An Experimental Comparison on Visualization Techniques of Long Menu-Lists*

긴 메뉴항목 리스트의 시각화 기법 비교에 관한 실험적 연구

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ABSTRACT

With the rapid change of the Web and E-transaction application, the search interface is providing more powerful search and visualization methods, while offering smoother integration of technology with task. Especially, visualization techniques for long menu-lists are applied in retrieval system with the goal of improving performance in user's ability to select one item from a long list. In order to review visualization techniques appropriate to the types of users and data set, this study compared the five visualization browsers such as the Tree-structured menu, the Table-of-contents menu, the Roll-over menu, the Click menu, and Fisheye menu. The result of general analyses shows that among the hierarchical methods, the experienced group prefers the Table-of-contents method menu, whereas the novice's group prefers the Tree-structure method menu. Among the linear methods, the two groups prefer the Roll-over menu. The Roll-over menu is most preferred among the five browsers by the two groups.

초록

인터넷 환경과 디지털자원의 활용환경이 빠르게 변화됨에 따라 탐색과 브라우징을 제공해주는 정보시스템의 인터페이스 또한 새롭게 변해가고 있다. 특히 최근에 검색 인터페이스에서 많이 사용되고 있는 긴 리스트의 메뉴항목을 이용자가 보다 쉽게 브라우징하고 선택할 수 있도록 하기 위하여 시각화기법을 이용하여 디스플레이하고 있다. 본 연구는 이용자와 데이터 특성에 맞는 긴 메뉴항목 시각화 기법을 제안하기 위하여 긴 리스트의 메뉴항목을 시각화하기 위하여 많이 사용되고 있는 기법 즉 트리구조 메뉴, 목차방식 메뉴, 롤-오버방식 메뉴, 클릭방식 메뉴, 어안렌즈방식 메뉴를 비교하였다 그 결과 계층구조 메뉴 중에서는 전문가는 목차방식 메뉴를, 초보자는 트리구조 메뉴를 선호하고, 또 순차적 구조 메뉴 중에서는 전문가와 초보자 모두 롤-오보방식 메뉴를 선호하고 있음을 알 수 있었다.

Keyword: visualization techniques, menu design, browsing interface, tree-structured menu, table-of-contents menu, roll-over menu, Click menu, fisheye menu 시각화 기법, 메뉴설계, 브라우징 인터페이스, 트리구조 메뉴, 목차방식 메뉴, 롤-오버방식 메뉴, 클릭방식 메뉴, 어안렌즈방식 메뉴,

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*This research was supported by Hansung University in 2006.

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1. Introduction

With the introduction of the Web and E-transaction application, the environment for information retrieval is changing anew. Especially its interface becomes user oriented and multiple modes that enable users to explore information with a joyous experience. In other words, the search interface concerns on finding a narrow set of items in large collection that satisfy as well-understood information need as well as making sense of information or discovering unexpected patterns within the collection(Shneiderman & Plaisant 2005). Therefore, the search interface is providing more powerful search and visualization methods, while offering smoother integration of technology with task.

Recently, in the digital library it is becoming increasingly common to use menus for browsing and selecting data items. For example, menus are used to browse a long list of subject terms, to select one database out of thousands, to select a journal from a resource list, or to select a web site from a list of favorites. Browsing and selecting data items from menus is different than selecting functions because there are typically many more data elements in a menu and the users do not exactly know where each data item is located(Bederson 2000). If the list of menu items maybe much longer than the 30 to 40 lines that can reasonably fit on a display screen, the system must carefully apply the visualization techniques which uncover the structures and relationship of data set and make users browse a long list easily and efficiently.

Because the length of the menu is crucial in determining usability, the visualizing methods used for selecting from one of many displayed items in a long list have been researched rigorously. First, the most commonly used method is hierarchical “cascading” menus. The menu elements are classified into several groups, so that one entry that represents each group is placed in the menu. When the user selects that group element, the members of the group are displayed in a second menu off to the side. If the user knows the hierarchy structure well, then

this approach works. If not, however, the user must look in each group, which is potentially time consuming(Norman & Chin 1988).

Second, another common alternative is linear structured menus to display sequential data items sorted by a certain criterion, such as alphabetic order and chronological order. Linear menu sequences guide the user by presenting one decision at an item and are effective for novice users performing simple task(Zaphiris et al. 2002). The third one is fisheye menus to make present the entire menu on a single screen without requiring buttons, scrollbars, or hierarchies. In fisheye menus, all of the elements are always displayed in a single window that is completely visible, but the items near the cursor are displayed at full size, and items further away from the cursor are displayed at a smaller size(Bederson 2000).

These information visualization techniques for long menu-lists are applied in retrieval system with the goal of improving performance in user's ability to select one item from a long list. Effective interface techniques emerge only after careful consideration of and testing for numerous design issues. Now it is necessary to figure out how much the users satisfy these techniques and to investigate the problems of these techniques. This paper clarifies the features of each visualization technique used for long menu lists and investigates user preference among these techniques. Furthermore, this paper reviews visualization techniques appropriate to the types of users and data set and suggests future application for browsing interface.

