WEB BROWSING
FOR THE VISUALLY IMPAIRED

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Abstract

The aim of our work is to enable visually impaired users to effectively browse the Web alone or with sighted co-workers. We have built a prototype browser which uses information retrieval to provide a set of complementary options to summarise the Web page. Synchronised visual representation enables co-work with sighted users.

1. Introduction

At the Speech Project at Oxford Brookes University we have built a Web navigation tool called BrookesTalk that employs information retrieval techniques to summarise a Web page for quick orientation [7]. This paper describes the facilities embedded in BrookesTalk. It includes a brief description of the information retrieval techniques used to extract keywords and abridged text from a Web page.

The paper also describes our evaluation of the usability of BrookesTalk particularly the keywords and summary information facilities. We discuss the future for information retrieval techniques in page orientation and then discuss some of the questions our evaluation raises.

2. The aims of the speech project

Speech output screen readers for the blind such as JAWS and browsers such as pwWebSpeak, enable the user to move around the screen, jump to interaction objects in the screen and read particular areas of text enabling the user to build up a picture of the screen and move around within it.

These tools become unwieldy when moving quickly around the Web searching for information and making hasty decisions about which pages or bits of pages might be useful. Users are often searching for information on a set of related themes and need to keep track of where they have been and which pages might be useful within themes. In addition visually impaired people need to work on the Web with sighted users.

The aim of BrookesTalk is to support users in this type of activity where speedy decisions about the usefulness of a page or part of a page are paramount [6].

3. How BrookesTalk works

BrookesTalk is a small speech output browser which is independent of visual browsers and also independent of text to speech software applications as it uses Microsoft speech technology.

It includes the functionality of a standard Web browser for the blind [4] such as pwWebSpeak in that it can break up the text part of a Web page into headings and links and read out paragraphs etc. However the main aim is to provide an orientation tool for blind users in the form of a virtual toolbar of functions that will provide different synopses of a Web page to help the user decide whether it will be useful to them or not.

Users can select from a menu of list of headings, list of links, list of keywords, list of bookmarks, an
A WEB NAVIGATION TOOL FOR THE BLIND

While the speech driven browser is our first priority, the need for blind or visually impaired people to co-work with sighted users is paramount for total integration into the workforce. In addition people with residual sight need to use all senses that can help them. For this reason we have included different visual representation of the Web page as a facility in BrookesTalk. Users can elect to run a standard visual browser concurrently and also display a large text version of headings, links and keywords. An indicator shows which word is being spoken at any time.

The list of keywords consists of words which are assumed [1] to be particularly meaningful within the text. These are found using standard information retrieval techniques [5] based on word frequency. Abridged text is also compiled of special sentences which have been isolated using key trigrams. The scratchpad allows users to save any sentence they are listening to, which they consider important or worth noting, simply by pressing a key. They can then playback lists of sentences linked to particular pages. The summary of the page includes author defined keywords, the number of words in a page, the number of headings and the number of links.

4. Keywords and abridged text

A list of keywords for three different Web pages are shown in Table 1. It can be seen that the small number of keywords could be used to augment or replace information given in the title if it was not available or perhaps not informative.

When keywords are used contextual information imparted by the position of a word in a sentence is lost. Extraction of three word key phrases or trigrams preserves some word position information. The technique is based on ‘Word level n-gram analysis’ in automatic document summarisation [3] To provide a measure of similarity, groups of words appearing together rather than individual words are compared. To reduce the number of word-level mismatches due to the normal changes in spelling required by grammar, each element of a trigram was assigned the stem of a word [2] rather than the word itself. The trigrams presented were ranked by frequency.

<table>
<thead>
<tr>
<th>Trigram</th>
<th>Frequency</th>
<th>Content Words</th>
<th>Keywords</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>equal opportun polici</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>
Table 2  Scores for Trigrams and their components on the RNIB ‘Equal Opportunities Policy’ page.

High frequency trigrams occur twice, low frequency trigrams once, providing at first glance little to distinguish between them. Many of the words in the trigrams are noise words which are required for grammatical correctness and are not content bearing. A summation of frequency of trigram, number of content words in the trigram and number of keywords in the trigram appears as the score for the trigram in Table 2. which shows key trigrams for the RNIB ‘Equal Opportunities Policy’ page.

