TactiMote: A Tactile Remote Control for Navigating in Long Lists

ABSTRACT

This paper presents *TactiMote*, a remote control with tactile feedback designed for navigating in long lists and catalogues. *TactiMote* integrates a joystick that allows 2D interaction with the thumb and a Braille cell that provides tactile feedback. This feedback is intended to help the selection task in novice mode and to allow for fast eyes-free navigation among favorite items in expert mode. The paper describes the design of the *TactiMote* prototype for TV channel selection and reports a preliminary experiment that shows the feasibility of the approach.

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

Keywords: Target acquisition, navigation, selection, tactile feedback, visual feedback, list, joystick.

INTRODUCTION

The selection and navigation in long lists or catalogues is a common problem, especially in multimedia environments. For example, cable TV may offer several hundred channels, MP3 players such as the IPod can store more than one thousand songs and the number of podcasts and web radios is continuously increasing.

Users often have some favorite channels (or favorite songs, radios, etc.) that they access frequently, while most other sources are seldom used. Some multimedia systems provide simplified interaction to select favorite items. Eyes-free interaction techniques may be especially well suited for selecting favorites as they can be used in situations of divided attention, without having to perform a visual search in a menu system. For example, the EarPod [10] makes it possible to navigate in a list of songs by using auditory feedback. Tactile feedback provides another way to perform eyes-free interaction. This modality has been explored for target acquisition [9] or for selecting items in small lists [6]. However, it has not still been experimented for navigating in long lists or catalogues.

This paper presents a tactile remote control that integrates a joystick for navigation and a Braille matrix for tactile feedback. This feedback is used to help the selection task in novice mode and to allow for fast eyes-free navigation among the favorite items in expert mode.

As an example, we have tested this device for selecting an element in a large set of TV channels. In novice mode, these channels are organized as a table (Figure 1) where columns correspond to typical channel categories such as Sports, News, etc. Tactile feedback occurs when the category is changed or when the selection passes over favorite channels. The table is not shown in expert mode, the only output provided in this case is the tactile feedback.

A key point in using Braille cells is that this kind of equipment is relatively common and inexpensive, but can only provide a limited number of simple signals to the user (a 4x2 Braille cell was used in our system). Although our device could be useful for blind users (for tasks such as selecting a song or an audio channel), it has been primarily designed for determining the ability of untrained sighted users to distinguish simple tactile patterns and to use them efficiently in a selection task.

Figure 1: The 2-dimensional list of TV channels as they appear in novice mode. Favorite channels have a pink background. The current category and the current channel in this category are respectively highlighted with yellow and purple colors.

The next section describes the device and the interaction technique for selecting channels. Emphasis is put on the design of a simple set of tactile patterns that could easily be distinguished by non-expert users. We then present preliminary results obtained from informal testing. Finally, we compare with previous work and conclude.

TACTIMOTE DESIGN

We first present how we designed *TactiMote*, a remote control with tactile feedback that was developed for this study. *TactiMote,* that is illustrated in Figure 2, consists of: a mini joystick and a hardware button, a 4x2 Metec B10 Braille cell (METEC^{TM}: www.metec-ag.de) that acts as output and a micro-controller and a ZIGBEE chip for wireless communication with a PC or a multimedia center

As explained in the next paragraphs, a pistol-like shape was chosen in order to make it easy for users to interact with the input devices (i.e. the joystick and a trigger button) while feeling the output provided by the Braille cell.

The traditional design of remote controls supposes that the user holds them in such a way that the thumb is the only finger located on the top of the device. This makes it possible to operate the remote by using the thumb if the device is not too large. As shown by studies on mobile interaction [6], thumb operation is a desirable feature because users can use the other hand to perform another operation (such as reading their favorite TV guide in the case of a remote control).