2. Literature Review

To implement an efficient browsing interface, efficient classification, systematization of information, and visualization are essential steps. A systematically organized and visualized menu provides a user with an easy access to information, and enables a user to recognize the quantity and the content of information and the structure of relation efficiently. In the last few

years, visualization research has been explored in terms of developing various techniques and enhancing efficiency and usability of information display.

Lamping & Rao(1996) and Allen(2002) introduced the hyperbolic browser or a focus+context technique based on hyperbolic geometry for visualizing and manipulating large hierarchies. Seo(2002) investigated and analyzed information visualization techniques in information retrieval system in the three-schematic levels. In result, it was found that first, scientific data, documents, and retrieval result information are visualized through various techniques; second, information visualization techniques which facilitate navigation and interaction are zoom and pan, focus+context techniques, incremental exploration, and clustering; third, the visual metaphors used by the visualization systems are presented in the linear structure, hierarchy structure, network structure, and vector scatter structure. Koua & Menno-Jan(2004), in addition, introduced the Self-Organizing Map(SOM), which are used to view the structure, patterns, an relationship within the data and for the creation of abstractions where conventional methods may be limited. Turetken(2004) noticed that one way of coping with information overload is to create a grouping structure within the collection of information and suggested that visualization techniques which could be useful for understanding graphical system models is the fisheye distortion. Recently, Wan(2006) discussed that combining information visualization techniques and current library technologies can help library users find information more effectively and efficiently, and concluded that to apply information visualization is critical to design interface after reviewing numerous visualization application already existed in various fields today.

On the other hands, a limited research is focused to develop and/or compare the menu design. Park & Kim(2000) compared the methods used for reducing the depth of menus in web sites such as, Top menu, Drop-down menu, Boolean menu, and Table of contents. They carried out the performance tests and subjective evaluation. In results, there were no significant

differences in terms of response time among the 15 menu types, while table of contents and drop-down in which the first and second level of menus were visible induced the least number of error, In the subjective test, the top-menu structure with colors and presentation of its submenu without clicking mouse were preferred. Bederson(2000) introduced fisheye menus, which makes it possible to present the entire menu on a single screen, as an efficient mechanism to select items from long menus. He compared user preference of fisheye menus with traditional pull-down menus that use scrolling arrows, scrollbars, and hierarchies and found that users preferred the fisheye menus for browsing task, and hierarchical menus for goal-directed task.

3. Methodology

3.1. Selecting A Menu Item List

For constructing a menu list browser, menu items must be selected, classified, arranged and structured in order. Next, the selected and structured menu items are graphically visualized for allowing users to interact conveniently. But, for this experiment, the menu items and their structure of the current databases are used because the purpose of the study is not on analyzing the classification and structure of menu items, but on evaluating the display techniques of menu items.

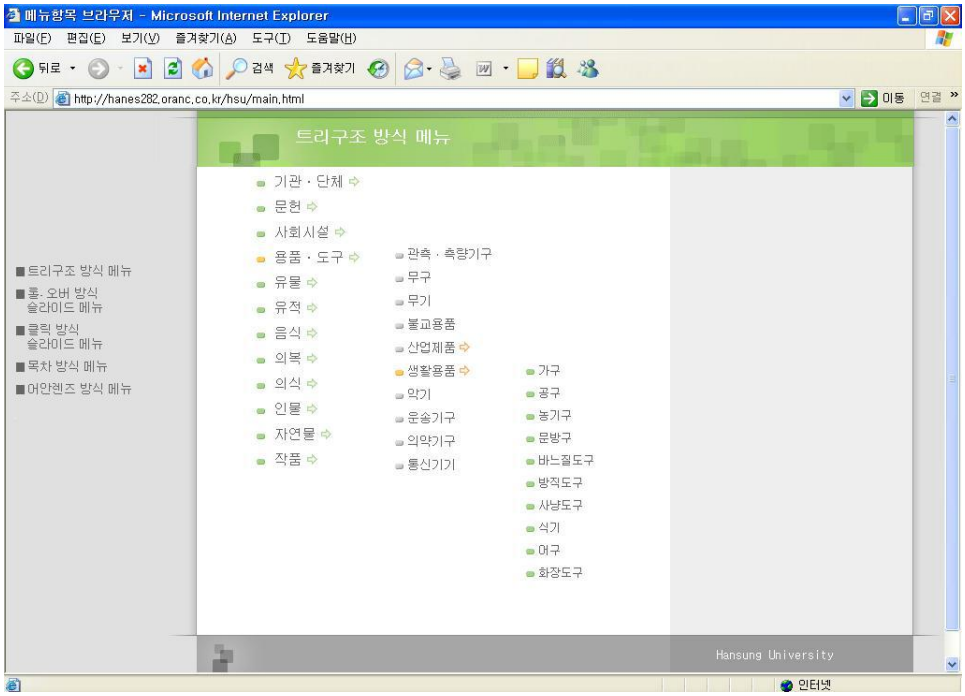
Therefore, the databases with menu item list which meet the following requirements: 1) allowing access by subject terms, 2) having more than 500 menu items, and 3) not covering too specific subject areas, are chosen. In results, Doo-San Encyclopedia, Encyclopedia Britannica, and ENCYKOREA are chosen in the first place. Doo-San Encyclopedia and Encyclopedia Britannica which have more than 200,000 menu items with 3-4 layers are too large and complicated to adopt for the experiment. Finally, ENCYKOREA is chosen because its classification and arrangement of subject are comparatively clear, and its terms of menu items

