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ABSTRACT

One of the most difficult issues in using the World Wide Web is navigational difficulty. Users easily and quickly lose their sense of where they are on the Web within a few mouse clicks. The problem occurs because the structure of the Web is not suited for organizing large amounts of information. In fact, the Web structure is a chaotic network of hyperlinks that does not have locations users can visually perceive. Additionally, Web URLs do not necessarily give clues of their locations. This paper proposes a new navigation structure of the World Wide Web that gives users the ability to know the position they are currently visiting and the point they will go to when they click on a hyperlink. It employs the structure of a regular multi-layered geographic map. With its simple and intuitive coordination organization, users can easily visualize the structure of the Web and navigate with confidence.

Keywords: Web Navigation, Hypertext Navigational System, World Wide Web, Information Retrieval System, Information Interfaces and Presentation

1 INTRODUCTION

Undoubtedly, the World Wide Web is known as the medium for driving the global economy of the 21st century. With its tremendous accessibility, it tears down the world’s trading boundary and brings people from around the globe to meet as though they were sitting next to the others. Nevertheless, because the Web organization is not designed in the first place for dealing with large amounts of information, the structure of the Web obstructs itself from showing its highest benefits.

Obviously, the structure of the Web is derived from a tree-like file system structure. It employs the concept of directories, subdirectories, and filenames to its URL (Uniform Resource Locator), which is used to allocate a document called a Web page. The tree structure has a drawback in that users can easily lose their sense of the position they currently view on the Web site. In addition, its non-standard structure does not give necessary information for users to recall the address of Web pages they have visited.

There are a number of studies presenting methods for solving this problem. Nevertheless, all available solutions trying to overcome the navigational difficulty are based on the current structure of the Web. In an attempt to solve the problem, this paper presents a new navigational structure entitled Multi-Layered Map Navigation (MLMN) that is designed for a wide information space such as the Web. In this paper, the concept of MLMN and its application to the Web are proposed. MLMN advantages and limitations are also discussed.

2 THE PROBLEM AND ITS CURRENT SOLUTIONS

The structure of the World Wide Web employs a tree-like structure. It starts from the “root” directory, which is referred to as its beginning point of the Web site. Then, using filenames and subdirectories from the root directory, it forms a URL (Uniform Resource Locator) to specify an address of a Web page. However, the length and complication of an URL are unpredictable since they are solely dependent on the decisions of Web designers. Therefore, the URL of a Web page does not give predictably possible information for users to recall and allocate the page on the Web space.

Furthermore, since a Web page is a hypertext document, it can link to an unlimited number of other Web pages by referring URLs of the others. The links, with the loose structure of the Web, create a chaotic network of Web pages in which no one can visually perceive its structure. Without an imaginative structure, users can easily lose their sense of the position they currently visit on the Web space.

Acknowledging the problem, several papers present solutions that are aimed to raise Web navigational performance. For instance, Lynch and Horton [4] assist Web designers to organize Web information into units and arrange them to be Web sites. They also provide some basic information structures that can be applied to the organization of Web sites. Spool, et al. [6] provide design tactics to improve site navigation. Additionally, admitting the unstructured environment of Web sites, Whitaker [7] suggests ten principles of navigational design.

Nielsen [5] emphasizes site design as a primary part of the success of Web sites, although the site structure is not explicitly presented to users. He provides advice for site developers to improve navigational performance by designing the site structure according to users’ tasks and goals. He also reviews different styles of site designs of existing Web sites. Nevertheless, he admits that Web browsers need to provide better tools for structural navigation. Additionally, he proposes the concept of “active sitemap,” which spots the user’s current position and gives the user’s trail of traveling throughout the site. This concept indicates the need of navigational structure similar to MLMN discussed in Section 3. Nielsen also shows his concerns about the complicated nature of URL structures. He then provides advice on how to design understandable URLs.

Methods presented in the literature give guidance on how to minimize problems caused by the deficient nature of Web structure. Following these methods, Web designers are responsible to cope with the problems. As the result, navigational quality of Web sites is varied according to
experts of their Web designers. Therefore, to improve benefits of the Web as a whole, the Web structure needs to be redesigned with an understanding of the problems and being aware of other potential problems that may arise when applied to larger information space.

3 MULTI-LAYERED MAP NAVIGATION

To overcome the problem as explained in Section 2, this paper proposes a new navigational system called Multi-Layered Map Navigation (MLMN). Other than eliminating the problem, this new navigational system also shows advantages over the current one.

3.1 The Conceptual Framework of Multi-Layered Map Navigation

The conception of MLMN is primarily adopted from a two-dimensional geographical map. Since this type of map has been ubiquitously used in everyday life, it is assumed that users can easily understand MLMN without much effort. MLMN is pictured as a heap of maps, where each map is placed on top of the others. Every point on each map can be reached using a two-dimensional coordination system that is similar to a regular driving map. With this system, an address of a point in MLMN consists of (1) a name of the map the point is located in, (2) the point's row coordination, and (3) the point's column coordination. Figure 1 shows a virtual structure of the MLMN in the way users might visually perceive it.

