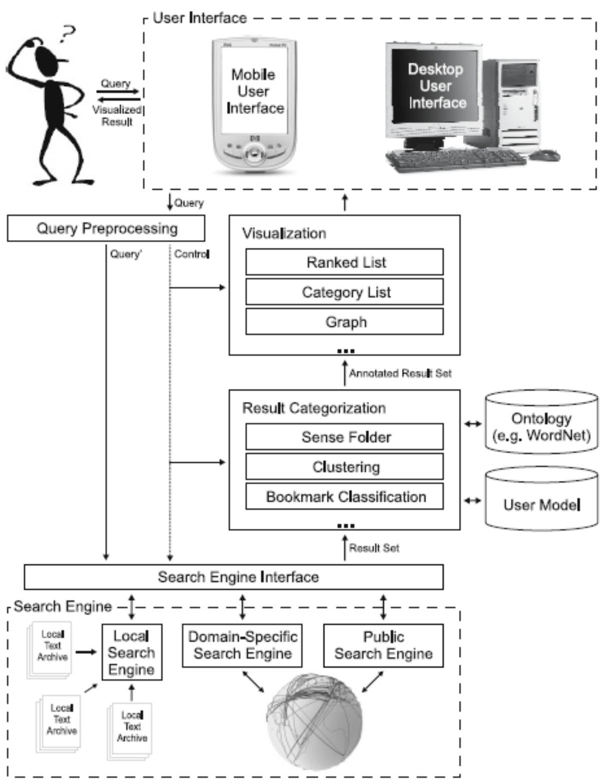

Figure 1: CARSA system architecture [4]

4.2 Task Analysis

The program is supposed to allow users to find information using a search engine and selecting the relevant information from categories, provided by cluster analysis of CARSA.

4.3 Technical and competitive Analysis

The smartphone used here supports multi-touch and accelerometer input. Multi-touch allows users to send commands to a device by applying multiple finger gestures simultaneously to the display. In most mobile applications multi-touch is used for zooming in and out by using pinching gestures. Prominent examples include Safari, Photos and Google Maps. A different use for multi-touch is in painting applications like Cyberlinks's YouPaint, where users can paint on a canvas with multiple fingers simultaneously.

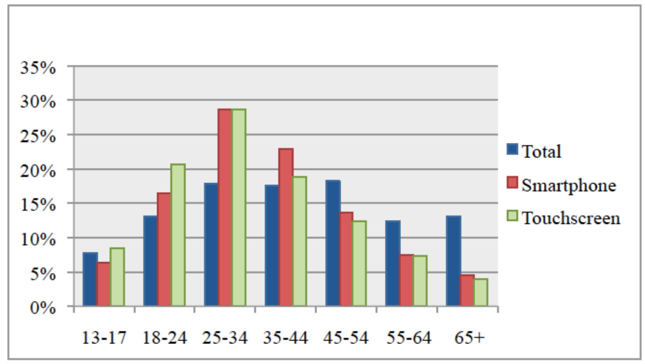

Figure 2: Age distribution of smartphone users [9]

The accelerometer is often used to determine the orientation of the mobile device. Examples include Safari and Notes. A further use for accelerometer input is in games, e.g. for aiming or steering. Although the novel interaction techniques are used extensively in games, it seems that they are rarely used in productivity applications and if they are used, their use is only limited to certain cases.

4.4 Concept and Design

The comic strip developed for this work is shown in Fig. 3. The first screen to the left shows the screen the user will see upon executing the program. This layout has a text box for entering keywords and a tag cloud [16], which shows the most recently, used search queries. The search box design was chosen, because most users will be familiar with it from search engines like Google, thereby we are keeping consistency and complying with user experience and habits. To provide an alternative entry point for users recently used search keywords are shown in a tag cloud. This personalizes the user interface and might speed up the search process, since users do not have to enter repetitive popular keywords. This quite new and unconventional dialogue design was chosen since the aim group were relatively young users, where the acceptance of new concepts is higher.

The navigation bar at the top of each screen is common to many iPhone applications. As defined in the iPhone Human Interface Guidelines [1], the navigation bar should show the name of the application and allow the user to go back to the previous screen.

Once keywords have been entered and the search button has been pressed, the third screen appears. This screen shows a clustered view of the results. Clustering helps users

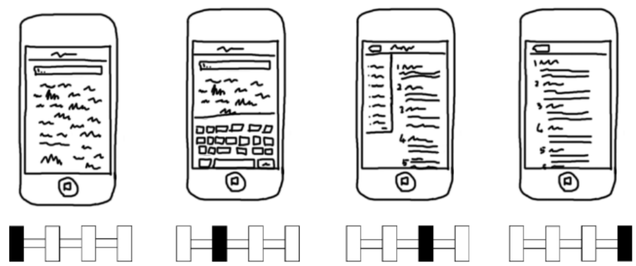

Figure 3: Application flow comic strip with state diagram: 1st selecting input mode, 2nd enter a query, 3rd and 4th choose from (clustered) result list

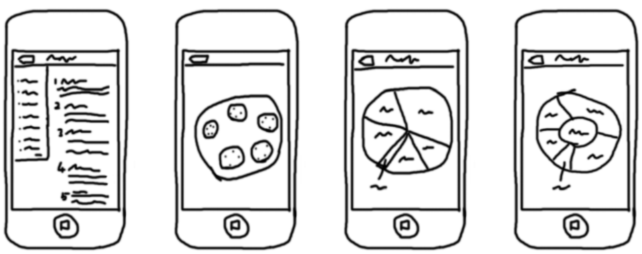

Figure 4: Different pre-prototype sketches for cluster visualization methods: 1st ordinary list view, 2nd Venn diagram view, 3rd pie chart view, 4th touch-optimized pie chart view

refine their search results and avoids users having to scroll through long lists containing a lot of irrelevant information. The small nature of mobile device displays makes it important to prevent an information overload. That is why information shown on one screen needs to be kept to a minimum. In the comic strip in Fig. 3, a hierarchical folder layout was chosen to visualize the clusters, but a number of different options exist for displaying clustered search results. The designs shown in Fig. 4 represent the most common alternative techniques of visualizing clusters.