Abridged pages were created by computing the key trigrams of a page, according to score, and then creating a page consisting of the sentences in which the trigrams appeared. Abridged pages on average worked out to be 20% of the size of the original text and, unlike keyword lists, are composed of well formed (comprehensible) sentences.

5. Evaluation of BrookesTalk

5.1 Keyword evaluation

Preliminary experiments were performed to assess the usefulness of the keyword list as an indicator of page content compared to the headings list or the links list. Headings and keywords in particular were judged to be roughly comparable in that they provided a list of indicating words or short phrases. The argument for incorporating keywords in the BrookesTalk menubar is that it provides more flexibility for the user in summarising the Web page. If the author has truly encapsulated the meaning of subsections of the page in headings then headings should provide a significantly better indicator of page content than keywords. However headings are often represented as images which do not provide speech output, or are eye-catching rather than informative. In this case keywords could provide a better summary. The aim of BrookesTalk is to provide a range of tools to aid orientation thus overriding many of the vagaries of Web page authoring.

Users’ perception of the usefulness of the representation was measured by asking them to evaluate the usefulness of describing a Web page using the three different types of summary representations, headings, links/anchors, and keywords.

Twenty subject users were given the different representations for six different Web pages. The pages were chosen to maximise variability. Subjects gave a score between 0 and 5 for each representation. The sum of the scores for each representation, together with the percentage of the total score it represented, was taken to give an indication of its effectiveness. Results are shown in Table 3.

We see that users perceived that keywords provide a considerable improvement on the use of links to orientate users to Web pages. Headings gave the best score but the score for keywords was not significantly different.

<table>
<thead>
<tr>
<th></th>
<th>Total Score</th>
<th>Percentage of available marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headings</td>
<td>406</td>
<td>58.09</td>
</tr>
<tr>
<td>Anchors</td>
<td>313</td>
<td>45.24</td>
</tr>
<tr>
<td>Keywords</td>
<td>392</td>
<td>55.28</td>
</tr>
</tbody>
</table>

Table 3. Scores for different representations
5.2 Experiments with summary information

The page summary was perceived to be an important tool in Web page orientation. pwWebSpeak a leading browser for the blind gives the numbers of headings, links, and images as its summary. The BrookesTalk summary comprising title, author name (if any), author defined keywords (if any) number of words in the page, headings, links and extracted keywords was found to be more useful. The number of words in a page was found to be particularly useful for page orientation.

Special tests were run to determine the relative value of author defined keywords compared with extracted keywords. The vast majority of Web page authors do not include author defined keywords. The main purpose in including them being to facilitate inclusion in searches. Where author defined keywords did occur they were more valuable for page orientation than extracted keywords.

5.3 Usability and the BrookesTalk environment

The prototype BrookesTalk was used by a group of blind users including those at the Royal National Institute for the Blind (RNIB). User acceptance was no problem as this group were committed to finding out what software is available for blind people. They were all technically able although our ultimate goal is to develop software for non-technical users so that all blind people can use the Web.

Earlier versions of BrookesTalk required TextAssist software for the speech synthesis. This often required patching in Windows’95 and caused discouraging technical complications before getting started. BrookesTalk was then re-written to run on the Microsoft Speech engine for Windows'95. While increasing portability users were concerned that the speech engine currently uses a lot of disc space. Both versions are available.

BrookesTalk uses different voices for conceptually different parts of a Web page. This was appreciated by most but described as irritating by one. We plan to make different voices optional in the future.

Users felt that it was an advantage for sighted co-workers to work with visually impaired users and that it could often be useful when clarification was needed. Synchronisation of visual display and speech was a problem as speech output ‘jumps’ rapidly around the page. The sighted user must scroll the page independently. Some speech output has no equivalent screen pattern. Users commented that the speech output of headings and links also helped sighted users to orientate themselves to a page.