are quite simple. ENCYKOREA classifies the subject of Korean culture into 26 first-level categories each of which is classified into 250 second-level items. And every second-level item is classified into 488 third-level items.

3.2. Developing Menu Item Browsers

3.2.1. Tree-structured menu

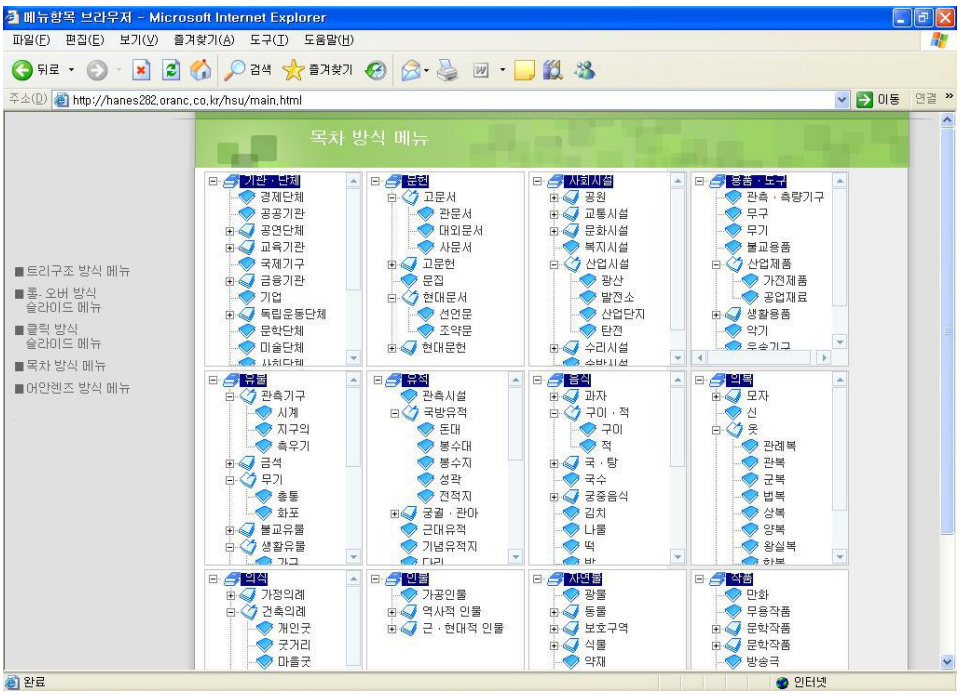
Tree-structure method classifies menu items into upper/lower levels and displays them hierarchically so that a user can browse the menu step by step. This method places the menu items of the uppermost level on the left of screen and with a click on a menu item of upper level it displays the items of the next lower level on the right(See <Figure1>).



