Digital Index Card Creation and Management for Memorizing What You See on the Web

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Abstract. This paper proposes a method of enabling users to memorize important information obtained from daily Web browsing by letting them manage their browsing history as cards. People always encounter a lot of information on websites, but most of it is forgotten even if needed later. Therefore, we implemented a memory retention support system based on card creation and management. This system allows users to make cards semi-manually using their website browsing history. The system displays the cards in an easy-to-view manner and provides management functions. By creating and organizing the cards that summarize their daily browsing activities and reviewing the cards they collected, users can realize what they value and recall necessary information more easily. The results of the user study in which the participants used the system for a Web search task demonstrated that the proposed semi-manual card creation has positive effects on memory retention after four days.

Keywords: Information Access · Memory · Browsing History · Index Card.

1 Introduction

Historically, people have used cards to summarize unorganized information and make it stick in their memory. Such cards used to manage and learn from information are generally called "Index Cards," and many applications and styles are being introduced. Organizing and remembering information through card management is common and leads to the proposal of various applications.

Here, let us consider a method to apply such card-based memory retention techniques to Web browsing. Organizing miscellaneous information on the Web as cards will likely make it stay in one's memory. In addition, looking back at

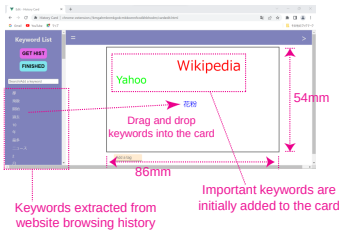

Fig. 1. A screenshot of the proposed semi-manual card creation.

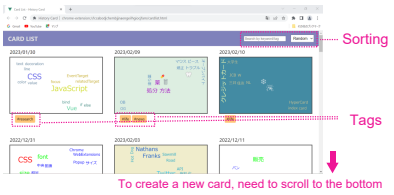

Fig. 2. A screenshot of the proposed card list for review.

the created cards and comparing them with the previously accumulated cards will make the user aware of their interest and aid in decision-making.

To this end, this paper proposes a system that takes a day's website browsing history as an input and allows users to summarize it as cards semi-manually. Figure 1 shows an overview of the system. With the support of this system, users can summarize information gained from the websites visited on that day into a card about the size of a business card.

The system also allows users to collect and manage the cards they created, as shown in Figure 2. Before proceeding to the card-making process, the system shows the list of cards the user has previously created. As a result, users can create, collect, and manage cards daily, allowing them to organize and make use of important or interesting information from the Web.

For evaluation, we implemented a Google Chrome browser extension prototype to prove that such a system is helpful. We conducted a subject experiment that lets participants use our prototype system for an information retrieval task, and checked the degree of memory retention after four days.

2 Related Work

This section introduces some related studies on website browser history analysis, card-making in the field of education, and lifelog analysis and visualization.

2.1 Web Browsing History Analysis

The analysis of Web browsing history that aims at making browsing experiences more comfortable and meaningful has been researched frequently. As an example, Wexelblat *et al.* [7] propose a method to visualize the users' paths during website browsing as a graph. There are several studies that visualize website browsing history and encourage knowledge retention. For instance, Xu *et al.* [8] express website browsing history as an undirected semantic graph based on a spring model. Our research focuses on encouraging users to look back at websites and also keep important information in memory. Also, our approach expects positive effects from creating cards semi-manually. This relates to the effect in which

people feel attached to things they make on their own, known as the "Ikea Effect [3]."

2.2 Card Making in Education

Since information cards written in the past are considered precious information resources, there are some studies attempting to digitize such cards [2]. "Hyper-Card", one of the most famous Wiki-like electronic card management systems, is proven to be effective for education [1]. Hidayat *et al.* [4] propose a method to associate paper information cards and electronic devices with an education support system for smartphones using AR (Augmented Reality) technology. Our study aims to apply such phenomenon that these cards are effective for memory retention and organization to Web browsing.

As a method to create paper cards from operation history, Shoji *et al.* [6] propose an application to automatically presume the interests of the visitors from their museum guide device and create a postcard as a souvenir.

2.3 Lifelog Analysis

Website browsing history is related to lifelog analysis, which analyzes photographs and activity data for visualizing and recording what users saw. As an example, Pirsiavash *et al.* [5] propose a method to analyze photographs as lifelogs and determine what events occurred at certain times.

In contrast to such lifelogging strategies, webpage information is more complex since it contains more detailed information and involves doing several tasks simultaneously using multiple tabs. Therefore, we propose a method to manage information semi-manually instead of classifying and choosing a representative out of it automatically.

3 Method

This section will cover our methods using the actual implementations for Google Chrome as an example. Our system consists of a Google Chrome extension API module for loading website browsing history, a front-end module for card making, and a server-side module for storing and organizing cards.

