Pinch Keyboard: Natural Text Input for Immersive Virtual Environments

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ABSTRACT
Text entry may be needed for system control tasks in immersive virtual environments, but no efficient and usable techniques exist. We present the pinch keyboard interaction technique, which simulates a standard QWERTY keyboard using Pinch Gloves™ and 6 DOF trackers. The system includes visual and auditory feedback and a simple method of calibration.

KEYWORDS: Keyboard, text input, virtual environment, 3D interaction, 3D user interface, pinch gloves.

INTRODUCTION
Immersive virtual environment (VE) applications have largely avoided the task of entering text information. This may be the result of the popular conception that VE interfaces should be completely "natural." We do not adhere to this philosophy, preferring to focus on usability, efficiency, and usefulness in completing a task when designing three-dimensional (3D) interaction techniques. In fact, there are many situations where text input might be useful in a VE. Examples include: leaving an annotation for the designer in an architectural walkthrough, entering the filename to which the current world should be saved in a layout application for interior designers, or adding labels to virtual molecules in a system for chemistry education

Another reason for the lack of text input in VE applications is that the currently available techniques all present serious obstacles to their use. In general, one cannot assume that the user will be able to see the physical world (e.g. when using a head-mounted display) or that a surface, such as a desk, is available. One-handed chord keyboards [3, 4], can allow efficient typing, but require significant training, and most force the user to carry an additional device in the VE ([5] presents an exception). Speech recognition systems have improved, but may require system training, are susceptible to errors due to environmental sounds, and are cumbersome to use one letter at a time, which would be required for typing non-words such as filenames. "Virtual" or "soft" keyboards [6], such as those used on PDAs, can be implemented in an immersive VE using the "pen & tablet" metaphor [1]. A keyboard layout would be displayed on the surface of a virtual tablet (corresponding to a physical tablet) and selected with a virtual pen (corresponding to a physical pen). Such a technique requires the user to hold two devices, however, and does not take advantage of touch-typing skills.


Figure 1. User wearing HMD and Pinch Gloves™

We have developed a technique for text input in VEs called the pinch keyboard. It uses Fakespace Pinch Gloves™ (figure 1), lightweight gloves with conductive cloth on each fingertip that sense when two or more fingers are touching. The gloves are comfortable to wear, and because of their discrete nature, there is no ambiguity to user actions. Our technique also uses a standard QWERTY keyboard layout, so that users can take advantage of the typing skill they already have.

DESIGN OF THE PINCH KEYBOARD TECHNIQUE
The basic concept of our virtual keyboard is that a simple pinch between a thumb and finger on the same hand represents a key press by that finger. Thus, on the "home"

row of the keyboard, left pinky represents ‘a’, left ring represents ‘s’, and so on.

We also need the ability to use the “inner” keys such as ‘g’ and ‘h’, and the ability to change rows of the keyboard. We accomplish this through the use of 6 DOF trackers mounted on the gloves. Inner keys are selected by rotating the hand inward (figure 2). Since this can be an awkward motion, we also provide the alternative method of pinching the thumb to both the index and middle fingers to select an inner key.

The user changes the active row by moving the hands closer to the body (bottom row) or farther away (top row). Users calibrate the location of the rows before using the system by indicating the middle of the top and bottom rows while holding the hands palm-down. Still, because the trackers have limited accuracy, fairly large-scale motions are required to change rows or select the inner keys, reducing efficiency.

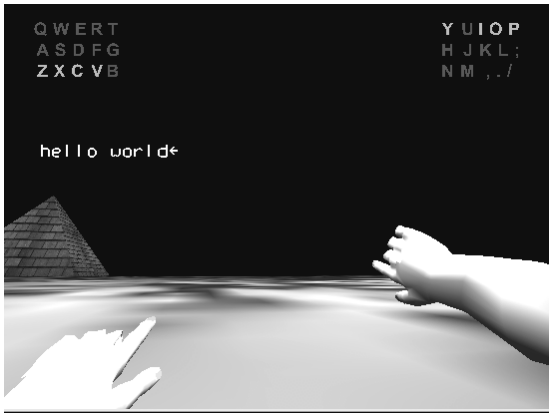

Figure 2: User’s view of the pinch keyboard

Visual feedback is extremely important to make up for the lack of visual and haptic feedback provided by a physical keyboard. Two feedback objects are attached to the view. These show the location of each character, and the currently active characters (based on hand position and orientation) via highlighting (figure 2). The text entered by the user is also attached to the user’s view. In addition, we provide audio feedback that lets the user know when a key has been pressed or when calibration is complete.

ADDITIONAL FEATURES

We provide special gestures for space (thumb to thumb), backspace (ring to ring), delete all (pinky to pinky), and enter (index to index). This set of arbitrary gestures is small enough to be memorized by the user.

We also implemented a menu to allow the user to control pinch keyboard parameters. When the left palm is turned upwards, menu items are attached to three of the fingers. The user selects a menu item by pinching the left thumb to the appropriate finger, in a manner similar to menu item selection in the TULIP technique [2].

The menu includes commands to hide or show the visual feedback, turn the audio feedback on or off, and recalibrate the system. This last option is especially important, because users may want to decrease the distance between rows once they are more comfortable with the system.

CONCLUSIONS AND FUTURE WORK

In our experience with the pinch keyboard technique, novice users type very slowly and deliberately, even though many of them are speedy touch typists. This might suggest that typing skill does not transfer to our technique and that training is required. However, all users immediately *understand* the technique. Expertise is gained not through cognitive training, but rather through motor training, since the movements are different than a standard keyboard. Therefore, novice users can immediately begin typing, although their performance might be poor. Currently, “experts” with the pinch keyboard (one hour of use or more) can type on the order of 12-15 words per minute.

In the future, we plan to extend the pinch keyboard technique to allow additional types of input, including numbers, punctuation and capital letters. Also, we plan empirical comparisons to other text input schemes for VEs, and integration into a realistic application.

ACKNOWLEDGMENTS

The authors would like to acknowledge the contributions of Chad Wingrave to this work.

REFERENCES

1. Angus, I. and Sowizral, H. Embedding the 2D Interaction Metaphor in a Real 3D Virtual Environment. In *Proceedings of SPIE, Stereoscopic Displays and Virtual Reality Systems*, 1995, pp. 282-293.

2. Bowman, D. and Wingrave, C. Design and Evaluation of Menu Systems for Immersive Virtual Environments. In *Proceedings of IEEE Virtual Reality*, 2001, pp. 149-156.

3. Matias, E., MacKenzie, I., and Buxton, W. Half-QWERTY: A One-handed Keyboard Facilitating Skill Transfer from QWERTY. In *Proceedings of ACM INTERCHI*, 1993, pp. 88-94.

4. Noyes, J., *Chord Keyboards.* Applied Ergonomics, 1983. *14*: p. 55-59.

5. Rosenberg, R., *Computing without Mice and Keyboards: Text and Graphic Input Devices for Mobile Computing*, 1998, Doctoral Dissertation, Dept. of Computer Science, University College, London.

6. Zhai, S., Hunter, M., and Smith, B. The Metropolis Keyboard - an Exploration of Quantitative Techniques for Virtual Keyboard Design. In *Proceedings of the ACM Symposium on User Interface Software and Technology*, 2000, pp. 119-128.