<Figure 1> Tree-Structured Menu

3.2.2. Table-of-Contents Menu

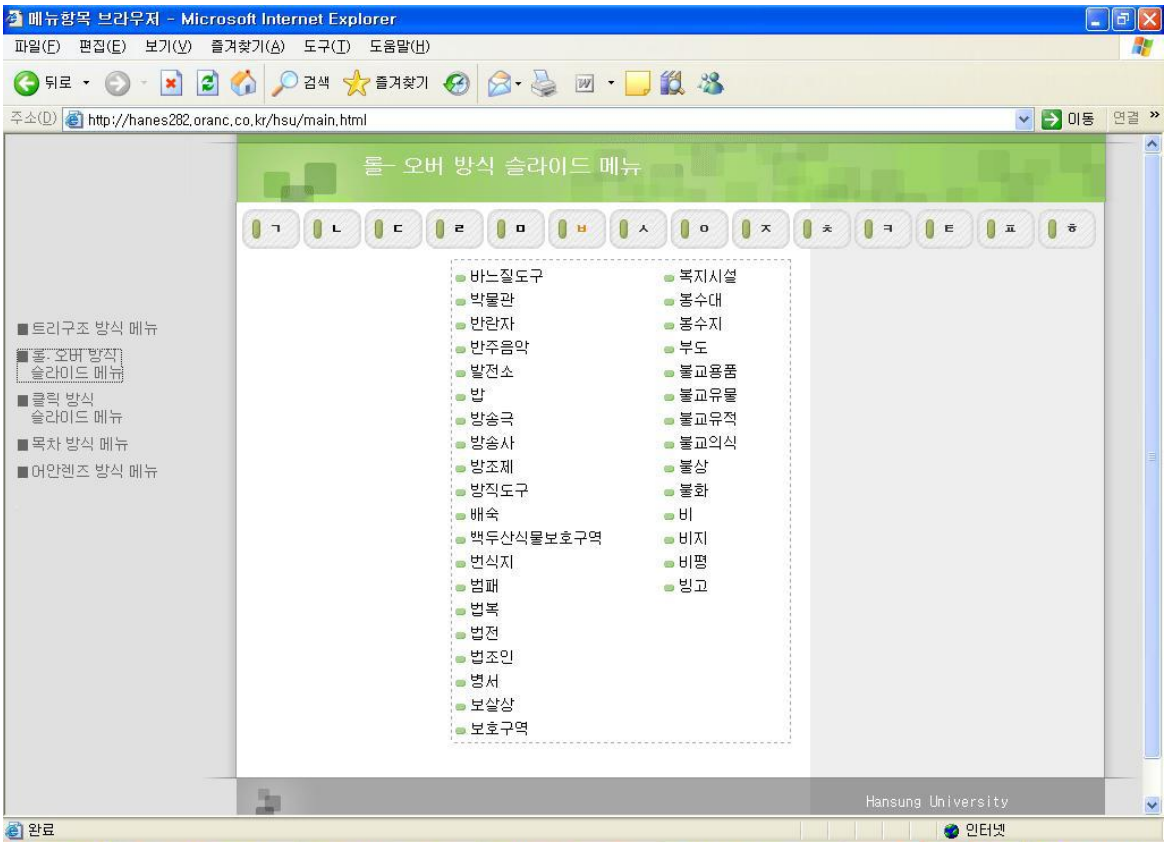
Compared to the Tree-structured menu which can not show a whole structure of menu items and detailed items on a screen at the same time, Table-of-contents method displays many different upper level items with their lower level items on a screen simultaneously. An upper level item comes up with “+”, “-” button, if it has lower level items. A click on “+” button displays the lower level items vertically and a click on “-” button conceals them(See <Figure1>). (fig.2).



<Figure 2> Table-of-Contents Menu

3.2.3. Roll-Over Menu

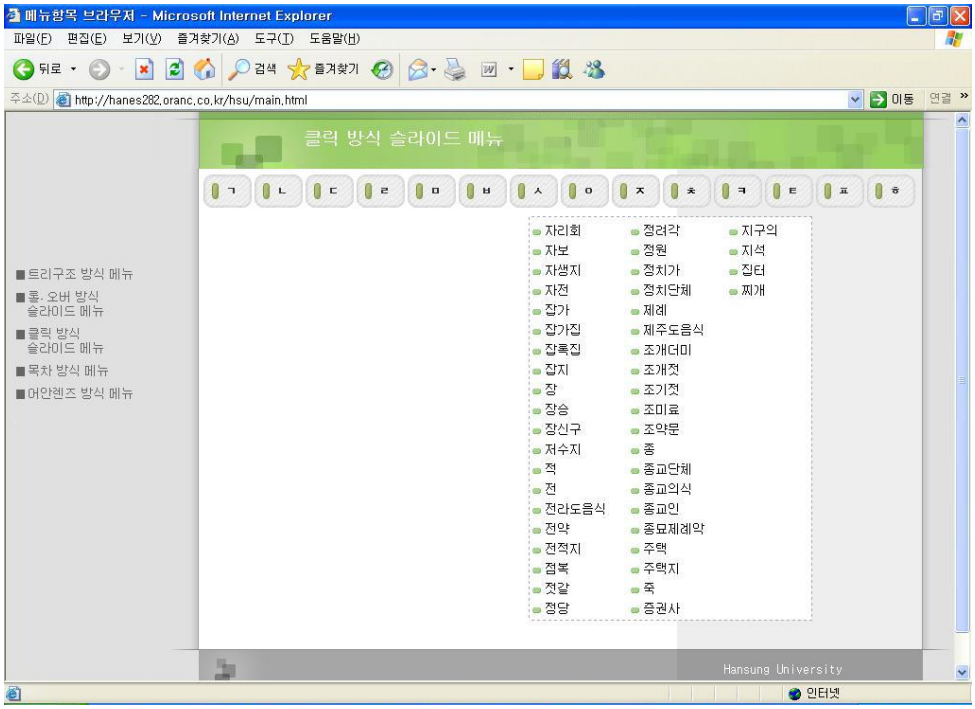
In the slide menu based on Roll-over method, the access points are horizontally placed on the upper part of screen. Just by putting a mouse on an access point, a user can get the lower level items displayed vertically. Menu items are usually arranged in alphabetical order(See <Figure 3>).



