Facilitating Parallel Web Browsing through Multiple-Page View

Wenchang Xu   Chun Yu   Songmin Zhao   Jie Liu   Yuanchun Shi

Key Laboratory of Pervasive Computing, Ministry of Education

Tsinghua National Laboratory for Information Science and Technology

Department of Computer Science and Technology, Tsinghua University, Beijing, 100084, China

{wencxu, yc2pcg, zhaosongmin, liujiejesse}@gmail.com, shiyc@tsinghua.edu.cn

ABSTRACT

Parallel web browsing describes the behavior where users visit web pages in multiple concurrent threads. Qualitative studies have observed this activity being performed with multiple browser windows or tabs. However, these solutions are not satisfying since a large amount of time is wasted on switch among windows and tabs. In this paper, we propose the multiple-page view to facilitate parallel web browsing. Specifically, we provide users with the experience of visiting multiple web pages in one browser window and tab with extensions of prevalent desktop web browsers. Through user study and survey, we found that 2-4 pages within the window size were preferred for multiple-page view in spite of the diverse screen sizes and resolutions. Analytical results of logs from the user study also showed an improvement of 26.3% in users' efficiency of performing parallel web browsing tasks, compared to traditional browsing with multiple windows or tabs.

Author Keywords

Parallel web browsing; multiple-page view; user study.

ACM Classification Keywords

H.5.2 [Information Interfaces and Presentation]: User Interfaces - Interaction styles.

INTRODUCTION

Browsers such as Internet Explorer, Firefox and Chrome are the primary means by which people access the web to get information and obtain services. Nowadays, the prevalent using paradigm with these browsers is parallel browsing, which describes the behavior where users visit web pages in multiple concurrent threads [3]. Typical examples of parallel browsing include filling in a web form with multiple online articles opened for reference, navigating and comparing several pages from Google search results or certain web portals, etc.

Qualitative studies have observed users using multiple

browser windows or tabs to browse in parallel. In general, multiple tabs are more frequently used than browser windows since they are more light-weighted and easier to navigate [3]. Nevertheless, as reported by Weinreich et al. [9], participants used multiple windows frequently in the web navigation study, enabling them to compare search results side by side. Some participants also explained that they used new tabs for closely related tasks and new windows for parallel tasks. However, neither multiple tabs nor windows are ideal enough for parallel browsing since a large amount of time is wasted on switch among windows and tabs [3]. Even though we can resize windows and arrange them side by side, there are still time-consuming adjustments before a satisfactory arrangement is obtained.

To further facilitate parallel web browsing, in this paper, we propose the multiple-page view, which is made up of an optional number of non-overlapped page containers in the same browser window and tab. More specifically, the multiple-page view was implemented as browser extensions for Firefox and Chrome on the desktop, with which users could open the current page or a hyperlink in a selected page container from the context menu of either a certain container or a window tab. Users could then visit multiple web pages in page containers of the multiple-page view without frequently switching among windows and tabs.

To evaluate our design, we conducted a user study and a survey involving 18 participants. From the usage and participants' oral feedback, we found that 2-4 pages within the window size were mostly preferred for multiple-page view on the desktop, in spite of the diverse screen sizes and resolutions. Analytical results of logs from the user study also showed an improvement of 26.3% in users' efficiency of performing parallel web browsing tasks, compared to traditional browsing with multiple windows or tabs.

