An Adaptive Web Browsing Method for Various Terminals: A Semantic Over-Viewing Method

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Abstract. This paper proposed a semantic over-viewing method. This method extracts headings and semantic blocks by analyzing a layout structure of a web page and can provide a semantic overview of the web page. This method allows users grasp the overall structure of pages. It also reduces the number of operations to target information to about 6% by moving along semantic blocks. Additionally, it reduces the cost of Web page creation because of adapting one Web page content to multi-terminals. The evaluations were conducted in respect to effectiveness, efficiency and satisfaction. The results confirmed that the proposed browser is more usable than the traditional method.

Keywords: cellular phone, mobile phone, non-PC terminal, remote controller, web browsing, overview.

1 Introduction

Ubiquitous computing has enabled people to communicate at any time and any place. Besides PCs, terminals capable of browsing Web pages, such as mobile phones, PDAs, TV sets, car navigation systems, and information appliances, are growing increasingly diverse. In a conventional way, Web creators make pages for each specific terminal. Thereby, additional cost is needed to create and to maintain the pages. For solving this, research on terminal-adaptive User Interface (UI), which does not depend on the size of display area and input device with terminals, has been studied. For instance, techniques converting Web pages designed for PCs to pages for specific mobile terminal [Britton] have been proposed, and techniques parsing Web pages and providing adapted displays [Chen] [Baudisch] [Baluja] have been researched. Furthermore, mobile browser techniques can directly view Web pages designed for PCs on a mobile phone [Opera] [Parush].

However, these conventional techniques have problems: users cannot easily grasp a page's overview because of smaller display size or resolution, and they reach target information with too many operations due to simple input device.

Our goal is to propose an adaptive UI which allows users to browse Web pages on mobile terminal with small screen and simple input device with keeping high usability only when making pages for PCs. In various types of terminals, this paper focuses on the mobile phone because it is the typical case.

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2 Problems of Terminal-Adaptive UI

2.1 Problems from the User's Point of View

When browsing web pages for PC on mobile phone, there were several traditional methods such as converting tags from PC's to mobile phone's, and directly browsing web pages for PC on mobile phone (called a mobile browser).

However, from the user's point of view, these traditional methods have two problems.

(1) Difficulty of grasping overall structure
Because an only small part of page can be displayed, users cannot grasp an overall structure of the page and cannot understand the position of each piece of information on the whole.

(2) Low operability
In addition to a small screen, because users cannot use a pointing device, e.g. a mouse, they must require many operation steps for reaching target information.

2.2 Problems from the Content Provider's Point of View

From the content provider's point of view, when content providers create web pages for each type of terminal, the cost of creation and maintenance are necessary for each terminal.

To overcome these problems, this paper proposes an adaptive UI which allows users to browse Web pages on mobile terminal with small screen and simple input device with keeping high usability only when making pages for PCs. This paper defines usability as effectiveness, efficiency and satisfaction in the definition of ISO9241-11[ISO]. Effectiveness is defined as that users can access desired information for PCs' Web page on mobile phone. Efficiency is defined as less operation steps. Satisfaction is defined as more positive answers by subjective evaluation.

3 Novel Terminal-Adaptive UI

3.1 Semantic Over-Viewing Method

First, regarding the problem of grasping an overall structure, we featured a minified image for mobile phones to allow users to get the entire picture. However, with an only simple minified image, the smaller image prevents them from seeing details. Hence, we designed that headings is exploited and presented to showing users detailed information.

In addition to the minified image, a detailed view was provided to display detailed contents. With transition between this detailed view and the minified view, a zooming in/out technique was applied since it is more commonly used. With the traditional straightforward zooming, however, a display is not always desired, and adjustments to positioning of display are necessary, when magnifying. These adjustments are the

critical problem because non-PC does not involve direct pointing. Thereby, zooming in/out by unit of a semantic block makes it possible to magnify and minify in the more desired position and to reduce the user's adjustment of the position.

