Specialized Design of Web Search Engine for the Blind People

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Abstract. In this research, Google Website was taken as a Web prototype to get modified. Specialized Search Engine for the Blind (SSEB) was constructed with an accessible interface and some improved functions (i.e., searching assistance functions, user-centered functions, and specialized design for the blind). An experiment was conducted to verify the effect of SSEB. From experimental results, it's significant that users attained better performance in SSEB than in Google. Users also showed higher satisfaction with SSEB.This research proves that the consideration for designing an accessible website for the blind users is very important. It is expected that the users group of SSEB can be expanded to all visual-impaired people in the future. So that all people can keep pace with the changing World Wide Web, and make good use of all the Internet resources without disabilities and limitations.

Keywords: Web search engine, Blind; Web searching, Web accessibility, Google.

1 Introduction

Accessibility is becoming increasingly indispensable to the Internet experience. For the disabled persons, especially the blind people, the minimum condition is to ensure that everyone can understand all the content of the webpage.

World Wide Web Consortium [11] developed "Web Content Accessibility Guidelines 1.0" which contains 14 significant guidelines. These guidelines explain how to make Web content accessible to people with disabilities. They are intended for all Web content developers and for developers of authoring tools.

In compliance with the difficulties encountered by the Department of Communication and the Arts, Online Public Access Initiative, and some studies of the people with disabilities in surfing the web [3][10], we can classify the difficulties according to the computer equipment and the data obtaining operation.

Several studies about audio supplementary instruments have been great contributions to the people with visual impairment [2][4][7].

The Web Access Project [4] has developed methods for adding captions and audio descriptions to movie clips, making Web-based multimedia more accessible to users with sensory impairments.

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World Wide Web Consortium [12] recommended that content developers should offer search mechanisms which satisfy varying skill levels and preferences when providing search functionality. Most search facilities require the user to enter keywords for search terms. Users with spelling disabilities and users unfamiliar with the language of the web site will have a difficult time finding what they need if the search requires perfect spelling. Search engines might include a spell checker, offer "best guess" alternatives, query-by-example searches, similarity searches, etc.

The Web and especially major Web search engines are essential tools in the quest to locate online information for many people. Jansen & Spink [9] examined characteristics and changes in Web searching from nine studies of five Web search engines based in the US and Europe. They compared interactions occurring between users and Web search engines from the perspectives of session length, query length, query complexity, and content viewed among the Web search engines.

Jansen et al. [8] have analyzed more than 50,000 queries in Excite's query log and found that users use few terms (2.21 per query) when searching the database. The survey also shows that only approximately 5% of the users use advanced search features like the Boolean AND-operator (very few use OR and AND NOT) and relevance feedback (the latter is used in 5% of all queries). A third important point is the examination of search results. Only 20% of the users looked beyond the first two result pages. On average each user looked at 2.35 pages.

Google [6] makes a beta function open to public use, that is, Personalized Search. Using Personalized Search, users can get the results most relevant to them, based on what they've searched for in the past.

In this accessible Web, the functions are constructed from the blind people's requirements. Four main objectives of the research are as below:

(1) To design an accessible Interface especially for the blind people;
(2) To modify the searching process, and to simplify the input methods and steps;
(3) To construct user-centered functions and specialized design for the blind;
(4) To help the blind people to shorten their searching time, and to seek the right information successfully.

It is expected that the blind person can learn and use this website by him/herself just like ordinary person, and get all the information he or she needs by this system. So that they can keep pace with the changing World Wide Web, and improve their learning scope and efficiency.

2 Methods

2.1 Basic Design Structure of SSEB

Google Website[5] is selected as a Web prototype to construct an improved web searching engine: Specialized Search Engine for the Blind (SSEB). To refer to Chapanis'[1] methods of system design, operational-need for the blind people and system requirements are analyzed firstly. Then functions and interface are designed, and the website simulator, i.e. SSEB is constructed. An experiment is conducted to

test and verify the performance of SSEB and Google, and the performance between ordinary and blind people.

In addition to improve the blind users' searching process, some user-centered functions will be added to SSEB to make it more accessible. The interface will be designed to conform to web accessibility especially for the blind people.

Three primary aspects of improvement are as below:

(1) To design an accessible interface especially for the blind people;
(2) To modify searching process;
(3) To construct user-centered functions.

