A Zigzag Approach to Cascading Menus

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Abstract   The traditional cascading menu, commonly used in most desktop applications to traverse hierarchical menu systems, can be a time consuming and difficult task. In particular, the wider the submenu the more difficult it becomes to navigate the constraints of a menu item to reach the submenu. As a consequence, the submenu may disappear requiring additional attempts to attain the submenu. When a target menu items resides several layers deep, the required navigation can produce inefficient time and distance management. In this paper, we present an innovative cascading menu called the zigzag menu to address these issues. In the zigzag menu, submenus appear in alternating directions reducing the navigational distance to reach a submenu. A user study confirmed that a zigzag cascading menu effectively reduces the total mouse traversal required and decreases navigational time as familiarity with the system increases.

Keywords: *human computer interaction, menu navigation, cascading menus, steering law*

1. Introduction

Menu navigation is a common task that computer users perform frequently when using the operating system, browsing the net or using any desktop software. This navigation gives us access to different features of an application or various contents in a website. Mice and touch pads are commonly used navigation tools. Usually menu systems are designed in cascading fashion where similar operations are grouped under some main menu items. Then submenus are grouped under those main menus for operations that can be viewed as subtasks under the main operations.

The accepted standard for menu traversal upholds submenu appearance in the rightward direction up until the edge of the display area is reached at which point submenus appear on the left. This traditional cascading menu, used in most GUI-based systems, poses several problems to users. To reach a submenu, a user must navigate the cursor the entire width of a menu item to obtain the submenu. In hierarchical menu systems, this navigation becomes a sequence of tunnel steering tasks. The longer the traversal the more difficult and inefficient the tunnel-steering task becomes [1,2]. During a lengthy traversal, a user may drift outside of the activation region of the parent menu item causing the submenu to disappear. This demands further attempts to reactivate and reach the submenu – a frustrating GUI task, which requires significant amount of neuromuscular focus. The traditional cascading menu approach, with each submenu

appearing to the right of its parent, introduces another problem. This approach lends itself to lengthy traversals. In particular, for submenus that are several layers deep, the distance can be considerably lengthy and requires tedious manipulation of the mouse for the entire navigation, as exemplified in Figure 1.
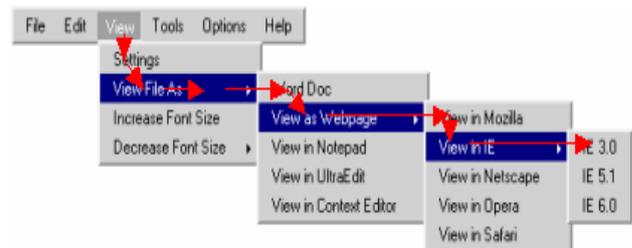
Figure 1. A traditional cascading menu, where each submenu appears to the right of its parent. The arrow shows the navigation required to reach the target item, "IE 3.0", located in the fourth layer of the menu hierarchy

With menu navigation being such an integral part of today's GUI-based systems, we propose a cascading menu approach that reduces the lengthy navigations. In the suggested approach, for a multi-layer menu system, the submenus alternate between appearing to the right and the left of the parent menu item, Figure 2, with the first submenu appearing to the left of the base menu, provided enough screen real-estate exists in that direction. This approach reduces the amount of horizontal traversal required to reach a submenu, allowing for short and quick cursor movements that decreases the amount of tedious navigation required, while potentially diminishing

extraneous submenu appearances. Thus, better management of time and distance can be achieved using the suggested approach, which we call a zigzag cascading menu.
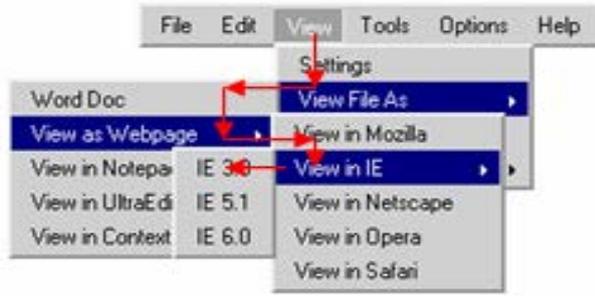
Figure 2. The proposed zigzag approach to a cascading menu hierarchy, where each subsequent submenu layer is displayed in the opposite direction of its parent. The arrow shows the navigation required to reach the target item, "IE 3.0", located in the fourth layer of the menu hierarchy

2. Related Work

Earlier techniques in studying menu navigation were primarily focused on menu selection of first-level items, where Fitts' law [3] is more directly applicable. These studies focused on reducing the navigation required to reach a menu item. Such approaches have investigated using radial menus [4,5,6] or adaptive menus that rearrange or hide menu items, like split menus [7]. However, these approaches still require tunnel steering to reach a submenu.