Second, solving of the low operability requires a support method for moving within a page. Indeed, there is a method with which users can jump between a certain distances. However, the method needs user's adjustments of the position for them to reach a desired target because with it they have to jump without considering the structure of the page. As mentioned above, with non-PC terminal it is the critical problem. To overcome the problem, we presented a jumping method by unit of a semantic block for improving the operability.

On the basis of this idea mentioned above, this paper proposed a method which analyzes a structure of web pages, presents the headings on the minified image, zooms in/out and jumps by unit of the semantic block, called a semantic over-viewing method. A whole browser including semantic over-viewing method is called a semantic browser.

3.2 Design of Semantic Overview

This sub-section describes design of overview. Specifically, it explains extraction of headings and semantic blocks, and layout design of overview and detailed view.

3.2.1 Extraction of Headings and Semantic Blocks

Realizing a semantic over-viewing method requires extracting semantic blocks and headings. Hence, our layout analysis technique [Tatsumi] was applied. The layout analysis engine analyzes display elements which were rendered (e.g. position and color) in addition to structure of HTML elements so that the analyzed layout is fit for human sense. Figure 1 illustrates an image of our layout analysis.

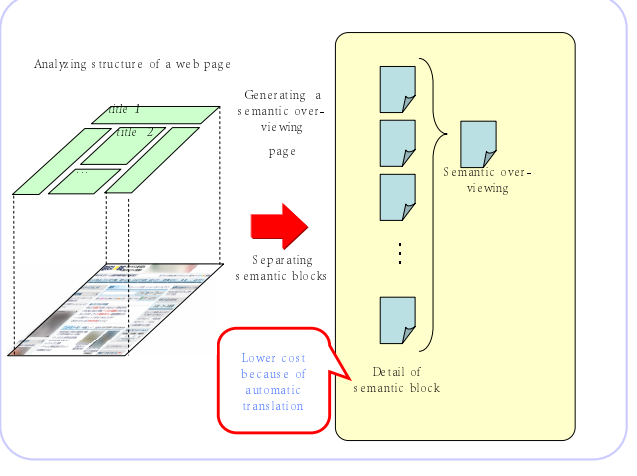

Fig. 1. Image of Layout Analysis

In this paper, a semantic block is a piece of layout with a certain size which is reflected by the page structure. The block includes some display elements. These blocks correspond to green areas in Fig. 1. The heading is the representative of the content of page, what we call headline, cross-head and subheading. The headings are shown as “title1” and “title2” in Fig. 1.

3.2.2 Overview and Detailed View

Figure 2(a) shows a screen shot of the overview. A minified image is displayed. This is a sample where the block “services” is selected. The selected block is bounded by a blue rectangle.

(a) Overview (b) Detailed View

Fig. 2. Examples of Screen Shot

Figure 2(b) shows a screen shot of detailed view. This is a sample where users jumped into the block of “services”. The aim of the detailed view is for users to get the detailed information. W adopted a display type without horizontal-scrolling such as a mobile browser because text information is more readable than a display type with horizontal-scrolling.

Although the layout of the detailed view differs from that of the overview, an animation of a frame of zooming helps users understand the relation between detailed view and overview.

4 Implement

4.1 System Architecture

The system was composed of a server and client. The server was implemented in C++ and Java Servlet. The client was implemented in java application for mobile phone. The system architecture is shown in Fig 4.

On the server-side, a layout analysis engine obtains a page designed for PCs and analyzes the page. Next, a page making/dividing section converts tags for PCs to those for mobile phones. A client server communication section sends HTML texts and images to the client-side. On the client-side, a pre-load control section loads images in the background. An overview image creation section creates an overview image from the analysis. A zooming control section controls zooming in and out based on user's operation, and translates between the overview and the detailed view smoothly with animation. A HTML rendering section renders HTML element (e.g. a tag, img tag, input tag).