. <Figure 3> Roll-Over Menu

3.2.4 Click Menu

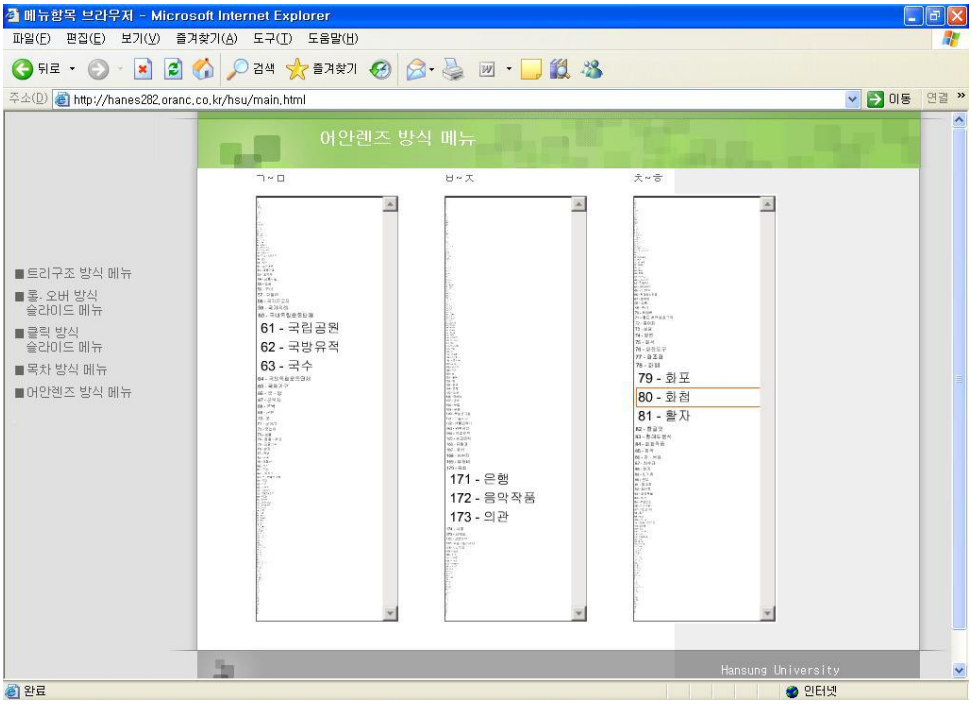
In the slide menu based on Click method, the access points are horizontally placed on the upper part of screen. With a click on an access point, the lower level items are displayed vertically. Menu items are arranged in alphabetic order as roll-over method(See <Figure 4>).



<Figure 4> Click Menu

3.2.5. Fisheye Menu

Fisheye method menu makes one list out of all the menu items. It allows a fast browsing of a long list just by mouse dragging at one place. It helps a user to browse the interested menu items easily, by magnifying the item pointed by a mouse. To display all of the items on a screen it divides the items into 3 sections for this study(See <Figure 5>).



<Figure 5> Fisheye Menu

This study developed five kinds of menu browsers with 26 subjects and 738 menu items such as Tree-structure, Table-of-contents, Roll-over, Click, and Fisheye menu browser. Fisheye menu browser is implemented by using flash, and others by javascript. DHTML(Dynamic Hyper Text Language) and XML(eXtensible Markup Language) are employed here.

3.3. Evaluating Menu Item Browsers

3.3.1. Selecting peer groups

Two different evaluation groups are made on the assumption that users' preference and satisfaction as to menu item browsers are different according to their specific knowledge and experiences of information retrieval. One group is an experienced group that has the knowledgeable experiences on searching various databases and on navigating an amount of

web data, and the other is a novice's group that doesn't. The experienced group is consisted of 20, junior and senior students who took three coursed such as 'Theory of Information Retrieval", 'Use of Databases in Libraries', and 'User Interface' at the department of Library and Information Science, Hansung University. The novice's group is consisted of 20, 2nd and 3rd graders at Kyung Hwa Girls' Middle School, who have experiences on only web searching.

3.3.2. Evaluation procedures

To evaluate preference as to the menu item browsers, each one of two groups is asked to evaluate the features and the evaluation scores of each browser by performing the tasks given. Besides, the researchers observe and interview the evaluators to find their browsing behavior. The procedures are as follows:

First, in order to find the functions and the features of a visualization browser, the evaluators are asked to perform the four tasks : 1) finding the indicated menu item, "declaration"; 2) finding the menu item related to the subject, "independence movement in Korea"; 3) finding the upper-level menu item which may cover the subject, "traveler's journal and diary"; 4) finding all of the upper-level menu items appropriate for the subject, "Hyang Gyo (an old-time Confucian school in a locality)". Theses 4 tasks reflect the three cases of inquiry situation, that is, 1) finding a known menu items, 2) finding a menu item with a broad subject term, and 3) finding a menu item with a specific subject term. The following <Table 1> is a summary about the purposes of performing these four tasks and about the menu methods to be evaluated.