The output of the system is read by audio supplementary instruments mainly. Information on the interface of SSEB will be read by screen readers such as JAWS and Big Eyes. Users use a keyboard to input keywords, keyboard shortcuts, personal setting, or other data. Three major parts of the design functions are:

(1) Analysis of searching conditions;
(2) Analysis of searching results;
(3) Specialized design for the blind.

2.2 Constructing SSEB

After confirming all functions, SSEB is constructed by a web development tool, Macromedia Dreamweaver MX 2004. The documents are written in the type of Asp VBScript, and Microsoft Access is adopted as the database to store the query results and subjects' searching records. A friendly interface is designed by considering the blind people's experience of using Google

Basic Functions

1) Users have to register a user ID in SSEB in order to use other specialized functions.
2) Uses have to login SSEB by their registered ID and password.
3) Users can input keywords to execute the searching function.

New Establishing Functions

1) Adjustable display function

Users can change the display mode according to their preference. Fig. 1 shows the unabridged mode, and each search result contains five items in this mode, i.e. website title, concise content, url, webpage size, and the latest updated time.

In the brief mode, three items of each search result are abridged, and only two are left: website title, concise content. This mode can help users to focus on the focal point of each result, and then users can browse the result pages quickly.

2) Results sorting function

Searching results can be sorting by five items (i.e. website title, concise content, url, webpage size, and the latest updated time). Users have to choose one item, and to ascend or descend the data.

3) Bookmark function

Users can label bookmarks for the sake of retrieving searched websites. If they are interested in any of the results, they can click the link of the serial number above each result, and then this result will be stored into the "Bookmark List" page. With this function, users can browse more searching result pages and find more useful websites for them.

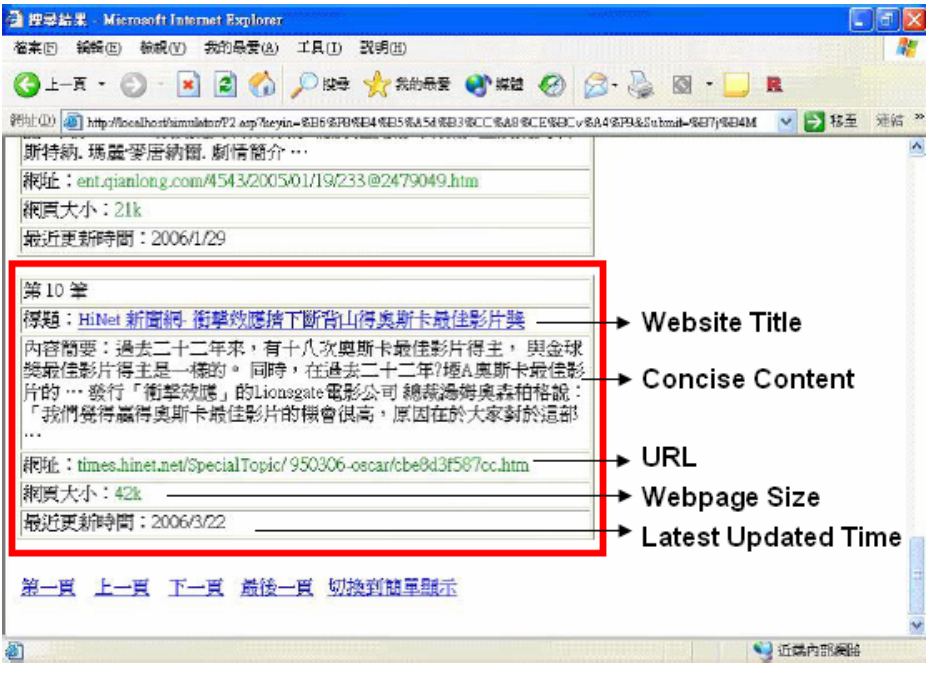

Fig. 1. The unabridged mode

Experiment and Verification. After SSEB had been constructed and accomplished, an experiment was conducted to test the performance of this system.

The experiment was designed to compare the performance of SSEB with the original Google search engine (i.e. control). All subjects were asked to fulfill two kinds of experimental tasks:

(1) Subjective judgment and opinion:

Questionnaires were carried on to test learning efficiency and users' degree of familiarity and preference with this simulator;

(2) Objective searching experience:

Searching time and correct rate were collected after each searching tasks.