3.1 Extraction of Phrase Candidates from Website Browsing History

First, the system reads the webpage contents from the website browsing history using the Google Chrome API and infers important keywords. Next, morphological analysis is applied to the webpage titles in the loaded website browsing history. After extracting all words with the analyzer, words analyzed as nouns are selected as candidates for the important keywords. The keywords' importance is chosen from three ranks according to the number of times they appeared in the titles of the accessed webpages.

3.2 Memory Retention Support with Semi-Manual Card Making

When the user calls the system, it will call the API, extract words from the day's browsing history, and calculate the importance of each word. Words with relatively high importance ranks are added to the cards automatically. In the initial state, the font size of the keywords is proportional to the three ranks of importance, and the font colors are set based on this ranking as well.

Users can edit the keywords on this card by adding keywords from the given list or the keyword input textbox and removing keywords from the card. The rotation angle, size, and color of the keywords on the card and the card's background color can be modified. In addition, users can add tags to the cards for grouping.

3.3 Reflection Support with Card Management Interface

Immediately after activating the system, the screen shows a random list of the cards the user created. The cards on the list can be rearranged in the order of their creation date, or they can be grouped based on their keywords or tags. Additionally, the view of the list can be changed to only show certain cards by indicating keywords or tags the cards contain in common. Each card on the list can be enlarged, and users can revisit the links they have visited from the URLs associated with each keyword on the card.

The system tries to increase the frequency with which users look back at cards created in the past. Therefore, the card-making button does not appear on the initial screen, and the user has to scroll through the card list screen to find the button at the end.

4 Evaluation

We empirically evaluated the memory-retention-support effect of the proposed method through short-term website search tasks.

4.1 Comparison Methods

In the experiment, the effects of making cards semi-manually and reviewing cards are evaluated by comparing the following five methods:

- **Semi-manual creation + Review**: participants can create cards semi-manually and review them by managing the cards;
- **Semi-manual creation + No Review**: participants can create cards semi-manually, but they cannot review the cards;
- **Automatic creation + Review**: participants only get to review the cards created automatically;
- **Automatic creation + No Review**: participants only get to see the cards immediately after they are automatically generated;
- **No assistance**: participants are not involved in card-making or reviewing.

Table 1. The average ratio and number of items remembered immediately after the task and four days later (two subjects for each task, maximum of seven items).

	Immediately after	4 days later
Semi-manual Creation + Review	1.00 (7.0 / 7.0)	0.93 (6.5 / 7.0)
Semi-manual Creation + No Review	1.00 (7.0 / 7.0)	**1.00 (7.0 / 7.0)**
Automatic Creation + Review	0.93 (6.5 / 7.0)	0.57 (4.0 / 7.0)
Automatic Creation + No Review	1.00 (7.0 / 7.0)	0.86 (6.0 / 7.0)
No Assistance	1.00 (7.0 / 7.0)	0.79 (5.5 / 7.0)

4.2 Experimental Tasks

In the short-term evaluation experiment, the participants were provided with one of these two tasks:

- Make a travel plan to Hamamatsu City (a local area in Japan);
- Think of a menu for a casual wedding party.

Participants were assigned to each of the ten patterns that can be formed from the combination of the two tasks and the five methods (see Section 4.1). Each participant was assigned seven items consisting of a decision target and several requirements to investigate for the given task.

The participants were given 20 minutes to search the Web for information to help them decide about the items in the task. After searching, the participants either started making cards, reviewed the cards they created, or simply did nothing, according to the assigned card-making method. When the participants finished these, they were orally asked about their decisions for each item in the topic. Four days later, the participants were asked what they remembered about their final decisions for the items again.

4.3 Experimental Results

Table 1 shows the average number and ratio of the items the participants could recall on the day of the short-term experiment task and four days after that day. In evaluating the memory consistency of the items immediately after the task and several days later, cases in which participants forgot the main contents were judged as "inconsistent memory."

The results show that the memory consistency rates of the participant groups that made cards semi-manually were relatively high on the day of task execution and several days later. However, regardless of card making, the participant groups that reviewed the cards had lower memory consistency rates.

5 Discussion

This section discusses the effectiveness of creating cards semi-manually and reviewing them based on the results of the evaluation experiments.

The participants who edited the cards tended to have a high memory consistency rate several days later. From this result, it can be inferred that editing cards manually has a specific effect on memory retention. On the other hand, participants involved in card management had comparatively lower memory consistency rates than those who were not involved. Therefore, we could not seek a positive effect from organizing cards.

6 Conclusion

In this paper, we proposed a system that allows users to retain the information they gained from the internet on a particular day by summarizing and organizing their website browsing history with cards. From the results of the short-term evaluation experiment, it can be concluded that the proposed semi-manual card-making has some effect on memory retention.

We plan to conduct a long-term experiment to verify the effects of card editing and organizing in the future. Furthermore, we would like to upgrade the system's functions to improve its usability and increase the memory retention support effect.

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