5.4 Evaluating the BrookesTalk virtual toolbar

Users were observed to rely heavily on one function rather than move between different summarising representations. They had been encouraged to try using the different functions to complement one another as they provide different views of the page. Users said that they usually know what type of page they are searching for, research work, entertainment, product details etc. They therefore know how useful headings are likely to be and can use keywords accordingly.

Surprisingly one user orientated himself by using the ‘movement between links’ key 90% of the time. We had not anticipated that he would build his conceptual model of the page by looking at what was behind it. This approach will be investigated fully!

The abridged version of the page received most criticism. The trigram analysis could easily pick out the wrong trigrams as being significant and important headings were frequently left out of the summary. The algorithm for picking trigrams is not very stable it can easily be influenced by irrelevant words. It was suggested that trigrams should carry some kind of semantic weighting if they appear in the title or headings.

The scratchpad worked well and provided an easy way of saving important sentences from the page. As yet sentences are linked to pages and a new scratchpad must be started with each new page. Users suggested that sentences could be tagged as related to search themes. In this way sentences from several different pages could be grouped by theme.

6. The role of information retrieval techniques
We have seen that keyword and trigram spotting has contributed to page summarisation, but how far can these techniques be exploited? They are purely statistical and rely on counting words to determine their importance. This is surely rather a clumsy representation of an entity as complex as understanding. Information Retrieval technology was developed to aid the location of documents in a library or other archives that match an example document, i.e. documents that are related to the content of the example document. This works well in specific areas that have their own sets of descriptive words, for example biochemistry.

The world wide Web contains a wide range of unrelated, un-refereed, diverse and freely composed documents. The content of any document is not under strict control as is the case for, say, journal articles, and so presents a less than ideal source for the information retrieval techniques to work upon. Using information retrieval techniques to aid in Web page orientation requires that the Web page conform to the expectations of those techniques. This is not always the case. Furthermore we make the assumption that a document is a complete entity dealing with one topic. We plan to extend our page summarisation to include an analysis of the page as a multi-subject document.

6.1 Multi subject documents

The method of determining keywords described above fails when the document under examination contains more than one subject. This is because the words from each subject tend to dilute each other, leading to a mixture of unrelated keywords being generated. A partial solution to this problem can be obtained by changing the focus of keyword generation from the whole document to individual paragraphs. The sentences comprising a paragraph are traditionally closely related. The identification of sets of keywords relating to the different subjects contained within a document will aid the user in the orientation process. The number of subjects in a document may also be useful as an indicator of the difficulty in locating any particular piece of information. Preliminary paper studies have indicated that the procedure is worth investigating further, and software capable of multiple subject determination is being developed.

6.2 The limits of information retrieval

The problem with using information retrieval technology to provide orientation clues is that it depends entirely on the statistical rules it embodies. The richness of any language allows a variety of words to be used to convey the meaning. The statistical methods employed here would fail to notice the connection between two documents using disjoint word sets to describe the same object or event. In order to obtain relevant keywords and subject areas in these instances, the underlying meaning of the document and its paragraphs must be taken into account. In other words the system must understand what the document is about. The structure of knowledge bases and analysis methods capable of simulating the understanding of text are currently being researched in The Intelligent Systems Research Group at Oxford Brookes University and it is intended to optimise BrookesTalk using tools developed by the group.

7. Conclusion

Initial evaluation highlighted the potential usefulness of features designed to improve navigation, such as the use of keywords and page summary. Blind users emphasised the potential of a tool such as BrookesTalk to sort through what they referred to as the ‘increasing pile of paper that arrived on their desks’ during the working day. Methods used to translate HTML formatting to speech can be applied to other formatted documents.

Evaluation has shown that users have many different approaches to the use of BrookesTalk. Some stick with a small set of options and use them all the time. Others make what at first appear to be quite perverse choices of facilities, for example the user who orientated himself to the Web using links only. How do we perceive a Web page? Do visually impaired users perceive it differently from sighted users? The British Computer Association for the Blind (bcab) mailing list has recently dealt with the ambivalent attitude of the visually impaired towards visual images. We continue our work to determine the best way
of encapsulating the information in a Web page.

8. References


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