Predictive Text Entry in Immersive Environments

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Abstract

One of the classic problems with immersive environments is data entry; with a head-mounted display (HMD) the user can no longer see the keyboard. Although for many applications data entry is not a requirement, for some it is essential: communicating in collaborative environments, entering a filename to which work can be saved, or accessing system controls. Combining datagloves and a graphically represented keyboard with a predictive spelling paradigm, we describe an effective text entry technique for immersive environments; we explore the key issues when using such a technique, and report the results of preliminary usability testing.

1. Introduction

Virtual Reality (VR) has progressed significantly since its conception, enabling previously impossible applications such as virtual prototyping, telepresence, and augmented reality. However, data entry remains one of the classic problems with this technology [4], and although there have been previous attempts to address the issue, there is, as yet, no elegant solution to the problem.

Existing techniques for data entry include speech, chorded keyboards, pen and tablet systems, and various gloved techniques. Speech recognition systems offer a natural interface, but can require considerable training, suffer in noisy environments, and are inefficient for text editing and manipulation. Chorded keyboards, such as the Twiddler2 [5], allow one handed text entry, but beginners are required to learn a complicated alphabet of chords before they begin to type. Pen and tablet techniques, while natural, are limited by the handwriting speed, and can be slowed further by the need to learn and use adapted alphabet characters to aid recognition accuracy.

Datagloves are commonly used for interaction in immersive environments, allowing the wearer to interact in a natural way with virtual objects. A text entry technique which uses datagloves is thus likely to be easily incorporated into many immersive environments.

Systems using datagloves for text entry include the Pinch Keyboard [1], VType [2] and Finger-Joint Gesture Wearable Keypad [3]. While the Pinch Keyboard allows users to select individual letters on a virtual keyboard by mapping the user's hand in 3D space to select the desired row, both the Finger-Joint Gesture Wearable Keypad and VType use ambiguous keyboards, with a dictionary of words used to help predict the users intention.

We suggest a method of data entry that combines aspects from both the Pinch Keyboard [1] and VType [2]. Using two 5DT datagloves, a predictive text paradigm, a graphically represented keyboard, and intuitive interaction techniques, we developed a text entry technique that is both simple and effective; a method that attempts to utilise user muscle memory, but ignores the position of the hand and instead predicts which key the user actually wants based on finger flexure and the statistical redundancy of the English language.

2. Predictive text entry in immersive environments

The central idea is that, when data entry is required in a virtual environment, the user is presented with a graphical representation of a keyboard, with each finger mapping to a column of keys. To type, the user simply flexes the relevant finger to select the correct column. After a sequence of finger flexes the user is presented with the predicted word. Users may rotate through alternative matching words to indicate the desired word if the initial prediction is incorrect.

At any stage during the course of text entry there may be several clashing words for a given series of key presses. When there are clashing words, our system offers the user an ordered list of the potential words ranked according to their probability. The most likely word is highlighted ready for selection, but the user can highlight any of the words in the list by altering the tilt of their

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wrist. On the left hand side, the user sees the words that map to the current sequence of keys they have pressed. These are highlighted by tilting the left hand and selected by pressing the left thumb (Figure 1).

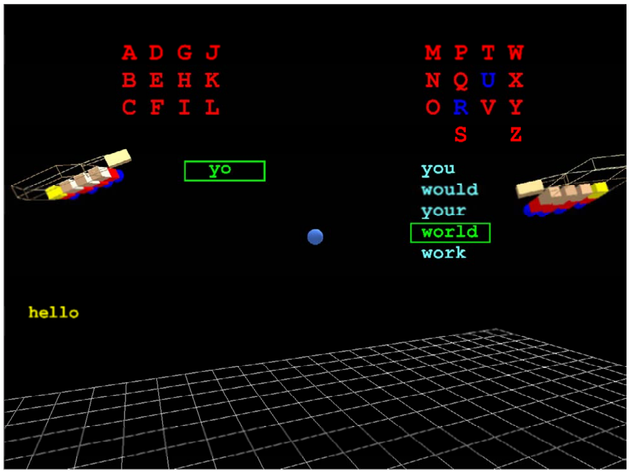

Figure 1

3. Design and implementation

We focused on the three areas central to the use of ambiguous keyboards in immersive environments: the disambiguation engine, the associated interaction techniques, and the keyboard layout.

Central to the use of the system is the disambiguation engine, which must predict the word intended by the user with reasonable accuracy to avoid user frustration. Statistically, a QWERTY keyboard layout, with its uneven finger distribution, leads to a high clash count - where a sequence of finger flexures map to more then one potential word. However, using a language model (based on a 4 million word corpora) and analysing the previously typed words, word prediction accuracy of 96% was achieved.

Further increases in prediction accuracy are, in fact, possible if keyboards are designed to minimise clashing. By analysing the frequency of each word in a dictionary, it is possible to create optimal keyboard layouts that have a prediction accuracy of over 99%. While these keyboards are likely to seem foreign and unfamiliar to users, the potential speed gains offered by high prediction accuracy may counter the extra time spent searching for keys.

Word completion offers further opportunities for increased text entry speed. Originally designed for people with physical disabilities, who had difficulty using a standard keyboard for text input, word completion systems generally wait for a user to enter the first letter of a word, and then offer a list of potential completed words. When word completion is active the user sees a list of complete words that they may choose from on the right hand side (Figure 1). These are highlighted by tilting the right hand and selected by pressing the right thumb.

4. Usability tests

Informal tests were carried out to evaluate various aspects of the system, including keyboard layout and word prediction. It was hoped that the rich graphical nature of VR would reduce the strain experienced by users searching alternative, optimised keyboards, and facilitate quick scanning of complete word lists as they type, making word completion an extremely useful method of text entry. Three keyboard layouts were tested: a traditional QWERTY; an alphabetic, similar to those found on many phones (Figure 1); and a layout optimised to reduce clashing. All three layouts were tested, on 5 participants, both with and without word completion active, giving a total of 6 tests per user.

5. Conclusions and further work

Our results showed that our text entry technique was easily understood, with beginners typing at an average speed of 9 words per minute (WPM) after just 12 minutes training (More experienced users type at over 17 WPM). Keyboard layout caused no significant change to text entry speed; however, word completion provided significant speed increases for all users, increasing WPM by and average of 33% when used.

Further test are currently underway to evaluate alternative keyboard representations, and the effects of various visual cues on speed and ease of use of the system.

6. References

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