Secondly, after the evaluators complete the tasks, they are asked to evaluate each browser from the aspects such as: 1) explicitness (you can explicitly browse the information you want?); 2) systemicity (you can browse logically? Or its hierarchy is organized systematically); 3) accessibility (it is easy to access?); 4) compactness (the items displayed on the screen are

compact?). 5-point scale(Likert-type scale) measurement method is employed for the evaluation.

Lastly, to find out their overall impression about the visualization techniques, the evaluators are interviewed on the questions like: 1) what is your general impression about the visualization browser?; 2) the techniques and the design of the browsers are familiar?; 3) how much are you satisfied with the browsers?; 4) can you recommend any browser to be applied on your retrieval system?

<Table 1> Summary of Four Tasks

	Purpose of Task	**Task**	**Tested Menu**
1	Finding the indicated menu item	Finding “declaration”	Tree-structured menu, Table-of contents menu Roll-over menu Click menu Fisheye menu
2	Finding the menu item which may be cover the subject	Finding subject related with “independence movement in Korea”	Tree-structured menu, Table-of contents menu Roll-over menu Click menu Fisheye menu
3	Finding the upper-level menu item which may be cover the subject	Finding upper-level item which includes “Traveler’s journal or diary”	Tree-structured menu, Table-of contents menu
4	Finding all upper-level menu items appropriate for subject	Finding upper-level items about “Hyang-Gyu”	Roll-over menu Click menu Fisheye menu

3.3.3. Analyzing experimental results

The evaluation results are analyzed from the two different aspects. First, preference as to the

browsers is analyzed by task performed, in respect of explicitness, systemicity, accessibility and compactness. This analysis shows which type of menu item browser is preferred according to the purpose of tasks.

Secondly, preference as to the browsers is analyzed by evaluation group. After the overall analysis of browser evaluation done by each group, the researcher performs multi-variance T Test using SAS system to find out meaningful differences in preferences between the two groups.

4. Findings

4.1. Analyzing Browser Preference by Task

4.1.1. Searching a specific menu item

In the task of searching for the menu item, “declaration”, the Roll-over menu gets the highest score on explicitness(4.13), accessibility(4.33), and compactness(4.30). The Tree-structured menu gets the highest on systemicity(3.80). While preference for the slide-type menus such as Roll-over menu and Click menu are considerably high in general, the Fisheye

<Table 2> Browser Preference for Searching a Specific Menu Items

	Tree-structure	Table-of-contents	Roll-over	Click	Fisheye
Explicitness	3.60	3.68	4.13	4.10	3.18
Systemicity	3.80	3.80	3.53	3.48	3.13
Accessibility	3.03	2.93	4.33	3.95	3.13
Compactness	3.30	3.03	4.30	3.48	2.98
Average	3.44	3.36	4.07	3.750	3.10

menu gets the lowest. As expected, in searching for a specific menu item, visualization browser based the linear structured method is preferred to the hierarchical method(See <Table 2>).

4.1.2. Searching a subject

In the task of finding for the menu items related to a specific subject, while users still most prefer the slide-type menus, but the Tree-structured menu and the Table-of-contents menu follow closely next. The Click menu gets the highest score(3.73) on explicitness, and the Table-of-contents menu gets the highest on systemicity(3.83) The Fisheye menu gets the lowest score on systemicity(2.38). In other words, the slide-type menus are preferred along with the hierarchical menu in searching for the information related to a specific subject(See <Table 3>).

<Table3> Browser Preference for Searching a Subject

	Tree-structure	Table-of-contents	Roll-over	Click	Fisheye
Explicitness	3.23	3.63	3.73	3.78	2.90
Systemicity	3.30	3.83	3.58	3.58	2.38
Accessibility	2.98	3.60	3.93	3.55	3.08
Compactness	3.08	3.03	3.70	3.83	2.78
Average	3.15	3.52	3.74	3.69	2.79

4.1.3. Searching for the proper upper-level menu items

In the task of searching for the proper upper-level menu items, systemicity on the both hierarchical menus gets the highest score, but compactness the lowest. On systemicity and explicitness, the Table-of-contents method is preferred. However, on compactness, the Tree-structured menu is preferred. On accessibility, the two menu methods get the same scores(See

<Table 4>).

<Table 4> Browser Preference for Searching the Proper Upper-level Items

	Tree—structure	Table-of-contents
Explicitness	3.30	3.45
Systemicity	3.48	3.70
Accessibility	3.30	3.30
Compactness	3.13	2.65
Average	3.31	3.29

4.1.4. Searching for all of the upper level items related to a subject

To evaluate the linear structured menu, the evaluators are given a retrieval item which belongs to upper-level menus. The Roll-over menu gets the highest score on accessibility(4.03), and the Click menu gets the highest score on explicitness(3.93). The Roll-over menu is evaluated as the best to search for all of the upper level items related to a specific subject(3.82), but there is no significant difference from the Click menu(3.80). The Fisheye menu is evaluated as the lowest in every aspect(See <Table 5>).