To reduce the amount of horizontal navigation required to reach a submenu Kobayashi and Igarashi [8,9] propose a vertical cascading menu structure that considers the direction of mouse movement. To reduce extraneous submenu appearances horizontal cursor movement is used to open and close a submenu, instead of solely depending on focus. In addition, a submenu is opened at the position of the cursor, instead of requiring the user to navigate across the entire width of the parent menu. Their approach reduces the total navigation distance, selection time, and navigational errors. However, the gesture-based approach did have a negative impact on some users.

A novel approach suggested by Ahlstrom [10,11] uses force fields to help reduce navigational errors and the amount of time required to reach a submenu. In this technique, a virtual force field is used to guide and pull the cursor toward the submenu. The approach works like a magnet, the closer the cursor is to the submenu the stronger the pull and the quicker the cursor moves toward it. The suggested approach is a good idea for experienced users who already know their navigational path. However, while browsing the menu items an unsuspecting user may be pulled toward the wrong submenu due to an inclination toward that submenu. In contrast to the approaches of Kobayashi & Igarashi and Ahlstrom, our approach opens submenus based on the more traditional focus approach, without having to try to predict the intention of the user.

James Kalbach and Tim Bosenick [12] carried out a study to find evidence of menu navigation dexterity in websites based on menu location - either on the left or on the right side of a page. They concentrated on finding out if placement of menu items on left or on right side of a web page has any significant performance differences in terms of time to reach and activate a menu. Their study showed no considerable variations in time taken to complete navigation tasks by the participants whether menus were placed on the left or the right side.

3. A Zigzag Cascading Menu

To address the problems with lengthy menu navigations in a traditional cascading menu, we propose an approach that modifies the placement of the submenu.

A submenu is obtained by traversing a menu item in the direction of the submenu until the submenu is reached. Even in a menu hierarchy that is not very deep, this typically requires a lengthy horizontal navigation to the right. For application-based menus, originating from the menu bar, this is a consequence of the initial menu group being much wider than the menu item in the menu bar, as exemplified by the menu group under the View menu bar item in Figure 1. Regardless of where the user selects a menu item in the menu bar a lengthy traversal to a submenu is required. The problem is similar for popup menus, where the upper-left corner of the menu originates from the cursor position when the popup menu is activated.
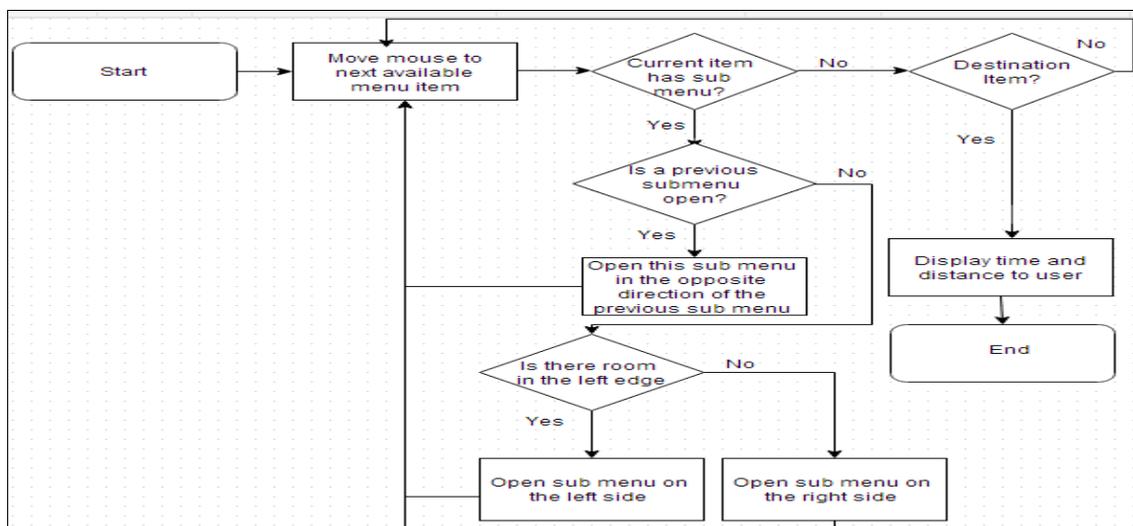
Figure 3. The working process of zigzag cascading menu