RELATED WORK

A number of studies have reported that multiple browser windows and tabs are used to support multitasking and web page revisitation. Specifically, Thatcher et al. [7] observed users conducting multiple searches simultaneously by opening multiple browser windows. Aula et al. [1] found that multiple windows and tabs were used to support backtracking or multitasking while one page was loading. Viermetz et al. [8] found that parallel browsing occurred 4-85% of the time, which was a rather wide range. Moreover,
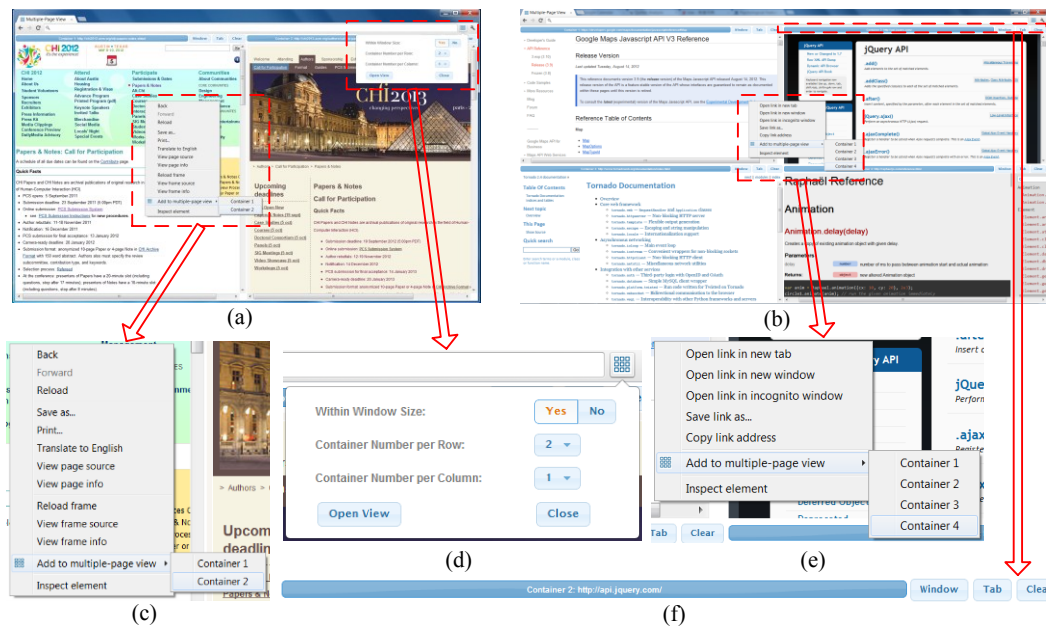
Figure 1. User interface of the multiple-page view: (a)(b) multiple-page view with 2 or 4 page containers within the window size; (c)(e) add a page or hyperlink to a page container from the context menu; (d) the setting panel; (f) the title and optional operations of a page container.

Spink et al. [6] discussed multitasking in web search, which they defined as searching for multiple topics in a single session. Recently, Dubroy and Balakrishnan [2] concluded through diary entries and interviews from 21 participants that tab switching was the second most important navigation mechanism in the browser, after link clicking.

Besides investigating users' parallel browsing behaviors, researchers have also paid close attention to the modeling and optimization of parallel web browsing. Miyata and Norman [5] explained from a cognitive psychology perspective that parallel browsing followed the model of foreground and background tasks, where foreground tasks had the current focus and background tasks did not require conscious supervision. Huang and White [3] found that users switched tabs at least 57.4% of the time, but user activity was split among tabs rather than increasing overall activity. Leiva [4] proposed to help users regain context during multitasking when performing web tasks. However, the reported results were limited. In fact, existing techniques of facilitating parallel browsing are still unsatisfactory. Next, we will introduce our design of the multiple page view and show how much it improves users' efficiency of parallel web browsing.

MULTIPLE-PAGE VIEW

Inspired by users' behavior of arranging windows side by side when performing parallel web browsing tasks, we propose the multiple-page view, which is made up of an optional number of non-overlapped page containers in the same browser window and tab. We implemented browser extensions for Firefox and Chrome on the desktop, with which users could open the current page or a hyperlink in a

selected page container from the context menu (Figure 1 (c) and (e)) of either a certain container or a window tab. We also provide a setting panel (Figure 1 (d)), where users could set the container numbers per row and per column as well as the display mode. If the display mode is set to be within the window size, all page containers of the multiple-page view will be arranged within the browser window uniformly. Otherwise, the size of each page container is fixed and the multiple-page view is scrollable if containers exceed the window range. Figure 1 (a) and (b) show the multiple-page view with 2 or 4 page containers within the window size. For each container, we display the URL in the top bar, and provide additional functions of opening the page in a new window or tab as well as clearing the existing container, as shown in Figure 1 (f). In general, the goal of the multiple-page view is to provide an important supplement to existing techniques of supporting parallel web browsing.

USER STUDY

To evaluate our design, we conducted a user study which compared the multiple-page view to traditional browsing with multiple windows or tabs. We recruited 18 participants including 13 males and 5 females, all of whom were active users of either Firefox or Chrome. The age of the participants varied between 22 and 31 years, with a mean of 26.2 years old. They were not native English speakers but had the basic English reading and writing skills.

Design

We designed two tasks, both of which were typical examples of parallel web browsing. Task 1 was related to

page comparison. Specifically, we prepared a model list of 10 different cars without any detailed features and divided them into two groups uniformly and randomly. We then asked participants to compare the 5 cars in each group from 6 aspects and orally report the "best" car of each aspect. We explained the 6 aspects beforehand so that participants had no trouble deciding the "best". Task 2 involved cross-page reference. Specifically, we selected 4 online medical professional articles of similar length and difficulty, and divided them into two groups uniformly and randomly, too. We prepared 6 questions related to the 2 articles of each group and asked participants to write down the answers in our prepared web page. Since they were not native English speakers and unfamiliar with medical-related subjects, they had to look up the medical terminologies in certain online dictionaries frequently.