<Table 5> Browser Preference for Searching all of Upper-level Items

	Roll-over	Click	Fisheye
Explicitness	3.88	3.93	3.10
Systemicity	3.65	3.73	3.05
Accessibility	4.03	3.68	3.20
Compactness	3.73	3.88	3.00
Average	3.82	3.80	3.09

4.2. Analyzing Browser Preference by Two Groups

4.2.1. Experienced group

As for the Tree-structured menu, the experienced group puts the highest score on systemicity(3.48), but the lowest on accessibility(2.87). This result reflects the features of Tree-structured menu which makes a hierarchical browsing possible. As for the Table-of-contents menu, systemicity gets the highest score(3.73) and compactness gets the lowest(2.88). It is because too many menu items are displayed simultaneously on a screen so that it looks complicated.

The Roll-over menu(4.12) and the Click menu(3.73) get the highest scores on accessibility because it is possible for the evaluators to access directly to the items they want. The Fisheye menu gets low score in general. They also pointed out that the fisheye menu is not familiar and mouse operation is difficult. It is also pointed out that its systemicity and compactness are not satisfying, presumably because of its quite a long list(See <Table 7>).

The overall preference evaluation reveals that among the hierarchical menus, the Table-of-contents menu is preferred to the Tree-structured menu, and the Roll-over menu is preferred among the linear structured menus. The average evaluation score by browser type shows that the experienced group places the Roll-over menu on the top of the preference list and the Fisheye menu on the last(See <Table 6>).

4.2.2. Novice's group

As for the Tree-structured menu, the novice's group gives high scores to systemicity (3.63) and explicitness(3.62) but low score to compactness(3.37). And accessibility is evaluated to be low because they have to click many times if they don't know which upper-level the retrieval menu item belongs to. The Table-of-contents menu gets the higher score on systemicity(3.72)

and on explicitness(3.72), but the lower score on compactness(3.18) than the Tree-structure method menu. Particularly, the novice's group experiences difficulty in browsing the Table-of-contents menu. And they don't think they need to understand the overall structure of information)(See <Table 7>).

The Roll-over menu gets high score on explicitness(4.13) and on accessibility(4.12). A similar result comes out at the Click menu. However, they feel a little inconvenience with the precise mouse operation required in the Roll-over method. The Fisheye menu gets high score on explicitness(3.43) but low score on compactness(3.28). Particularly, the novice's group complains of the Fisheye method because they might easily miss the menu items. But some of the evaluators think the new method interesting and want to apply it to their website. Compared with the experienced group, the novice's group prefers the Tree-structured menu among the hierarchical structured methods, and prefers the Roll-over menu among the linear structured methods. The preference evaluation by browser types shows the same result as in the experienced group that they choose, in general, the Roll-over menu to be the best and the Fisheye menu to be the worst(See <Table 6>).

<Table 6> Ranking Browser Preference by Group

	Explicitness		**Systemicity**		**Accessibility**		**Compactness**	
	experienced	novice	experienced	Novice	experienced	novice	experienced	novice
1 위	Click	Roll	Table	Roll	Roll	Roll	Click	Click
2 위	Roll	Click	Tree	Click	Click	Click	Roll	Roll
3 위	Table	Table	Click	Table	Table	Tree	Tree	Tree
4 위	Tree	Tree	Roll	Tree	Tree	Fisheye	Table	Fisheye
5 위	Fisheye	Fisheye	Fisheye	Fisheye	Fisheye	Table	Fisheye	Table

4.2.3. Comparing between the two groups

To find the preference differences by evaluation index between the two groups, the multi-variance T-test is performed with 0.05 significance level. Between the two groups, the study finds the significant differences on accessibility of the Tree-structure menu, on systemicity of the Roll-over menu and the Click menu, and on explicitness, systemicity and compactness of the Fisheye menu. In the Table-of-contents menu, no significant differences between the two groups are found.

This study finds that the experienced group tends to be less satisfied with accessibility of tree-structure method and with systemicity of roll-over and click methods than the novice group. Therefore, it is noticed that the experienced group indicates exactly each weakness of hierarchical approach and alphabetical approach for browsing. Also, this result reveals that the experienced group has more negative evaluation on the worst feature of each menu method than the novice's group(See <Table 7>).

<Table 7> Comparing preference between the two groups

	variable	Mean		Method	t value	Pr>|t|
		experienced	novice			
Tree-structure method	explicitness	3.2505	3.6170	pooled	-1.68	0.1008
	systemicity	3.4830	3.6330	pooled	-0.58	0.5636
	accessibility	2.8665	3.4170	pooled	-2.15	0.0381*
	compactness	3.0670	3.3675	stterthwaite	-1.40	0.1689
Table-of-contents method	explicitness	3.4170	3.7155	pooled	-1.28	0.2068
	systemicity	3.7330	3.7170	pooled	0.05	0.9565
	accessibility	3.0655	3.2500	pooled	-0.70	0.4877
	compactness	2.8840	3.1835	pooled	-1.04	0.3047
Roll-over	explicitness	3.6165	4.1335	pooled	-2.00	0.0522