In both instances, even when a user must navigate to a menu item located lower in the parent menu group, the movement is mostly vertical and tends to stay toward the left edge of the menu group. With the users' cursor likely near the left edge of a menu, a left-appearing submenu could be reached with a much shorter traversal, as exemplified in Figure 2. Once the cursor reaches the submenu, with a quick and short mouse movement, the cursor can be navigated along the vertical axis to reach the target menu item. If the navigation requires the display of another submenu, with the cursor oriented to the right of the current submenu, the following submenu will appear to the right. For subsequent submenus, the alternating approach continues.

The alternating approach causes back-and-forth cursor movement, or a zigzag effect. The zigzag approach confines user movements to a much smaller region, thus, reduce the navigational length to reach a menu item, while, in theory, reducing errors by enforcing shorter steering movements.

4. Evaluation

A user study was performed to compare the traditional approach to the proposed zigzag approach to navigating a cascading menu hierarchy. The details of this study follow.

4.1. Participants and equipment

A total of 80 volunteers participated in the survey. Sixty (60) participants were undergraduate students from the CSE & IT department of the University of Information Technology and Sciences. Among the rest, there were 5 IT professionals and fifteen (15) service holders at different sectors. All participants were familiar with using a mouse to navigate a cascading menu. Their navigation skill was on an average four on a scale of five according to their responses. All the participants were right handed and used mouse with right hand. One exception was a right handed participant who used mouse with left hand.

There were both desktop PCs and laptops used by the participants of this survey. Sixty (60) participants used corded, standard two-button optical scroll-wheel mouse; four participants used cordless mouse and the other 10 participants of our study used touchpad on their laptops. Forty six (46) of the devices used had screen resolution of 1366x768 while 33 of them had screen resolution of 1024x768 and one had 1624x768.

4.2. Experiment

The user study consisted of three separate cascading menu navigational approaches: the traditional approach, the zigzag approach, and a left-only approach where each submenu appears to the left of its parent. The menu system was created in a web page with the menu bar centered horizontally in the page to ensure that each submenu appears in the desired direction without encountering the edge of the screen.

All the menu systems were developed using javascript, CSS and HTML with same menu items in each system. Javascript was also used to calculate the time (in ms) and the distance traveled (in pixels) when a user reached a target menu item. The time and the distance were shown

(Figure 4) in a message box for users to log them at the end of each menu traversal task. Google chrome was used as the browser to render the menu systems.
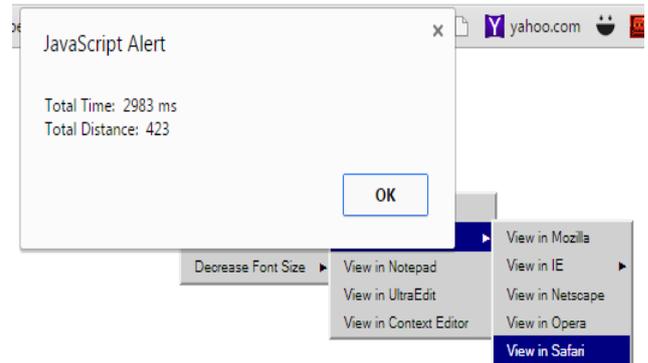
Figure 4. A message box to show the time and distance for users to log at the end of each menu traversal task

Since zigzag menu was a novel system that the users were not familiar with, we had to make sure that we removed cognitive latency out of the equation. To accomplish that each participant went through a warm-up practice session consisting of three sets of menu traversal tasks – one for each cascading menu approach. This was practiced by each participant and through this they were made familiar with the zigzag menu and the left opening menu.

The menu targets used for each approach were identical. The hierarchical levels of the target items consisted of 4 two-level, 1 three-level and 3 four-level.