![Figure 1. The virtual structure of Multi-Layered Map Navigation. Each plane is a separate map, and all maps together constitute the heap.](image)

3.2 Applying MLMN to the Web

MLMN is designed for use in a large information space of hypertext. When applying MLMN to the Web, each map in the heap is a Website. The entire heap of maps is the whole Web space. Hence, the picture of the whole Web space can be imagined as a heap of maps that has infinite number of maps. Each map has infinite number of height and width. Although the Web space according to MLMN has infinite properties, its structure is better organized and easier to visualize compared to the current one.

A Web site, (i.e., a map in the heap), has Web pages arranged according to a two-dimensional coordination system. A Website can have infinite columns and rows of Web pages. In MLMN, each individual Web page has its own unified address in which users can visually perceive. The address is based on the following rule:

[Website name]: [row coordination]: [column coordination]

For example, www.umbc.edu: 1: 3 refers to a Web page in the first row of the third column from the Website www.umbc.edu as it may be depicted in Figure 2.

![Figure 2. The virtual structure of the MLMN address www.umbc.edu: 1: 3](image)

The simplicity and intuitiveness of the rule may promote better navigation of the Web site. These properties, in turn, elevate the Website's usability level. Nevertheless, Web site usability heuristic guidelines need to be entirely reconsidered when the Web is designed according to MLMN. Having a better navigational infrastructure, as provided by MLMN, can produce usability guidelines of Websites that are simpler and easier to implement in the real-world development environment compared with the existing guidelines.
3.3 MLMN Web Browser
The advantages of MLMN rely on user interface elements of its browser. For each individual Web page, a MLMN browser behaves similarly to other typical Web browsers. The differences are its navigational controller components. A MLMN browser has two main windows: one for displaying Web contents called a content window, one for containing MLMN navigational controller elements called a control window. Figure 3 shows a mock-up example of a MLMN browser. MLMN navigational controller elements are explained as follows.

3.3.1 Four-direction navigational controller buttons
Instead of having back and forward buttons as typical Web browsers do, a MLMN browser gives four buttons to users to control their navigation on a Website. Those four buttons are named Up, Down, Left, and Right. Up and Down buttons are for users to navigate in a vertical path of a map, while Left and Right buttons provide users the ability to navigate in a horizontal direction. The arrow-headed line number 1 in Figure 3 shows the four-direction navigational controller buttons.

3.3.2 History navigational controller buttons
Other than the four-direction navigational controller buttons as explained in Section 3.3.1, a MLMN browser also has two buttons, Back and Forward, for users to navigate in the history list of Web pages they have visited. These buttons, pointed by the arrow-headed line number 2 in Figure 3, work similarly to back and forward buttons in typical Web browsers.

3.3.3 Zoom button
The Zoom button is placed in the middle of the four-direction navigational controller as pointed by the arrow-headed line number 3 in Figure 3. Its function is to activate the zoom ability of a MLMN browser. The window showing Web contents of a MLMN browser has two modes of displaying: detail and preview modes. In the detail mode, a Web page occupies the whole window space. The contents of the Web page are displayed in the window as typical Web browsers do. However, in preview mode, the Web page is minimized and displayed in the middle of the window. It is surrounded by its eight neighbor Web pages. The Zoom button is then for switching between both modes. This feature gives users ability to glance through Web pages around the Web page they currently view. Figure 4 shows mock-up examples of content windows in detail mode and preview mode.

3.3.4 Toolbar
Pointed by arrow-headed line number 4 in Figure 4, a toolbar in a MLMN browser contains buttons for performing frequent actions of using the Web such as reloading a Web page. In Figure 4, buttons for reloading a Web page, stopping loading of a Web page, and going to the homepage of a Website are shown. Those actions are considered as the most used ones. Nevertheless, different implementations of MLMN browsers may have different buttons in their toolbar. Note that when the home button of a MLMN browser is pressed, the Web page in the first column of the first row, considered as a homepage according to MLMN Web design guideline as discussed in Section 3.4, is loaded.

3.3.5 Location grid viewer
The location grid viewer of a MLMN browser is designed to show the users the position of a Web page currently visited. As shown by the arrow-headed line number 5 in Figure 4, it consists of 3-by-3 cells. The middle cell indicates the location of the presently visited Web page. The numbers of rows and columns are shown corresponding to location coordinates of the Web page. When users move to a new Web page, the numbers change according to the location of the new page. The location grid viewer is aimed to give users visualization of a Web page location. The visual ability sequentially gives navigational comprehensibility to users. This location grid viewer may fulfill Nielsen's requirement for the future Web browser as he indicates in [5].