However, adding a Braille cell on such a device poses several problems. First, as said before, all fingers except the thumb are roughly located under the remote device. This means that the Braille cell should be upside-down, on the back side of the remote, so that its pins would be in permanent contact with one finger (typically the index finger). Unfortunately, this design would not work well because the vertical position of the cell pins depends on gravity (and finger pressure) when they are in the "idle" state. Hence, they would tend to stay in the "activated" state even when they are not actually activated. This would lead to ambiguities as the user would need to press his finger very firmly on the tactile cell to distinguish activated and idle pins.

An alternate design would consist in inverting the locations of these devices so that the tactile cell would be on the top of the remote control, and thus, under the thumb. However, the thumb is not the best candidate for tactile feedback (it is less sensitive than the index finger) and users could not see the joystick, a feature that could be disorienting, especially for novice users.

The pistol-like shape of our proposed design solves these problems. The joystick is placed on the hammer position of the pistol to allow natural interaction with the thumb (Figure 2). The joystick is thus visible by users and its position makes it easy to interact with only one hand. It provides 2D continuous control and can also be used as a hardware button when pressed. A trigger button, that serves to toggle modes, is placed in the front of the handle. This button can be easily controlled by pressing the middle finger. The tactile cell is located on the top right side of the barrel so that users can conveniently keep the index finger on it. This position is compatible with the gravity constraint of Braille cells. It also provides good contact between the finger and the cell pins with the finger being naturally oriented in the direction of the tactile cell. This position can be changed for left handed users by rotating the barrel. Finally, the handle of the pistol provides good grip even when holding it with only two fingers. It also contains the batteries so that the gravity center of the whole device is located in such a way that it will not tilt forward.

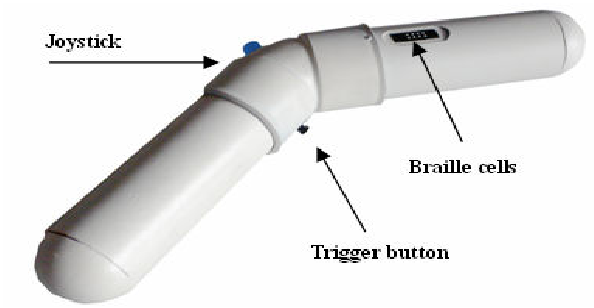

Figure 2: The TactiMote remote control.

TACTILE CUES

Tactile cues play a crucial role in the efficiency of the *TactiMote* device. The stake was to determine how many different patterns should be provided to users who are not trained for recognizing tactile outputs. The 4x2 pin matrix can theoretically provide 2^8=256 different configurations. However, in accordance with the results of [8], our informal tests showed that only a few of them could be easily recognized by untrained users. Although they can easily detect pin pattern changes, they are generally unable to distinguish patterns that are too similar. This is especially true when a quick decision must be taken based on the sensed pattern. We finally retained the seven patterns shown in Figure 3. To favor memorization, each pattern corresponds to a number from one to seven.

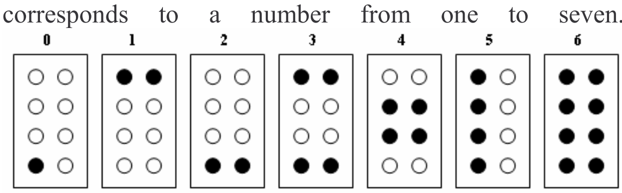

Figure 3: Tactile Patterns: black dots represent raised pins

In addition to static patterns, we also considered vibrating and spatio-temporal patterns. After some experiments, we choose a 3 Hz frequency [4] for vibrating patterns, a speed that seemed appropriate for our task and compatible with the capabilities of our tactile cells. Spatio-temporal patterns were also studied and finally rejected because they require an animation. As users must, at least wait for one cycle to recognize such patterns, they require too much time for the item selection task that was considered in this study.

As mentioned in [8], it appears that users can recognize a limited set of static patterns rather easily. In order to make it easy to distinguish a larger number of patterns in a short amount of time, we decided to provide to the user the seven patterns described above (Fig. 3), either in static or vibrating mode, as will be explained in the next section.

