Tactile Assistance for Selecting List Favorites with a Bifocal Absolute and Relative Representation

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ABSTRACT

We present a novel technique for navigating lists of everyday life containing phone contacts, TV channels, radio programs, music albums, etc. on handheld devices such as mobile phones, remote controls... Our technique addresses the selection of favorite items in moderate sized lists using absolute and relative finger positioning. It also allows eyes-free navigation among favorite items.

Keywords

Favorite-item selection, bifocal navigation, finger gestures, eyes-free selection, tactile feedback

ACM Classification Keywords

H5.2. [Information interfaces and presentation]: User Interfaces, Haptic I/O

INTRODUCTION

We present a novel technique for navigating lists of items (e.g., phone contacts, music albums, videos, radio programs, TV channels) on handheld or multimedia devices such as mobile phones, MP3 players, or remote controls. Most of these everyday-life lists are moderately large, containing hundreds of items, and are strongly under-utilized. We performed an informal study with 31 subjects and found an average of 150 items and 15 favorites for contact lists and 200 items and 20 favorites for cable TV channel lists.

Certain navigation systems use hierarchical representations to ease navigation. Had all the items of the list the same probability of being selected, the usual sort of hierarchy, based on logical inclusion, would seem optimal. However, given the strong preference biases of individual users, an alternative logic based on selection frequency seems sensible.

We present a bifocal navigation technique that makes favorite items easy to select. A notable characteristic is that it combines absolute/relative positioning and let users select items by performing a circular gesture. Another original characteristic of our technique consists of the delivery, in parallel to vision, of redundant tactile scrolling information. This feature allows eyes-free navigation among the favorite items.

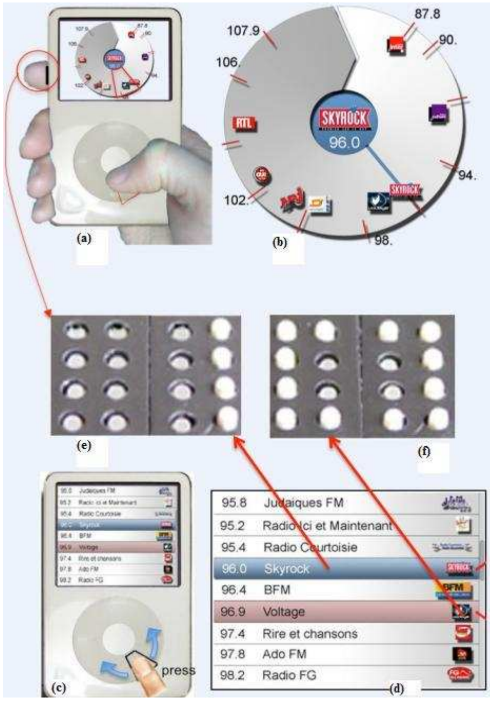

Figure 1: a,b) Absolute angular positioning (macro view), c,d) Relative angular positioning (micro view), e,f) Braille patterns associated with favorites.

RELATED WORK

Lists as large information spaces has been handled using zoom-based multi-scale navigation techniques [3]. For example, OrthoZoom [1] makes it possible, within some 15s, to reach any single line among 150,000 lines contained in Shakespeare's full works. However our study deals with a different problem: everyday-life lists that are moderately large, where people want to access favorite or regions of interest in a simple and systematic way (and possibly eyes-free).

In SpiraList [4] interaction technique, the authros used focus+context visualization strategy. Users can display and access large number of items in a list on a handheld device. SpiraList provides thumb interaction in order to browse through the list and to select an item from it. A limitation of SpiraList is not to display the categories around the spiral (i.e. no support for hierarchical list structure).

Tactile feedback was investigated in the Bullseye circular menu [2], divided into rings and sectors that emit tactile pulses when the cursor moves over them. Selection can be performed non-visually by counting the number of tactile pulses. This system was not related to lists and favorites. Besides, it can only work by using the tactile modality while our technique supports both, the tactile and visual modality separately or a combination of them.

Braille cells are normally intended for visually impaired people as they provide symbolic signals that are appropriate for reading. Few devices with similar actuators have been proposed for sighted people. As an example Ubi-Pen [7] describes Braille numbers (0 to 9) as tactile patterns. The purpose of this device is to provide complementary information for handhelds, as their small size limits the amount of data that can be displayed on the screen.