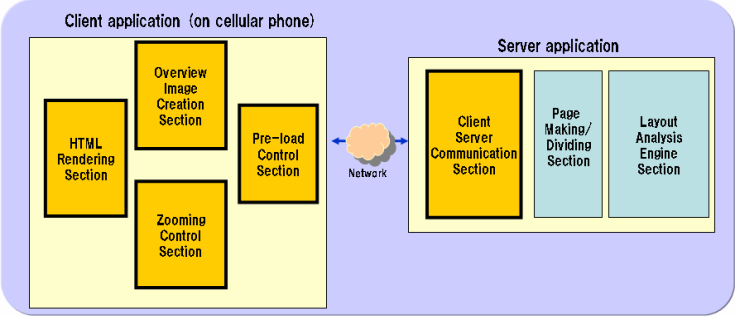

Fig. 4. System Architecture

5 Evaluation and Discussion

This section describes evaluation of the proposed method. As defined in section 2, the evaluation was conduced in respect to efficiency, satisfaction and effectiveness.

5.1 Evaluation of Efficiency

Efficiency is defined as less operation steps. An experiment actually measured the number of clicks while subjects started at the top of the web page and reached the center of the page. Specifically, the number of the clicks on the proposed browser was compared with that on the mobile browser for the web pages which were top 10 on access (e.g. Yahoo, MSN, and Amazon). The results show that the mobile browser needed 187 clicks on average. In contrast, our proposed method needed average 12 clicks. The number of clicks with the proposed method was only 6% on average compared with the traditional method. The proposed browser is significantly efficient.

5.2 Evaluation of Satisfaction

Satisfaction is defined as more positive answers on the subjective evaluation as a higher ratings. We evaluated user's satisfaction for the actual users and extracted advantages and issues on the semantic browser on the following procedures.

5.2.1 Subjects

Fifteen employees engaged in an IT company aged to twenties to forties were recruited. All of the subjects have experienced browsing PC pages on the mobile browser. Regarding the frequency for this access, "a few times a month" is eleven (79%), "a few times a week" is three (21%), and "every day" is one (7%).

5.2.2 Procedure

The subjects used freely for one month and a half. After trial use of our semantic browser, they answered the subjective evaluation. The questionnaires included three aspects: the total convenience of the semantic browser, the convenience of the semantic over-viewing method and operability.

5.2.3 Results

The results on the total convenience of the semantic browser are shown in fig. 5. Positive answers account for 60% and negative answers for 40%. The positive answer is more than the negative. Consequently, we judged that the semantic browser was positively evaluated by the subjects on the total convenience.

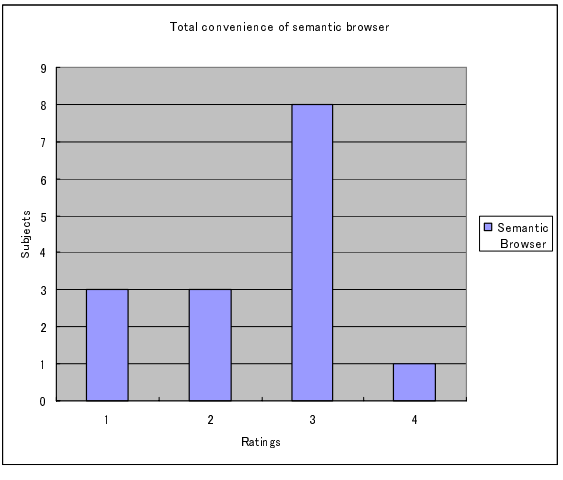

Fig. 5. Result of total convenience of semantic browser

The results on convenience of semantic over-viewing method were shown in Fig. 6. As a general trend, positive answers were 53% and negative were 47%. Little difference exists between the positive answer and the negative although the positive answer was a little more.

One of the two subjects who evaluated "not very convenience" answered "too late". Another subject answered "lower readability". One of the reasons for the low readability was due to poor image compressing algorithm when generating over-view images. Regarding delayed response, both the two subjects also rated "too late" on response. We recognized that the delayed response and low resolution downgraded the subject's ratings.