Each participant was briefed on the purpose of the study and given a demonstration of the three approaches. During each study the participant was presented a target menu item to select, specified in the following format: MenuBarItem -->MenuItem -->SubmenuItem -->TargetItem. Users were given 8 identical menu traversal tasks for each menu systems.

The users were allowed to study the specified path before beginning the menu selection process. The data collected for each menu selection was the total time and the total number of pixels traversed to navigate to a target item. The starting point for each measurement was the selection of the menu bar item and concluded with the selection of the target item. At the conclusion of all three studies each user filled out a questionnaire regarding their experience.

5. Results

As mentioned earlier, we have considered two aspects while tabulating the results. The data collected for each menu selection was the total time and the total number of pixels traversed to navigate to a target item. The results of the study are shown in Figure-5 & 6 with charts of the percentage of the participants who required least time and distance to perform each task. The charts show the comparison among three cascading menu systems. For example- to perform the task in step 1, among 80 participants 50, 17 and 13 people required least time in the zigzag approach, left-only approach and the traditional approach respectively. So, the percentages of the participants who required least time are 62.5%, 21.25%

and 16.25% accordingly. The percentage of the participants who required least distance in any of the menu system at each step is also calculated in a similar fashion.

Figure 7 & 8 shows the average time and distance of the participants to perform each of the tasks using three navigation approaches, thus demonstrating comparisons among them.
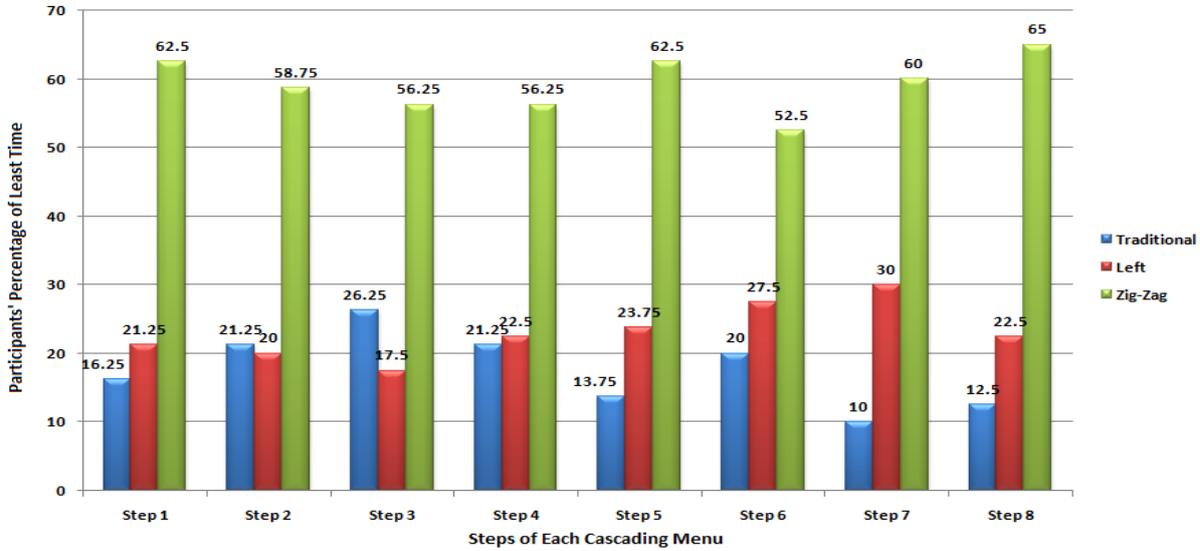
Figure 5. Participants' percentage of who require least time of each cascading menu
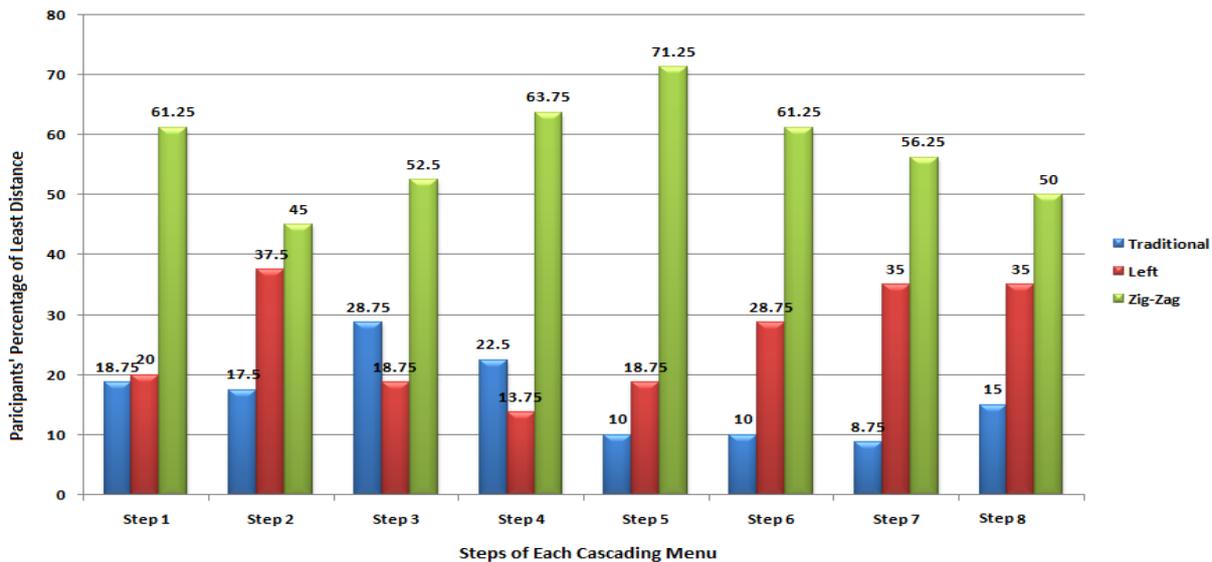
Figure 6. Participants' percentage of who require least distance of each cascading menu