A 4x4 Braille cell can be found on the VTPlayer mouse, which has been used to define and evaluate a small set of distinguishable patterns [9]. The set of tactile patterns we used in our experiment was partly inspired from this study by considering six patterns that have already been tested as found suitable as static patterns.

Finally, Luk et al. [8] showed that a user could feel a haptic icon while browsing items (eyes-free) on a list displayed on a handheld device (each item owns a specific icon). Various wave forms, directions and durations of haptic icons have been used to distinguish items. In contrast, the same tactile pattern can be shared by several (distant) items in our system in order to minimize recognition time and errors.

PRINCIPLES AND DESIGN

Bifocal list navigation

Our technique makes it possible to select an item in a bifocal representation by tracing a single arc. By placing a finger on a dial (Fig. 1a), the user selects an absolute angular position in a macro view (Fig. 1b). This position is then adjusted relatively in the corresponding micro view by dragging the finger.

The initial macro view shows a global view of the list as a radial array on which only favorite items are visible (Fig. 1b). A region of interest in the list can be selected by placing a finger at the corresponding radial position on the dial. The macro view is then replaced by a micro view (Fig. 1d) and the list appears vertically in all its detail. The desired item can now be reached by moving the finger along an arc (Fig. 1c) using an iPod-like device (linear motion could be used on other devices). Multiple arc gestures can be performed if needed, as item selection is not validated until a finger press occurs at the center of the dial.

Selecting favorite items

As mentioned, only favorite items are fully visible in the initial macro view. Two kinds of favorites are available: Primary favorites (PF) and Secondary favorites (SF). The selection of PF simply requires absolute angular positioning. These items act as *attractors*: they are selected even if users do not press their finger exactly at the proper location on the dial. No adjustment phase is required in this case, just selection confirmation at the center of the dial. Secondary favorites and other items are reached by scrolling the list in relative angular mode. Users have to simply put a fingertip on the dial and trace an arc, that single gesture allowing them to exert genuine two-scale control over list scrolling (scale1: absolute macro for the initial contact, scale 2: relative micro for the move).

The fact that PF are the only items that can be reached in absolute mode is consistent with the idea that frequently used items should be especially easy to select. However, their number is necessarily limited as their selection only relies on absolute angular positioning. Studies on circular menus [6] also based on angular positions, suggest that 12 items should be distinguishable. Two PF could be very close to each other because the number of items between them is not necessarily equal. To maintain a high level of precision, the angular sectors need: (1) to be large enough and (2) to not overlap with other PF sectors. Our solution is to distort the visual representation of the list so that all PF are evenly distributed on the macro view (Fig. 2).

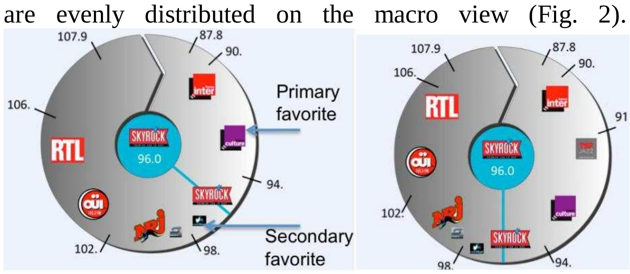

Figure 2. Left: six primary favorites and two secondary favorites, Right: primary favorites redistributed uniformly after the introduction of a new close primary favorite (91.1).

Secondary favorites (SF) are not directly accessible in absolute mode but are visible on the macro view (which makes them easier to find than non-favorite items, described below). Hence, their total number is not constrained by input precision but by available screen space. Typically, 24 icons or 16 text labels can be displayed simultaneously without overlapping. A possible limitation is when SF are not uniformly distributed. Placing more than 4 or 5 SF between 2 PF seems difficult and this problem will be addressed in future work.

Selecting non-favorite items

Contrary to favorite items, non-favorite items (NF) are not visible in the initial macro view. They must be found relatively to something else. First, users search and select the closest primary favorite item (according to either alphabetical order, radial frequency, social proximity, etc. depending upon the application). Then users scroll in the micro view to reach the desired NF, again by performing arc gestures. Hence, NF items that are close to favorites can be selected quite rapidly.

