EyePrint: An Information Navigation Method with Gaze Position Trace

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Abstract: We developed a document browser that traces a user's gaze position to support information navigation. It detects the user's eye movements to generate a trace. The trace is represented as a mask image on the document, and also becomes a document attribute that can be used to find the document. The trace makes it possible to know which areas of the document were accessed earlier; thus enabling the application to retrieve previously accessed information. Sometimes it is difficult to retrieve information that was just seen. This method offers a solution to the problem.

Keywords: EyePrint, information browsing, eye tracking, information retrieval.

1 Introduction

Nowadays, we can easily access a huge amount of information using computers. However, managing all of that information is difficult. One of the problem is the information reuse limitation; it sometimes becomes hard to acquire information that had been seen somewhere before. Many support methods have been proposed. An example is the bookmark function on World Wide Web (WWW) browsers, which helps us access the information the next time we want it. But such functions do not work well because we cannot evaluate the importance of the information at the time we access it.

One solution to this problem is to record everything. That is, all information acquired by users is stored and it stands waiting for the next access (e.g. Ayers, 1995; Wexelblat, 1999). But if the amount of the information grows, it becomes hard to find the exact information we want. For example, if we record everything we see, it costs too much to access the information (Bos, 1995).

In this paper, we propose a different approach to solving this problem. A trace, called *EyePrint*, which describes the user's interest, is measured from user eye movement and is attached to the acquired information. When the user wants to see a certain piece of the information again, *EyePrint* provides a clue to find it.

2 EyePrint

EyePrint is a trace generated from the user's information navigation process (Fig.1). It consists of three elements: One is the user's gaze point on the document which is measured by the eye tracker. Another is the degree of the information acquisition calculated from the user's gaze point. This is called *the value of area activation* (VAA), and it represents how long and how thoroughly the user looks at a particular area of a document. VAA is calculated in real-time for each small area of the document. The other is the user's status, which includes the date and time of document access, user's name, and the title of the document.

The VAA automatically increases when the user looks at an area, otherwise it decreases. Several assumptions are made in detecting the degree of user interest. For example, VAA increases rapidly if the gaze point moves horizontally back and forth in the same area because this indicates their careful reading of the area. The concrete VAA calculation is derived from a task analysis of online document navigation.
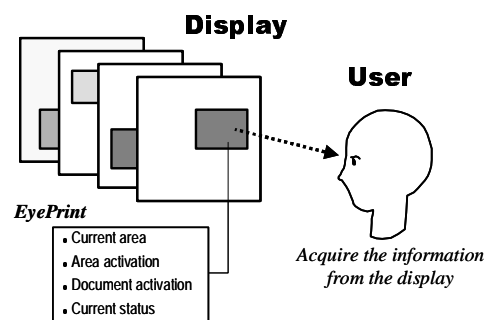

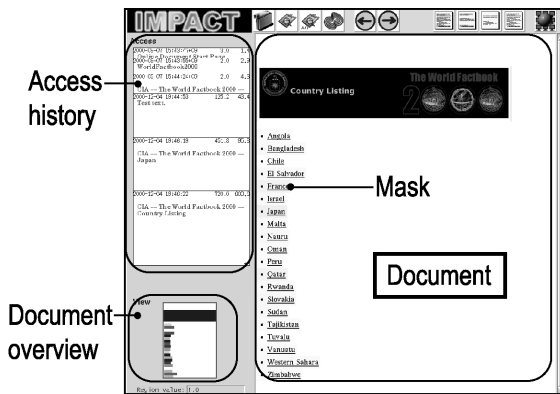**Figure1:** Overview of the EyePrint.

Figure 2: Screen image of the document browser. The Document is displayed on the right pane. Access history is displayed on the upper left pane, and a complete image of the document appears in the lower left pane.

3 Information Navigation with EyePrint

To support user information navigation, *EyePrint* provides three major functions.

- Visualization of the area activation. VAA is visualized as a mask on the area. The area turns dark if VAA is high; therefore, users are able to find an area of high activation in the document at a glance.
- Document summarization. High-VAA areas can be displayed selectively. With this function, users are able to see the well-accessed part of the document. It is also possible to display low-VAA areas, i.e. areas that users have not thoroughly read.
- Restricted keyword search. Sometimes, a keyword search for all documents results in too many candidates. VAA is used to reduce the number of candidates.

A prototype system was developed (Fig. 2). It is written in Tcl/Tk 8.3 and C and it works on a Sun Ultra2 workstation. It is able to display HTML files and plain texts, and the area of the document is defined by the HTML tags and blank lines. It is connected with an eye tracker, NAC EMR-NC, for detecting users' eye movement in 30Hz. Browsed documents and *EyePrint* are stored in a database, PostgreSQL 7.

4 User Experiences

To evaluate the usefulness of *EyePrint*, a preliminary experiment involving five volunteers (four researchers and one university student) was conducted. Twenty questions were presented and each person was asked to find the correct answer from an online document with the browser, and write it down on an answer sheet. The procedure consisted of two stages. First, they were asked to find the answers by browsing the document. In the second stage, the same questions were presented in a different order, and the subjects were asked to find the answers by browsing the document again. In the first stage, the mask was displayed on the document. In the second stage, it was displayed in the half of trials (mask condition and no-mask condition).

No significant difference in the browsing time was found between the mask condition and no-mask condition. After the experiment, *EyePrint* of each subject in the first condition was analyzed and 81% of the answers were correctly identified. With the restricted keyword search with *EyePrint*, the number of results was reduced by 83.5 % (Table 1). The results indicated that *EyePrint* did not improve the browsing speed, but it provided strong clues for finding the desired result. We also found that some areas in the document were too large and therefore contained too much information, which made it difficult for the users to find the exact position of the answer. It is necessary to refine the algorithm to define the area of the document.

	Normal	Restricted
Number of results	336	55.6 (average)

Table 1: Number of the keyword search results for the questions in the experiment.

5 Conclusion

A novel information navigation method, which uses a user's gaze pattern, is proposed. We are planning to integrate this system with a WWW browser for everyday use and evaluate the usability of the system.

References

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