6. Discussions

The results of the user study cleary shows that the Zigzag approach requires the least amount of cursor movements and also the least amount of time for menu navigation. Both these findings are relevant to both Fitts' law and the Steering law.

In the report session of the survey, there were 8 navigation tasks for collecting data. In each of these tasks, there were three cascading menus - traditional, left-popping and Zig-Zag. The eight tasks included target menu items with varying depths - four-level, two-level, three-level, four-level, four-level, two-level, two-level and two-level. The navigation tasks are listed below -
- File-> New-> Business Letter-> Create from Templates-> Template 2 and click.
- File-> Convert File-> To DOS and click.
- Edit-> Clear Content-> Clear All-> Keep a Copy in a Temp File and click.
- View-> View File As-> View File as Web Page-> View in IE-> IE5.1 and click
- Tools-> Spelling and Grammar-> Check Both-> Check Whole Document -> Use Auto-correct and click.
- Options-> Show Toolbar-> On the Left and click.
- Help-> Contact Vendor-> Get Phone Number and click.
- View-> Decrease Font Size-> By 20% and click.

Comparing results among three menu system from Figure 7 & Figure 8, we find that, in each task the average time and distance needed for Zig-Zag menu were considerably lower than those in other systems. It also means that most of the participants needed least time and distance under this new approach. It is also evident from