Eyes-free selection and tactile landmarks

Since, as argued above, recourse to favorite landmarks facilitates navigation, we hypothesized that users should be able, after some practice, to navigate to their favorite targets without having to look at the visual display. As for Marking menus [6], primary favorites should be selectable in open loop as they only rely on a simple angular specification. But since secondary favorites may lie in the same regions, some kind of feedback is necessary to distinguish them. Feedback is also required for reaching other items, to let the user count the number of positions that separates them from favorites. An audio cue, by using different tones, is an alternative but we wished to explore the potential of tactile feedback, a modality that has been rarely used for such purpose.

Among the interesting specific features of the tactile channel are its privacy (the information is available to users, not their neighbors) and the fact that reception of the message is under full control of users (free to place or to not place their finger on the tactile cell). Besides, tactile feedback leaves the audio channel free, so that users can listen to music, other people, etc. without hearing possibly disturbing sounds.

For the purpose of our study, we provided users with a 4x4 tactile stimulation device (two contiguous Braille cells, www.metec-ag.de). The Braille cell is placed on the side of the mobile device (Fig. 1a) in order to be accessed by the most sensitive index finger [5]. We empirically created a set of 11 different tactile patterns (Fig. 3). This set was designed to maximize the contrast between tactile patterns. According to preliminary study, this size seems to be realistic for inexperienced users. This pattern set was mapped to 6 PF and 5 SF. As a perspective, simpler purpose-specific device than Braille cells could be used as patterns only involve 5 different pin groups.

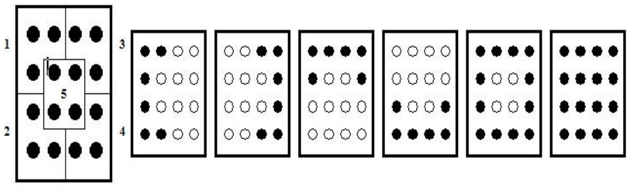

Figure 3. Tactile patterns: five elementary patterns and six possible combinations.

As we wished to use more favorites than the 11 above defined tactile patterns, we allowed tactile signatures to be shared by distant favorites on the dial. One reason why tactile feedback can be used for just disambiguation is because eyes-free selection relies on the ability to memorize angular positions, a sort of spatial memory known to be particularly effective [6]. A unique impulsion pattern was emitted when a user moves on a non-favorite item.

A LOWER INPUT INFORMATION LOAD

Figure 4(a) illustrates the simplified example of a 9-item list. Using a two-level hierarchy based on the usual logic of transitive inclusion (b), two consecutive choices would be required for any item to be selected. For example, selecting the dark-gray triangle would require selecting the triangle class first ($\log_2 3$=1.6bits), and then the dark-gray individual ($\log_2 4$=2bits), with total input information of 3.6bits. In real life lists, however, some individual items are much more likely to be selected than others (i.e., they constitute favorite), and so a hierarchy based on frequency of use rather than logical inclusion seems worthy of consideration.

Our technique (c) reduces the input information load by allowing users to select their favorites directly (1.6bits in this example). If the user's target is a non-favorite item, by definition a relatively rare event, that item will be reachable subsequently through list scrolling at the micro level. If, as we conjecture, a familiar list is represented by users as a linear array with favorites viewed as landmarks, then any secondary, non-favorite item is likely to be memorized relative to these landmarks, e.g., as 'the one just above X' or 'two spots below Y'.

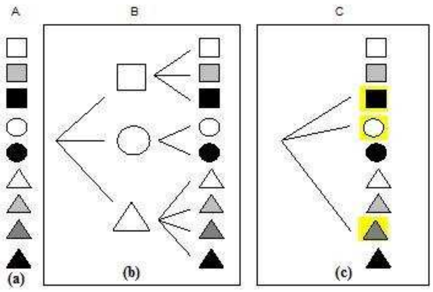

Figure 4: a) List, b) A hierarchical structure of the list with categories, c) Shown with a yellow highlighted background are arbitrary subsets of favorite items (landmarks).

EXPERIMENT

The goal of this experiment was to evaluate the ability of users to select items and especially favorite items in non-visual mode. For this purpose, we used a contact list of 100 names (celebrities) with 11 PF and 4 SF (chosen arbitrarily). Nine different tactile patterns were used: (4 for PF, 4 for SF, and 1 for NF).

As it was impossible to integrate a Braille cell in an iPod and test it, we used: 1) an IPAQ PDA with a flip cover to simulate a Touch wheel, 2) a laptop screen to display the visual feedback, and 3) two contiguous Braille cells for tactile feedback (Fig. 5). As our Braille device is relatively large (compared to some more miniaturized models [9]), tactile feedback occurred on the non-dominant hand (the dominant hand was controlling the Touch wheel).