Before the user study, we described the tasks to the participants and asked them to rate the correlations between the two types of tasks and their daily browsing tasks in a 5-point Likert scale. We finally got an average score of 3.67 (SD=0.91) and 3.44 (SD=1.04) for the two tasks respectively, which indicated that the designed tasks could reflect users' parallel browsing behaviors to a certain extent. We then asked participants to practice browsing web pages with the multiple-page view for at least 20 minutes until they got used to it. We also reminded them of changing the display mode and container number whenever they wanted. During the study, participants were required to complete one group with the multiple-page view and the other with only browser windows and tabs for both tasks. We asked participants to have a rest for 2 minutes between tasks. 3 LED monitors were prepared with sizes and resolutions of 15-inch & 1024*768, 19-inch & 1440*900 and 24-inch & 1920*1080 respectively, each of which was used by 6 participants. We also asked 9 participants to browse with the multiple-page view first, and the others to use tabbed browsing first to obtain counterbalanced results. We recorded all operations participants performed within the browser through the browser extension. In addition, we used the Tobii x50 eye tracker to collect the position of participants' eyes at the rate of 50Hz and an accuracy of 0.5°. Gaze data was logged by Tobii Studio. We performed a 9 point calibration of the eye tracker before each task started. Overall, all tasks were completed successfully by the participants. Next, we will show the results in aspects of preference settings, browsing efficiency and browsing experience.

Result 1: Preference Settings
Participants' preference settings showed how the multiple-page view was used. According to our log records, only 5 out of the 18 participants changed the settings during the study, which indicated that most users preferred a fixed usage pattern of the multiple-page view. 15 participants kept their display mode as within the window size, which was understandable since extra scrolling would aggravate
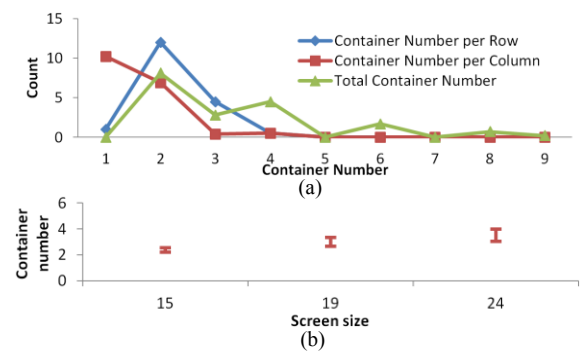
Figure 2. (a) Distributions of participants' settings of the container number per row, per column and in total; (b) the average container number with respect to the screen size (error bars represent standard deviation).
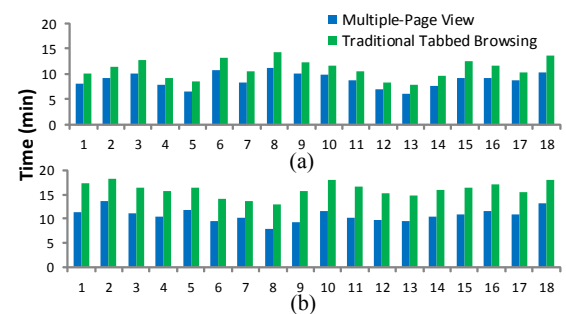
Figure 3. Completion time of (a) Task 1 and (b) Task 2 for each participant.

their browsing burden. Figure 2 (a) shows the distributions of participants' settings of the container number per row, per column and in total. For participants who changed the container numbers during the study, we count their numbers with weights proportional to the used time durations. We can observe from the figure that 2-4 pages were mostly (85.6%) preferred for multiple-page view although screens of different sizes and resolutions were used. We further studied how the screen size and resolution affected users' settings of the container number. In our study, we had 3 screen size & resolution combinations, each of which was used by 6 participants. The resolution was positively correlated with the screen size. Therefore, we described the impact by characterizing the average total container number with respect to the screen size, as shown in Figure 2 (b). The average total container number increased as the screen size got bigger, which indicated that users tended to try more containers on a larger display for parallel browsing tasks. We orally interviewed the participants and they reported that the selected container number was a balance of their browsing convenience and experience with a tolerable burden.