the data that most participants took lesser and lesser times and distance as they moved toward task at the lower end of the list. This proves an important fact that our efficiency in a particular task increases with repetition and increased familiarity. Most particpants were accustomed to the submenu appearing to right. The difference between traditional and left-popping menu is not higher as these two menus are quite similar to each other. The only difference between these two have is that traditional menu's submenu appears in right and left-opening menu's submenu appears in the left. In Zigzag menu, menu opened in alternating directions, which was totally new to the participants. But as they used the system more and more, they requires lesser and lesser time and distance for reaching target menu items.
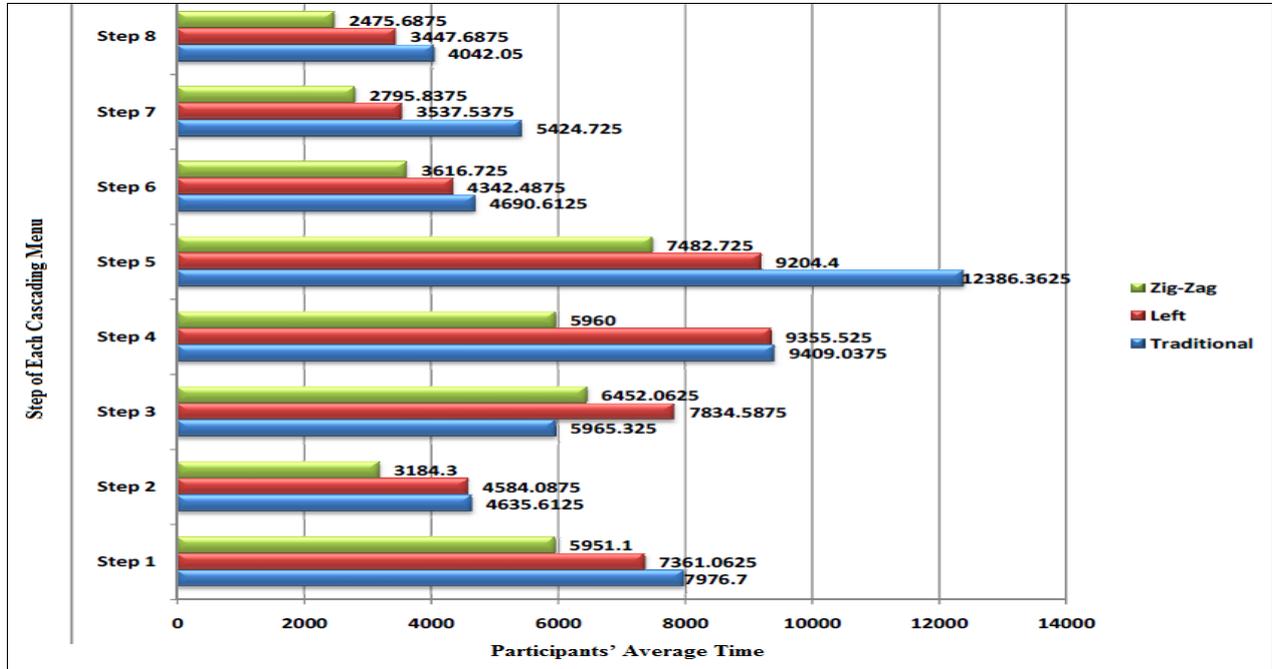
Figure 7. Participants' average time in different steps of each cascading menu
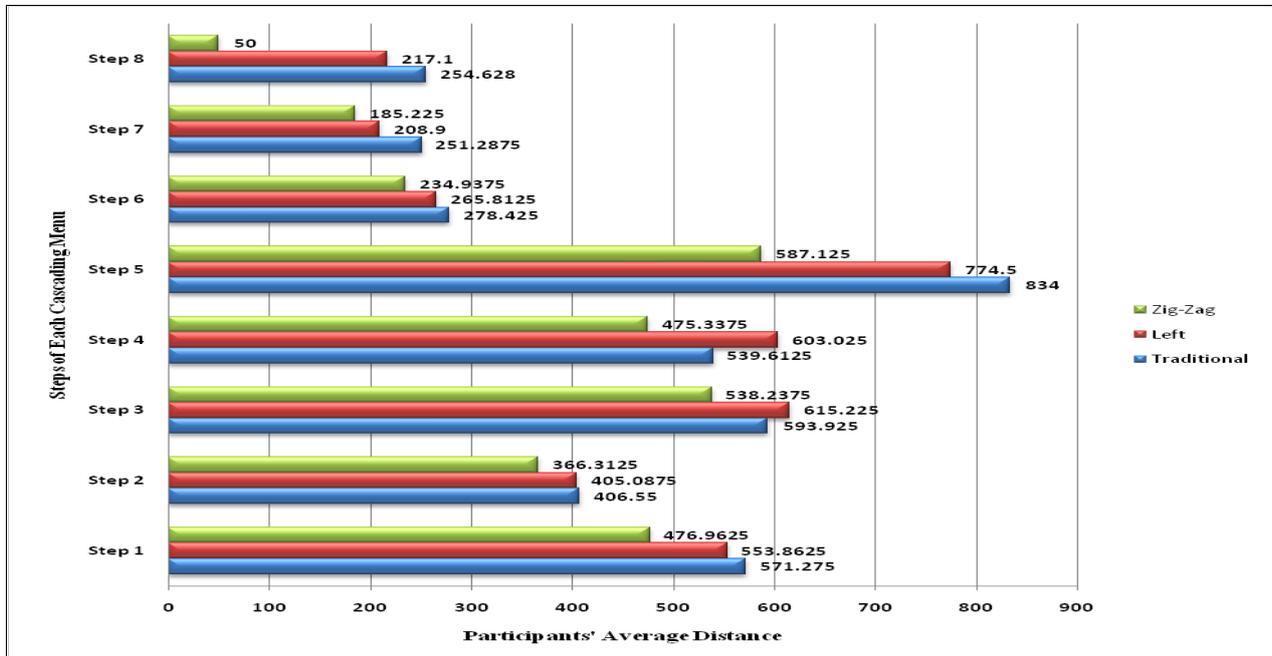
Figure 8. Participants' average distance in different steps of each cascading menu

