Performance Evaluation of a List Control based on the 3D-Translational Gestures of TUI

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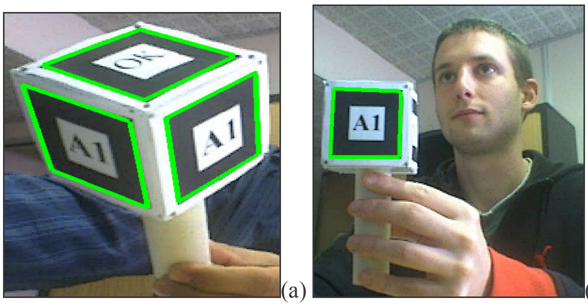
ABSTRACT
Controlled navigation and item selection in a list are frequent tasks. We propose a new interaction technique for navigation and selection of an item from a list by using a tangible user interface. We use augmented reality (AR) markers and 3D gestures to perform these operations. The translational movements of the markers are used to control the list navigation and selection.

Keywords
Navigation, selection, scrolling, gestures, tangible user interfaces.

INTRODUCTION
Tangible user interfaces (TUIs) make it possible for users to interact with digital information by using physical objects. TUIs have been used to control ambient environments as in [2] where "magic wands" serve as a tool to shift the activity from one place to another, such as transporting movies from the living room's TV to the kitchen's monitor screen. AR markers [1], that were originally designed for overlaying virtual images on real world objects, provide another way to develop tangible interfaces. Such TUIs can be used to control multimedia environments. In this paper we investigate the use of AR markers to control a set top box that makes it possible to select TV channels in lists displayed on a TV set.

MARKERS AND THEIR GESTURES
Our system is based on ARToolkit technology [1]. The user makes 3D gestures with a cube (Fig. 1.a) that have a different AR patterns printed on each side. These patterns are detected by a webcam in order to detect the horizontal and vertical movements of the cube (Fig. 1.b).

TV channels are displayed as selectable icons in a horizontal list (Fig. 2) on the TV set. By moving the cube the user can either scroll the list or move a selection box on this list as explained in the following sections. The motion of the marker is thus proportional to the movement of the items or to the movement of the selection box.



(a) (b)

Fig. 1. a) AR marker, b) Translational movements of marker

Moveable Selection Box
In this case the selection box moves over the items of the list. It is originally positioned at the central item. As the marker moves horizontally in space, it controls the position of the selection. First the user chooses the appropriate item by moving the marker in 3D space and then it performs horizontal translational movement to confirm the selection. It has been observed that the vertical translation of the marker provides unintentional change of target when performing selection. So the horizontal movement is considered for the selection.

Fixed Selection Box
In this case, the list is controlled by the horizontal marker movement while the selection box remains fixed. The user searches the target and *brings* it under the selection box by scrolling the list. The list is circular, so that the last item occupies the position of first item when the end of the list is reached. When the target is under the selection box, the user performs the horizontal translational movement of the cube for the selection.

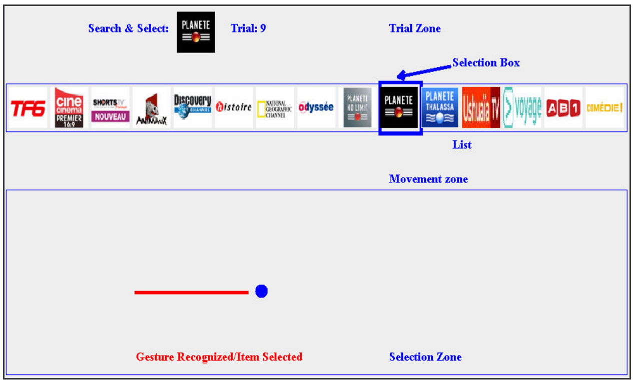


Figure 2. An overview of the experimental system

EXPERIMENT

The lists can be horizontal or vertical. To evaluate this, a study [4] has been conducted. They found no significant difference in selection times for both types of lists.

We conducted an experiment like [4] but in smaller scale and with different tools. The conditions include: the usage of markers instead of mouse, a smaller horizontal list of 15 items, all items displayed on the screen, the list of images with names rather than only text names and the list scenario is simulated on computer screen. The subjects search the item similar to the stimulus. We then compare the efficiency of the moveable and the fixed selection box techniques by evaluating the selection time. Eight participants volunteered. Each performed 10 trials of each technique (10x8x2: total of 160 trials). The hypothesis was that the both techniques would yield approximately the same selection time.

Selection time

In our experiment: the selection time is the addition of reaction time, search time, internal reaction time and execution time. The reaction time is the time when the stimulus appears and the user starts moving the marker to search an item. Search time is the time between the first movement of the marker and when the selection box covers the target (first technique) or when the corresponding item is under the selection box (second technique). Inner reaction time is the time when the target is *captured* and the user starts drawing the selection gesture. The execution time is the time between the start of the gesture and the end of the gesture.

Results

The results (Figs. 3 and 4) suggest that the selection time for the moveable selection box (first technique) is less than the selection time of the fixed selection box (second technique) except for the last subject. The average selection time for the first technique is 5594 milliseconds and 7399 milliseconds for the second one (Fig. 4). The ANOVA test reveals an average effect on selection time ($F_{(1,7)}$=4,22 , p<0,1). The results indicated that users clearly preferred the first technique.

The results clearly indicate that the first technique outperformed the second one. This is because participants find it easy to remember the position of items in the static list technique. This is in compliance with [3] which show that the remembrance of items in the list depends upon the frequency of access and on items location on the screen.

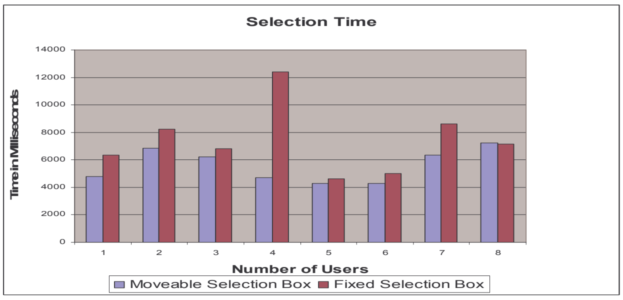


Figure 3. Comparison of the Selection Time by each user for both techniques

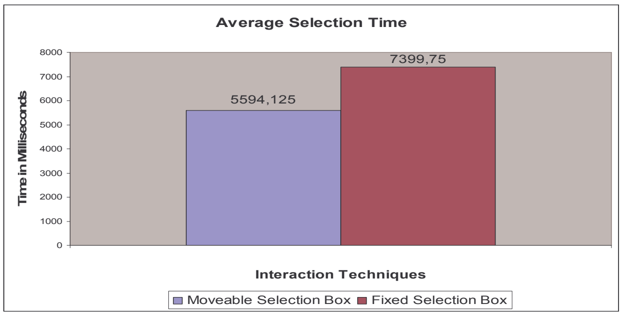


Figure 4. Mean Selection Time for both techniques

CONCLUSION

We introduced a new 3D interaction technique for selecting items in a list by using a tangible user interface. We further plan to use rotational gestures and compare their efficiency with the results of translational gestures.

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