method	systemicity	3.1660	3.9675	pooled	-3.31	0.0021**
	accessibility	3.9840	4.1160	pooled	-0.46	0.6448
	compactness	3.6990	3.9335	stterthwaite	-0.96	0.3457
Click method	explicitness	3.6490	4.1170	pooled	-1.66	0.1046
	systemicity	3.2670	3.9340	pooled	-2.44	0.0196*
	accessibility	3.7335	3.9340	pooled	-0.63	0.5303
	compactness	3.7160	4.0505	stterthwaite	-1.56	0.1288
Fisheye method	explicitness	2.7500	3.4335	pooled	-2.45	0.0189*
	systemicity	2.5665	3.3325	pooled	-2.78	0.0084**
	accessibility	2.8160	3.3330	pooled	-1.89	0.0669
	compactness	2.5660	3.2830	stterthwaite	-2.75	0.0091**

*: singnif .05, **: singnif .001

4.3. Evaluation Results

In general, the users prefer the linear typed menu to the hierarchical typed menu. They prefer the Tree-structured menu among the hierarchical structured menus and the Roll-over menu among the linear structured menus. Evaluation results of visualization techniques are analyzed as follows.

First, a user prefers the linear structured method which displays the items in sequence sorted by alphabetic order, to the hierarchical structured method which displays them hierarchically sorted by subject. The users without the background knowledge about subject area, find inconvenience in searching the subject and in moving among the large, middle, small subject areas.

Second, in case of the hierarchical structured visualization browser, the experienced group prefers the Table-of-contents menu, whereas the novice's group prefers the Tree-structure method menu and has difficulty with browsing the Table-of-contents menu. The experienced

group that is comparatively more experienced with the Table-of-contents menu finds no difficulty for browsing and points out this as an advantage to grasp the overall outline of subject.

Third, among the linear structured methods, the Roll-over menu is chosen as the best, whereas the Fisheye menu as the worst. While most of evaluators feel convenient with the Roll-over menu because they don't need to click a mouse, some of the novice's group feels confused because the menu items are displayed automatically even without a click. But, the preference for the Fisheye menu is quite low because its familiarity is low and the operation of a mouse is difficult. The preference for the Fisheye menu is higher with the novices group than with the experienced group. This result implies that the novice's group with less experience has more interests in a new method or type.

Fourth, the study finds differences between the two groups in analyzing the systemicity. The experienced group chooses the systemicity as the most important feature, whereas the novice's group chooses the accessibility.

5. Conclusion

The purpose of this study is to suggest a browsing interface appropriate to a user's style, by comparing and analyzing the visualization methods for a long menu list. For this, the five-type visualization browsers such as the Tree-structured menu, the Table-of-contents menu, the Roll-over menu, the Click menu, and Fisheye menu are implemented experimentally to be evaluated by each of experienced and novice's groups. The visualization browsers are evaluated by way of task performance, questionnaire, and interview.

The result of general evaluation shows that among the hierarchical methods such as the Tree-structured menu and the Table-of-contents menu, the experienced group prefers the Table-

of-contents method menu, whereas the novice's group prefers the Tree-structure method menu. Among the linear methods, the two groups prefer the Roll-over menu. The Roll-over menu is most preferred among the five browsers by the two groups. Accordingly, suggestions to be considered to visualize menu items are as follows.

First, since the most of users prefer the linear structured menu because of its convenient browsing, the linear method rather than the hierarchical method should be used when the menu list to be browsed is short. However, if a list is long with many items, the linear method and the hierarchical method should be used together. Especially, if large numbers of items need to be browsed at a time so that it is difficult to recognize and access to the information, the hierarchical structured browser should be used together to supply information by an amount adequate to be recognized by anyone at one time.

Second, in case that a lot of information is displayed on a screen, the users put the system very low score on explicitness and compactness. Especially the preference is low for the complicated screen which is dense with information. This result shows that the users think visual design of display more important than functions. Accordingly, a browsing interface must help a user to navigate through information by providing the functions like hiding, zooming, and panning of information. When a browser uses a hyperbolic method for a long list of menu items, a 3-dimension hyperbolic method of panoramic display is recommended rather than a linear hyperbolic method of fragmentary display.

Third, even though menu items are the access points to information to be retrieved, it sometimes happens that the terms for menu items could describe them incorrectly and/or vaguely. To prevent a user from choosing a wrong item because of these incorrect and/or vague terms, a summary or explanatory information about an item should be provided,

Fourth, a visualization browser of menu items implemented by a hierarchical structure had

better employ a complex menu method along with a chronological navigation method. With the chronological navigation method, it is only possible to navigate from the first-level to the second-level items and from the second-level to the third-level items, or vice verse, whereas, the complex menu method makes it possible to access a new item without going back to the previous menu. Using a browsing interface with this complex menu, a user can get a direct access of an item and can be relieved from time delay and complication caused by recurring navigation.

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