While we assess the average of participants' average time and distance for each cascading menu, we also find that both the average time and distance of Zigzag menu is always the lowest in every step than that of the traditional menu and left-opening menu.

From the above statistics, we can see that in step 2 where no of level is 2, the percentage of people taking the least time is 58.75. In step 3, for level 3 the time should have been more, rather the time is reduced and the percentage is 56.25. In the same way, while the time is assumed to be reduced in regard of level 4, it rather being the same in step 4 or reduced even more in step 1 where the percentage is 62.50.From the collected data, it is also noticeable that though the time required for level 3 or 4

would be comparatively higher than level 2, but in reality it required less time. This indicates that with increasing depths of the target menu, the time required by Zig-Zag menu is decreased gradually.

10 regular users of touchpad devices also participated in the exact exercise involving laptops. Data collected from that experiment shows similar patterns as those collected from desktop PCs.

Table 1. Percentage of least time required by participants for different step and level for Zigzag Menu

Step No.	No. of Level	Participants' Percentage of time (Traditional)	Participants' Percentage of time (Left-opening)	Participants' Percentage of time (Zigzag)
1	4	16.25	21.25	62.50
2	2	21.25	20.00	58.75
3	3	26.25	17.50	56.25
4	4	21.25	22.50	56.25
5	4	13.75	23.75	62.50
6	2	20.00	27.50	72.50
7	2	10.00	30.00	60.00
8	2	12.00	22.50	65.00

7. User Feedback

After the user study each participant filled out a short questionnaire asking for feedback regarding the suggested approach. Zig-Zag menu is more suitable to use and it does not takes more time or distance navigation. The participants think, Zig-Zag menu will be the best if this can be used as traditional. Then it will be faster and swifter than the other two. They highly appreciate the Zig-Zag menu.

However, the majority of participants were generally pleased with the zigzag approach. While comparing these two menus with Zig-Zag menu, the comfort and easy mode felt by the user is focused. Though there were some negative and neutral comments on Zig-Zag menu, most participants commented positively, such as-

- To me, zig zag menu is more suitable to use, though it takes more time due to less practice. I think, zig-zag menu will be the best if this can be used as traditional. Then it will be more fast and swift than the other two. I am highly appreciating the zig zag menu."
- Simple and Faster."
- Zig Zag menu is the best among three menus."
- Feeling comfortable with zig zag, good initiative."
- Enjoyed. Let's see how its work in future."
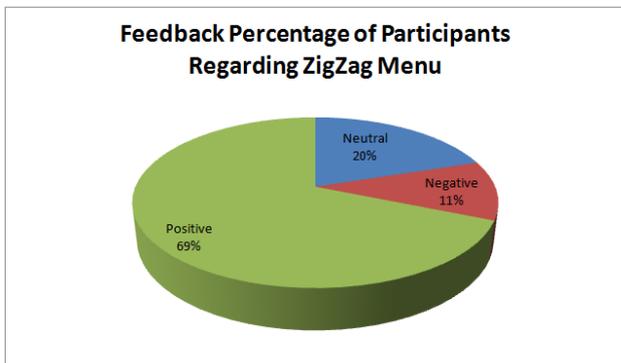
Figure 9. Feedback Percentage of Participants Regarding Zigzag Menu

8. Conclusion

Our study shows that the zigzag approach we suggest for traversing a cascading menu system provides a substantial reduction in time and distance compared to the more traditional method. These findings are completely in line with the expectations of Fitt's law and the Steering law. Our survey shows positive feedback from users toward the ZigZag menu system. It can also be safely suggested that as users become more familiar with the zigzag scheme a significant decrease in time will result. This new menu system can be a better alternative to the traditional system and can be used as the default scheme for any GUI application. In the future, we intend to study this system under tablet PCs.

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