Result 2: Browsing Efficiency
To evaluate the browsing efficiency, we recorded the time that participants finished both tasks. For task 1, the timer started when the car list of each group was given and ended
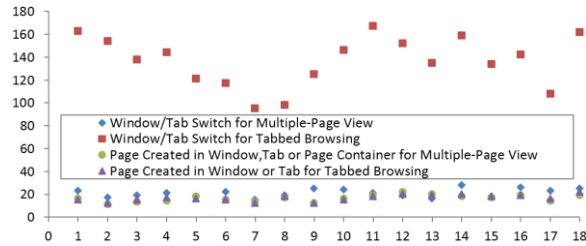
Figure 4. The count of window/tab switch and page created in the two tasks using multiple-page view and tabbed browsing for each participant.
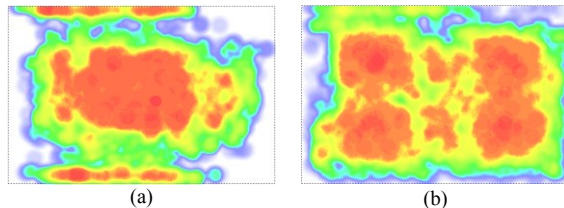

Figure 5. Heat map of viewing behavior across 18 participants in the two tasks: (a) tabbed browsing; (b) multiple-page view. (Red indicates higher frequency)

until participants reported the "best" cars of all aspects. For task 2, the timer started when the articles of each group were given and ended until all the questions were answered. Figure 3 illustrated the completion time of task 1 and task 2 for each participant. A significant difference was found between multiple-page view and tabbed browsing in terms of the completion time for both task 1 ($F_{1,16}=1.74$, $p<0.001$) and task 2 ($F_{1,16}=4.31$, $p<0.001$). The average completion time of using multiple-page view was 19.7% and 32.9% less than that of using traditional tabbed browsing for task 1 and task 2 respectively. Therefore, a general improvement of 26.3% in users' efficiency of performing parallel web browsing tasks was observed in our user study. We further investigated participants' window/tab switch and page visit behaviors during the study. As shown in Figure 4, although visiting a similar number of pages, participants switched 84.6% less among windows and tabs using multiple-page view than using tabbed browsing, which could explain the reason why the multiple-page view improved participants' parallel browsing efficiency in some way. Heat map visualization of viewing behavior showed that participants' attentions were more focused on the page content using the multiple-page view (Figure 5 (b)), while with traditional tabbed browsing, participants had to spare their attentions on managing tabs and windows, as indicated in the red areas at the top and bottom of Figure 5 (a).

Result 3: Browsing Experience

To investigate participants' browsing experience with the multiple-page view, we conducted a survey after the two tasks, asking participants to rate the multiple-page view in a 5-point Likert scale in aspects of "ease of use", "effect of browsing" and "would use in the future". The average

scores of the three aspects were 4.22, 3.89 and 4.50 respectively. Therefore, we can conclude that the multiple-page view was well accepted by users. Specifically, participants reflected that *the multiple-page view did what they used to spend a lot of time on automatically (resizing windows and arranging them side by side)* and *made a very good use of large screens to facilitate parallel browsing*.

CONCLUSION & FUTURE WORK

In this paper, we proposed the multiple-page view, showed users' preference settings of using the tool and proved through user study that it could greatly improve users' efficiency of parallel web browsing. Our design of the multiple-page view and study results could provide important guidance for the design of web browsers and even other browsing systems on desktops. For future work, we will further investigate the general usage of the multiple-page view along with browser window and tab through a long-term large-scale study.

ACKNOWLEDGMENTS

REFERENCES

1. Aula, A., Jhaveri, N. and Kaki, M. Information Search and Re-Access Strategies of Experienced Web Users. In *Proc. WWW 2005*, pp. 583-592.

2. Dubroy, P. and Balakrishnan, R. A Study of Tabbed Browsing among Mozilla Firefox Users. In *Proc. CHI 2010*, pp. 673-682.

3. Huang, J. and White, R. W. Parallel Browsing Behavior on the Web. In *Proc. HT 2010*, pp. 13-18.

4. Leiva, L. A. MouseHints: Easing Task Switching in Parallel Browsing. In *Proc. CHI EA 2011*, pp. 1957-1962.

5. Miyata, Y. and Norman, D. Psychological Issues in Support of Multiple Activities. In *D. A. Norman and S. W. Draper, Editors, User Centered Design*, pp. 265-284.

6. Spink, A., Park, M., Jansen, B. J. and Pedersen, J. Multitasking during Web Search Sessions. In *Information Processing & Management*, 42, 1, pp. 264-275.

7. Thatcher, A. Web Search Strategies: the Influence of Web Experience and Task Type. In *Information Processing & Management*, 44, 3, pp. 1308-1329.

8. Viermetz, M., Stolz, C., Gedov, V. and Skubacz, M. Relevance and Impact of Tabbed Browsing Behavior on Web Usage Mining. In *Proc. WI 2006*, pp. 262-269.

9. Weinreich, H., Obendorf, H., Herder, E. and Mayer, M. Off the Beaten Tracks: Exploring Three Aspects of Web Navigation. In *Proc. WWW 2006*, pp. 133-142.