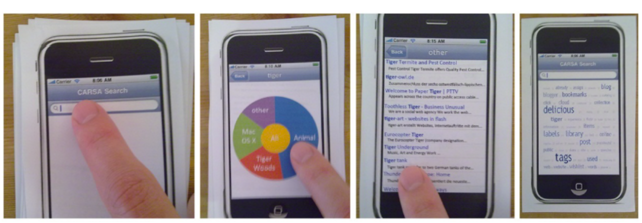

Figure 5: Testing with the paper prototype

5. IMPLEMENTATION

Recent searches are stored on the device in order to present them to the user in the form of a tag cloud on the first screen, which is shown in Fig. 6. Interaction with the program happens mostly by touch and multi-touch. On the first screen the user can enter a keyword by touching the search bar and then touching keys on the virtual keyboard. Alternatively users can touch a single or a multi-word composed query of recently used search keywords shown in the tag cloud. On the second screen a pie chart-like visualization appears and

Figure 6: The first, second (two zoom levels) and third screen

offers users to select from different categories (incl. "all") to refine the search. In order to offer users the opportunity to take a look into a specific cluster, users can zoom in using the pinch-in gesture to start a semantic zoom (ref. Fig. 6, second screen, zoom level 2). By zooming in more and more information about a certain cluster is unveiled. After selecting a cluster users will get a ranked result list (Fig. 6, third screen).

6. EVALUATION

After setting up various design reviews and tests with paper prototypes a final summative evaluation was conducted: As it was the case with previously done tests (Fig. 4), five users tested the system. According Nielsen et al. [15] this small number of users is sufficient to identify at least 85% of all usability design errors. The users were three women and two men and they had an average age of 23 years. In the first scenario users were asked to search for the tiger animal by using the keyword "tiger". They were further encouraged to use multi-touch zooming on the screen showing the clusters in order to experience the semantic zoom to choose from the correct category. After that they were asked to open one of the results. The overall task proved easy for the users and none of them had serious difficulties. Users had some comments about the semantic zoom. Two of the users liked the semantic zoom, two others said too little information was displayed when zooming in and one user said that using the semantic zoom wastes time and that the traditional method of just selecting a cluster without zooming is much faster. One user further suggested making the zoom faster. In the evaluation sheet users rated difficulty of the first scenario as "easy".

The second scenario consisted of users searching for the tiger tank by using the keyword "tiger". None of the users had problems with this task. The same was true for the third scenario, where users were asked to clear the stored search keywords from the last hour. The difficulty of completing both second and third scenarios was rated as "easy" in the evaluation sheet.

7. RESULTS

Even though semantic zoom was supported in the new version of the application, users rated the usefulness of multi-touch zooming only slightly better than in the previous test. Changing of the device orientation was rated the same as in the previous test with users saying it improves the usefulness

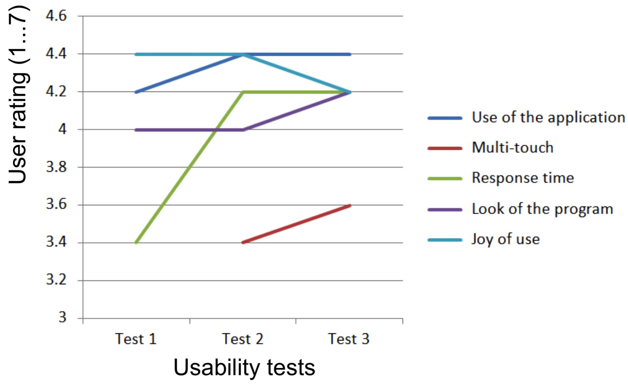

Figure 7: Results of the three user studies (1 = very bad, 7 = very good)

of the application "a little".

Overall users liked the program (Fig. 7). We used a Likert-scale with 1 = very bad and 7 = very good. Furthermore users said they would use it 2 to 4 times a week and it responded "fast" and looked "nice" and they enjoyed using the program. These are the same ratings the program received in previous tests. Most users understood all the words used in the application and on average no errors were encountered. One of the main improvements between user testings, the semantic zoom, proved less popular than expected. Nonetheless the application received favourable ratings, as in the previous test.

8. DISCUSSION AND FUTURE WORK

By the prototype presented in this paper we like to show the potential value of certain techniques, which might support users in satisfying their daily information need. Future work might include the integration of a lexical database like WordNet in order to provide the user with similar queries for the tag cloud in order to create an alternative entry point for the program. Since users felt the semantic zoom did not make the application a lot more useful, it could be examined how to improve or change the semantic zoom functionality in order to make it more attractive. Another area worth examining might be the representation of the final search results. At this point the program shows a list of results when a cluster is selected. This list of results could be improved by providing a more pleasing visualization, like for instance showing a cover flow animation of screen shots showing the various pages.

9. ACKNOWLEDGEMENTS

The work presented here was supported by the German Ministry of Education and Science (BMBF) within the ViERforES II project, contract no. 01IM10002B. Special thanks goes to Martin Schemmer, who developed the prototype within his study thesis.

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