Twelve subjects were invited to attend this experiment. Eight of them were visual-impaired people (including four blind people), and four were ordinary people. The experiment was designed so that each of the twelve subjects used the two systems in a

random order. Each subject could complete the evaluations at an individual pace, to ensure that the experiment reflected real-world conditions and to diminish the effects of fatigue on the users.

SSEB was a helper application which ran within Internet Explore of Windows XP on a notebook computer. All the text would be read out by the screen reader (i.e., Big Eyes I). The ordinary subjects were requested to wear an eyeshade during the experiment to imitate the blind people.

Searching time and correct rate would be collected and analyzed to compare the performance of SSEB with Google. The performance of three groups (i.e., the blind people, intermediate visual-impaired people, and the ordinary people) would also be discussed. The results of the subjective questionnaires would be analyzed to modify the system.

3 Results and Discussion

The data were collected from the experiment to compare the performance of SSEB with Google, and to find out if there is any difference of searching achievements between the visual-impaired people and the ordinary people. Subjects' performances were evaluated by three indexes: the searching time, the correct rate of searching tasks, and statistics of the subjective questionnaires.

3.1 The Searching Time

A two-way analysis of variance was adopted to test the equality of populations means classified by two factors: system and group. The two-way ANOVA is a factorial method to study the interaction among the independent variables of system and group and their effect on average searching time. There was a significant difference among the systems (p-value = 0.024 < 0.05). However, the effect of the three groups on the searching time was not significant (p-value = 0.199 > 0.05), and the results of a two-way ANOVA showed no significant interaction between Systems and Groups on average searching time (p-value = 0.163 > 0.05).

Because each participant fulfilled both the searching tasks of the two systems, the testing method of paired t-test was applied to test the mean difference between SSEB and Google. The results indicated that the mean time for SSEB (mean = 393.92) was statistically (p-value = 0.024 < 0.05) lower than the mean time for Google (mean = 717.33). It meant that users spent shorter time on searching the designated answer in SSEB than in the original Google search engine.

In order to find out the difference in detail, the searching time of three groups were analyzed separately. One-way ANOVA was adopted to test the equality of population means for SSEB and Google of each group. The results indicated that the mean time for SSEB of Group3 (Ordinary; mean = 403.50) was statistically (p-value = 0.027 < 0.05) lower than the mean time for Google of Group3 (mean = 1050.75). In other words, the ordinary people had better searching performance in SSEB.

There was no significant difference (p-value = 0.269 > 0.05) between the searching time in SSEB (mean = 280.25) and Google (mean = 601.00) of Group1 (Blind), and

the effect of the two systems on Group2 (Intermediate) was not significant (p-value = 0.991 > 0.05) either (SSEB mean = 498.00 and Google mean = 500.25).

3.2 The Correct Rate

It was found that the data of correct rate were not distributed in a specific distribution, so Friedman test, a nonparametric analysis of a randomized block experiment, was adopted to compare two treatments: SSEB and Google. Subjects were taken as blocks, and there were twelve duplications. (Suppose that there was no interaction between treatment and block.) All treatment effects were not rejected as zero (p-value = 0.414 > 0.05); that is, the effect of the correct rate of SSEB (mean = 0.8667) and Google (mean = 0.7250) was not significant.

To analyze the effects of different groups, Friedman test couldn't be adopted because there was no block. Kruskal-Wallis (Distribution-Free Test) was taken to compare three treatments: Blind (Group1), Intermediate (Group2), and Ordinary (Group3). An assumption for this test was that the samples from the different populations were independent random samples from continuous distributions, with the distributions having the same shape.

Three population medians were not significantly different (p-value = 0.939 > 0.05). In other words, the effect of the correct rate of three groups was not significant.

In order to find out the difference in detail, the correct rate of three groups were analyzed separately. Kruskal-Wallis Test was adopted to test the equality of medians for SSEB and Google of each group.

The results indicated that the correct rate of SSEB (mean = 1.0000) was statistically (p-value = 0.046 < 0.05) higher than the correct rate of Google (mean = 0.5500) in Group1 (Blind). That is to say, the blind people's searching performance of SSEB was better than that of Google.

However, there was no significant difference (p-value = 0.739, 0.617 > 0.05) between the correct rate of SSEB and Google in Group2 and Group3.