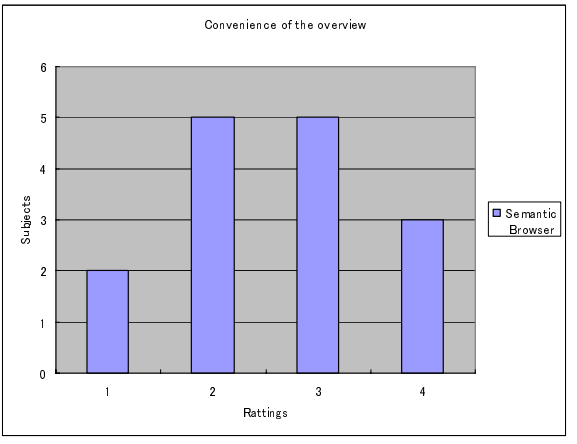

Fig. 6. Result of convenience of the overview

Figure 7 shows that the results on operability compared with mobile browser. The ratings tend to be low. Average ratings for semantic browser were 2.13 and those for mobile browser were 1.73. Although average rates for the proposed browser were a little higher than those for the mobile browser, there was little difference among the two. Three subjects rated “not very convenient of semantic browser”. The two of the three subjects are identical, who rated "not very convenient of the overview". The one subject did not comment. We judged that the reason for these low rates is similar on convenience of the overview.

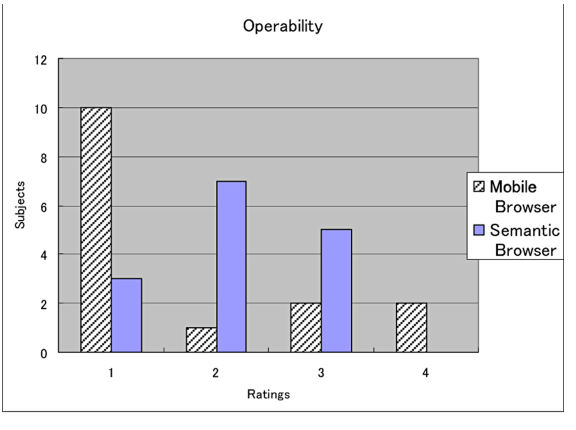

Fig. 7. Result of operability

5.3 Evaluation of Effectiveness

Effectiveness is defined as that users can access desired information through the overview. For effectiveness, evaluations on a user study and about accuracy of layout analysis were conducted.

5.3.1 Evaluation on User Study

All subjects reached the detailed view using the overview. Furthermore, on questionnaires, no one answered that she or he did not know how to use. These results confirmed that all subjects achieved the goal.

5.3.2 Accuracy of Layout Analysis

Evaluation experiment was conducted to investigate an accuracy of our layout analysis method in which headings determined by users and those extracted by the method were compared for 166 evaluation pages. The accuracy is 71.4%.

The inconsistency is divided into two patterns: excess of headings or deficiency of them. The analysis engine was designed to extract more headings. Even if too many headings are extracted, users can confirm the content within the overview selectively and they do not have to translate the detailed view. We recognized the browser had no problem in practical use.

Consequently, since they can reach all detailed views and archive the goal, the proposed browser was effective.

6 Conclusion

This paper proposed an adaptive-UI using a semantic over-viewing method. This method extracts headings and semantic blocks by analyzing a layout structure of a web page. By using the information, it can provide a semantic overview of the web page. This method allows users grasp the overall structure of pages. The features of the method are as follows.

- It reduces the number of operations to target information to about 6% by moving along semantic blocks
- It reduces the cost of Web page creation because of adapting one Web page content to multi-terminals
- It proves more usable than the mobile browser by the evaluation for effectiveness, efficiency and satisfaction

In the future work, we will plan to improve the response on semantic browser. This work also extends a task besides browsing such as navigation between pages.

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