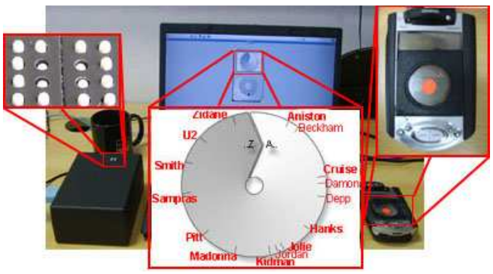

Figure 5: The experimental system

The interaction technique, tactile feedback and test procedures were explained to subjects (5mn) and they got 5mn for training before the actual experiment. They were instructed that the goal was to accurately select a maximum number of items without visual feedback which, by default, was not displayed but subjects could make it appear at any time by pressing any key on the keyboard. Each of the 8 stimuli used (4PF, 2SF and 2NF) appears one time in each block according to a Latin square design. The summary of the design is: 7 subjects x 16 blocks x 8 trials=896 selections. Our hypotheses were that users would be able to learn and recognize the tactile patterns and thus selecting favorites non-visually after sufficient training time.

RESULTS AND DISCUSSION

Repeated measures analysis of variance showed a significant effect for Block Number ($F_{15,90}=17.2$, $p<0.0001$) on CTS (the number of Correct Tactile Selection by total number of selections). This effect, visible on Fig. 6, has a double reason: subjects progressively use more often tactile selection and make fewer errors. The figure tends to be constant after block 11 (approximately 40mn of experiment). For the last 6 blocks, the proportion of tactile usage is 94% for favorites (74% for other items) and the accuracy when tactile is used is 88% for favorites (56% for other items). We also noticed that, for all item types, at least one participant was able to realize correct tactile selection during the last 6 blocks. Finally, the mean selection time for these blocks was respectively 8.6s, 12.2s, and 16.2s for PF, SF and NF. These results confirms our hypotheses that sufficient training should make users able to learn a small set of tactile patterns and thus select favorites eyes-free by using our technique.

Users enjoyed this experiment and said they would like to use tactile feedback on their mobile devices (despite of some hardware or software problems that occasionally activated wrong items).

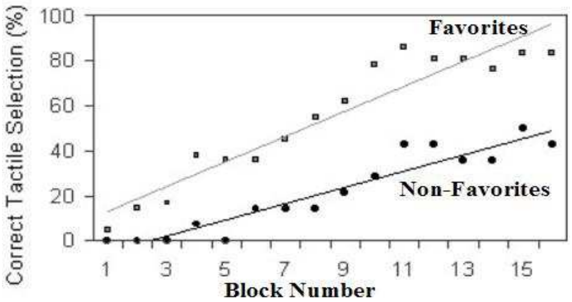

Figure 6: Mean CTS performance by block number.

CONCLUSION

We presented a new interaction technique for accessing favorites, and items located in the same region of interest, by performing simple gestures with the finger. By combining absolute/relative positioning, it is possible to select an element easily in a bifocal representation.

Compared to usual hierarchical representations, our technique reduces the input information load by allowing users to select their favorites directly. This feature is especially well suited for moderately sized everyday-life lists where certain elements are indeed very frequently used. An interesting consequence of this design is that non-favorite items are likely to be memorized relatively to favorites. Favorites will then act as “landmarks” for reaching easily other elements (e.g. channels close to a favorite TV channels). Favorites can also be used as representatives of a category or a group of related items (e.g. friends of my brother in a contact list; Miles Davis albums around “Kind of blues”). Favorites would then help accessing information according to the user personal organization of data. Besides, as with common folders, lists could then be ordered according to different criteria (personal, alphabetical, time...).

Another original characteristic of our technique is that it allows eyes-free navigation among favorite items. This feature can also be quite useful for reaching other items. By using a multimodal interaction strategy, users can find the proper region of the list quickly and without looking at the device thanks to tactile feedback, then use the visual modality to adjust the final position. We wished to explore the potential of tactile feedback, a modality that has been rarely used for such purpose. However, our technique could either work with audio feedback or a combination of audio and simple tactile cues, such as vibrations. We now plan to expand this design for the navigation in longer data set with a larger number of favorites by adding support for hierarchical organization.

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