TV CHANNEL SELECTION

We used *TactiMote* to interact with a set of cable TV channels organized by categories as shown in Fig. 1. This task could easily be generalized to other kinds of tables or catalogues such as radio channels, music albums, etc. In our system, TV Channels are represented vertically in seven categories (Sports, Movies…). Favorite channels are colored with a pink background as shown in Fig.1.

Users navigate in the table by using the joystick. When the user pushes the joystick upward (or downward) along the vertical axis and releases it, the joystick comes back to the neutral position and the next (or previous) channel is selected. Users can also keep pressing the joystick if they want to browse channels continuously. The amplitude of the joystick position then controls the scrolling speed. The same type of interaction applies on the X axis for selecting categories. The 2D movement of the joystick is thus in accordance with the 2D layout of the channel table.

Figure 4: User interaction in novice mode.

Tactile feedback occurs when users change the category. One of the static patterns described in the previous section is then actuated to indicate the current category. In order to favor the learning of tactile patterns in novice mode, a visual feedback of the pin array is also provided to the user.

Tactile feedback also occurs when users pass over a favorite channel. Vibrating patterns are used in this case for distinguishing favorite channels from categories. In order to facilitate memorization, the same set of pin patterns is used in both cases so that the Nth category or Nth channel correspond to the same pattern except that they vibrate in the second case. The current system currently supports tactile feedback for seven categories and seven favorite channels in each category. As users generally only have seldom favorite channels than they frequently access, the total numbers of channels that can have a tactile feedback thus correspond to what most users need.

Expert Mode

The expert mode is provided to improve the selection of favorite channels. It avoids having to look at the screen to move the cursor among the large number of available channels. This mode in entered by clicking the trigger button on the *TactiMote* (Figure 2) and is ended by clicking again on the same button. The expert mode works in the same way as the novice mode (tactile feedback is provided in both cases) except that non favorite channels are discarded. Expert navigation thus consists in jumping from one favorite channel to another, all of them having tactile feedback. Channel selection can hence be performed without having to use the visual modality.

Expert and novice modes can be mixed by clicking on the trigger button. This is especially useful for selecting non favorite channels that are close to a favorite. The user can then start the interaction in expert mode to reach to a well known item by "jumping" over favorites, and then enter the novice mode to select the desired channel.

EXPERIMENT

We performed a preliminary experiment to evaluate the ability of non-expert users to identify the proposed patterns. The task consisted in detecting a given pattern among a list of tactile patterns that were presented one after another to the user (each pattern was presented during 1 second). The user was asked to press the spacebar as fast as possible once he recognized the requested pattern. The list of tactile patterns was always containing 1 occurrence of all 7 proposed patterns, placed in a (controlled) random order. The stimulus indicating the requested pattern was a visual representation of the dot pattern.

A training phase was performed first so that users could sense all patterns. The testing phase then started. A block consisted of 7 consecutive trials with the same stimulus to detect but items differently ordered for each trial. 7 blocks were performed, one for each pattern. Only static pattern were tested in this experiment. The summary of the design is: 9 subjects x 7 blocks x 7 trials = 441 selections.