3.3.6 Address bar
The address bar of a MLMN browser behaves similarly to the one of typical Web browsers. It displays the address of the Web page currently displayed in the content window. Likewise, users can enter the address of a Web page they prefer to visit directly in the address bar. Nevertheless, the address shown in the address bar of a MLMN browser is in MLMN address format as explained in Section 3.2.

Figure 4. Mock-up examples of the content window of a MLMN browser in detail mode and preview mode.
3.4 MLMN Web Design Guideline
The objective of this paper is to present the initial concept of MLMN. The complete MLMN Web design guideline is a work in progress along with the development of MLMN itself. Nevertheless, the core concepts of the guideline are presented here to support the advantages of MLMN.

As explained, a Website according to MLMN is a two-dimensional map. The map is row-major. In other words, contents of a Website may first be divided into rows. Then, the contents in each row are categorized into pages in columns. Contents in lower number of row and column may have broader details than contents in higher row and column. As the result, the higher the number of row or column, the more details of content are expected. This guideline is illustrated in Figure 5.

Furthermore, some pages, rows, and columns of MLMN may have their default definitions. For instance, the page in column 2 of every row is expected to have help information according to the content of the row. For another example, the page in column three of every row may contain contact information of the person who maintains contents in the row. The complete guidelines of default meaning of pages, rows, and columns are expected to be accomplished as planned in Section 5.

![Figure 5. Illustrated guidelines of how to organize information in MLMN-based Web site](image)

3.5 Advantages of MLMN
As a new navigational system designed especially for the Web, MLMN is expected to show advantages as in the following discussion.

1. With the MLMN coordination system, users can perceive the address of each web page visually. This feature is expected to enhance navigational performance of users.

2. As the page at the first column of the first row is defined as the homepage of a Website, users who navigate in that Web site know how far they are away from it. According to the MLMN Web design guideline, the higher the number of rows and columns means the more details of contents of the Web site. With this guideline, users are aimed to understand their position in the Web site with only a glance at the control window of their MLMN browser.

3. With this addressing system, Web designers can define the meaning of each column or row so that users can easily remember. For instance, a multiproduct shopping store can name each row for each product line. In addition, a department store Web site can create a "floor" of their products that is simple to understand for their users.

4. Since MLMN adapts from the regular map system that is widely used everywhere, MLMN is expected to be easier to understand than the current Web structure system. With superior understandability, it consequently facilitates educating and training users to the Web.

5. With the heap-like structure of MLMN, traversal trace of an individual user can be drawn visually. For the present Web structure, this feature is not feasible. Being able to show a trace to a user visually gives many possibilities to both Web developers and users. For instance, for users, to know the trace of their travel on the Web may decrease their feeling lost on the Web. For developers, to see the pattern of user navigation in their Web site helps them to improve the site in various ways.

6. Current Web structure gives URLs of Web pages with non-standard and uncontrollable length. The URL of an individual Web page is assigned by the designer of the Web site. Although a study such as [5] proposes guidelines to design URLs of a Web page, there is no restricted rule to do so. Thus, URLs give unpredictable chunks of information. On the other hand, the address of a Web page designed according to MLMN has only three chunks of information, i.e., the address of a Web site, the row number, and the column number. Therefore, the address of a Web page according to MLMN is shorter and shows higher possibility that users can recall the address of the Web page than the current Web page addressing system.

7. MLMN is aimed to elevate the design method of a Web structure to reach a formal level. With strict structure of MLMN, one may foresee a number of formal methods of constructing Web sites are developed. For example, with MLMN structure, one may think of a method to detect dangling pages such that, by plotting a graph of links similar to Figure 6, dangling pages, which are defined as pages that do not have either an inbound link or an outbound link, can be effortlessly found.
4 CONCLUSION

Multi-Layered Map Navigation (MLMN) transforms Web navigation from a chaotic network to a virtually visualizeable map. MLMN is aimed to eliminate the lost feeling that generally occurs while users are surfing the Web and raise the ease of navigation. Nevertheless, benefits of MLMN as discussed in this paper are needed to analyze experimentally as explained in the next section.

5 FUTURE WORKS

MLMN proclaims its superiority over current navigational systems in many aspects. These features need to be examined experimentally as the proof of their advantages. Current work on MLMN is divided into phases. The first phase is to complete the MLMN Web design guidelines and specifications. In the next step, a Web browser, a Web server, and a Web site designed according to MLMN are built to demonstrate how MLMN works. Then, an experimental study comparing navigational performances between Web sites designed according to MLMN and Web sites built based on current Web navigation style is conducted. The result of the study will show the effectiveness of MLMN and the possibility to further the research on MLMN.

6 REFERENCES