3.3 The Analysis of the Subjective Questionnaires

The subjective questionnaires included two aspects: (1) users' preference for the SSEB or Google; (2) users' integral evaluation of SSEB. To integrate all questionnaires, the one-sample Wilcoxon signed rank test was adopted to analyze data.

Subjects agreed that the configuration (i.e., the place of characters, links, and buttons) of SSEB was more accurate than which of Google (p-value = 0.004 < 0.05). It's less possible to lose their orientation when surfing in SSEB than in Google (p-value = 0.002 < 0.05). SSEB's function of bookmark was more suitable for the blind than Google's (p-value = 0.006 < 0.05). The reaction time and stability of SSEB was better than Google (p-value = 0.011 < 0.05). For the novices, to learn the searching operation of SSEB was easier than that of Google (p-value = 0.001 < 0.05). Users could search out the information they wanted more easily in SSEB than in Google (p-value = 0.007 < 0.05).

Subjects agreed that the layout of SSEB was facile (p-value = 0.002 < 0.05); the function of adjustable display was great assistance for the blind people (p-value = 0.026 < 0.05); the function of results sorting was great assistance for the blind people

(p-value = 0.003 < 0.05); the function of bookmark was great assistance for the blind people (p-value = 0.033 < 0.05); the individual specialized functions (e.g., personal calendar, schedule reminding, newsflash, etc.) would be great assistance for the blind people (p-value = 0.002 < 0.05). However, subjects did not show significant favor for the number of results per page (p-value = 0.221 > 0.05).

3.4 Discussion

From the results of the experiment, the improved design of SSEB had shortened all users' searching time obviously. It could also help the blind people to search for the correct object, and enhance the integral performance significantly. Based on Web Content Accessibility Guidelines [11], the main factors that affected the performance were analyzed and described as follows:

1) SSEB provided equivalent alternatives to visual content, i.e. the alternative words of images, graphs, or buttons. Then the assistive technology, e.g., screen reader, would read those alternative words to visual-impaired people, so they could easily understand the information on the web page. Some unnecessary elements in SSEB were even removed in order not to confuse the users. However, Google didn't achieve this guideline, and therefore the difference between the two systems existed.
2) The characters in the pages of search results in Google were not read smoothly by Big Eyes I. By contrast, the characters of SSEB were pronounced unhindered, because the paragraphs were designed well to ensure that pages featuring new technologies transform gracefully.
3) There were many repeated functional items in the forefront of the result pages of Google, which would waste users' time on skipping among those items. The needless items would lower users' searching efficiency. As regard to SSEB, it provided clearer navigation mechanisms. It included document titles and identified the target of each link explicitly.
4) As to interim solutions, SSEB provided default, place-holding characters in edit boxes and text areas, and didn't cause pop-ups or other windows to appear without informing the user.

From the subjective questionnaires, subjects showed apparent preference for SSEB. They agreed that the configuration, navigation concepts, the function of bookmark, reaction time and stability of SSEB were all better than which of Google. Furthermore, it was easier for the novices to learn the searching operation of SSEB than that of Google, and users could search out the information more easily in SSEB than in Google.

As to subjects' integral evaluation of SSEB, their satisfaction with SSEB was quite high. Subjects agreed that the layout of SSEB was facile. The individual specialized functions, the functions of adjustable display, results sorting and bookmark would be a great help for the blind people. The advantages of SSEB were that the structure of pages was well organized and clearly stated, and to learn and operate SSEB was effortless. SSEB could help visual-impaired people to find information more easily and efficiently.

4 Conclusions

On the basis of Web Content Accessibility Guidelines 1.0 (World Wide Web Consortium, 1999), SSEB was constructed from the Google Website as a web prototype. SSEB provided an accessible interface designed especially for the blind people, and users could browse through this system by screen readers. With the friendly system, the blind people could use simple logical thinking to achieve their searching tasks.

With the assistive functions of SSEB (e.g., adjustable display and results sorting), the advanced searching process and conditions were modified, and the searching methods and steps to achieve the same goal were also simplified. The experimental results demonstrate that these functions could help the blind people to shorten their searching time, and to seek the right information successfully.

Especially for a large number of information retrieving, the user-centered functions and specialized design for the blind (e.g., bookmarks, personal calendar, schedule reminding, newsflash, etc.) would be great assistance for the blind people. It would be extremely convenient to the users that they could set SSEB for their personal behavior and habit to satisfy their own demand.

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