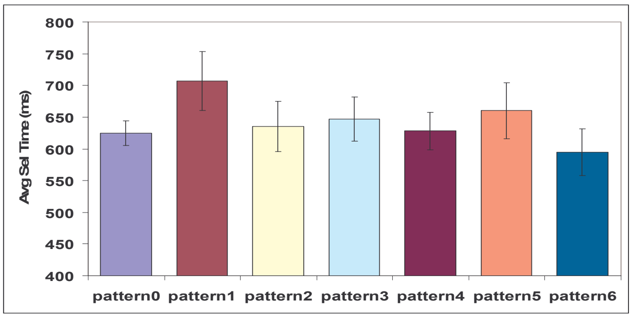

Figure 5: Average selection time for static patterns

Results and Discussion

The average selection time for static patterns was 642ms. Analysis of variance revealed a significant effect for pattern on response time ($F_{6,48}$= 6.25, $p < 0.0001$). A post hoc Tukey test showed that pattern 6 (Figure 3) was faster than other patterns. An incorrect pattern was chosen in 13.6% of the cases and ANOVA revealed no effect for pattern on accuracy. It is worth noticing that the experimental conditions are much less favorable than they would be for the proposed application because item order was randomly changed for each trial. Using TactiMote as a remote control, the order of the favorite channels would obviously not change each time the user wants to select a channel.

We also did a small experiment with the same design for a subset of three vibrating patterns. A longer execution time was obtained (823ms) than for static patterns, a result that corroborates the findings of [8]. We also observed that, during the detection of static patterns, users were often moving their finger up and down on the Braille cell to recognize the pattern. Such movements were rarely observed for vibrating patterns. This may be because dots are alternatively up and down in the vibrating case, so that some kind of "movement" can be sensed if the user waits for the next up/down cycle. This may also explain why the recognition of vibrating patterns takes more time.

Finally, most of the users said they found it "fun" to use TactiMote as an eyes-free selection technique.

RELATED WORK

Devices with Braille cells are generally intended for visually impaired people [2] because they provide symbolic signals that are appropriate for reading textual data. However, a few devices with Braille cells or similar actuators have been proposed for sighted people, such as TactiBall, TactiPen, TactiTab [5][11] that augment a Trackball, a handheld stylus or a Wacom Pen with Braille cells. Their purpose was to provide information that could not be easily displayed because of the small sized handheld screen. Another example is Ubi-Pen [4] which uses 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. VTPlayer (http://www.virtouch2.com) is a mouse with a 4x4 Braille cell. Various static and dynamic patterns were tested on this cell to compare the static and dynamic tactile information [8].

However, these devices have not been tested in real applications with sighted people and they do not tackle the problem posed in this study: the selection of favorite items in large lists. Several studies use other types of tactile feedback such as vibrations (for target selection in [9] or item selection in small lists in [6]). Few studies have investigated multiple target acquisition such as selection in pull-down menus [1]. In this study the mouse vibrates when users are over a menu item. It reveals that performance decreases because users get saturated after some time.

TactiMote is also related to commercial remote controls such as and the Sony Navitus (http://bssc.sel.sony.com/Professional/navitus/index.html) and the Wiimote (http://wii.nintendo.com/). The Wiimote is a motion sensing device that allows users to interact and manipulate items on the screen wirelessly. It provides several buttons, a 2D pointer on the TV screen and is able to capture orientation. Vibration feedback occurs when users are over an element on the screen or after a particular motion during gaming interaction.

TouchEngine [7] is a tactile feedback technology used in Navitus, a remote control for multimedia environments. It integrates an I/O tactile LCD screen. TV channels, songs or movie titles are visible on this display and can also be organized as favorites. However, due to the small screen space it is not possible to display all the categories and only ten favorite elements can be displayed at a given time. In this system, tactile feedback is only produced to confirm the activation of a command. An important difference between these devices and TactiMote is that TactiMote provides eyes-free selection, while these other devices are not intended to support this feature.

CONCLUSION

In this paper we presented *TactiMote* a new remote device that provides tactile feedback to improve expert and novice navigation in lists, catalogues and tabular data. Braille cells were used to provide static and dynamic tactile patterns to the users and to make eyes-free navigation possible. An example application was developed for selecting cable TV channels. A preliminary experiment showed the feasibility of the approach of using TactiMote as an eyes-free control device to select favorite channels.

As future work, we plan to perform more precise evaluation of the required amount of time for recognizing Braille patterns and to conceive a larger set of efficient patterns. We also plan to compare the selection time for *TactiMote* with a traditional remote control and to extend its design for the navigation in hierarchical lists.

ACKNOWLEDGMENTS

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