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A Wearable Electrotactile Interface for Text Entry in Virtual Reality

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***Abstract*—In this hands-on demonstration, a wearable electrotactile interface for text entry in virtual reality has been developed to enhance the immersion of human-computer interaction in virtual scenes.**

***Index Terms*—Electrotactile, Text Entry, Human-Computer Interaction, Virtual Reality.**

Text entry serves as an important human-computer interaction task in virtual reality (VR) environments. However, the transition from physical keyboards to virtual keyboards introduces technical challenges, particularly regarding tactile feedback limitations. Unlike conventional input devices, virtual keyboards lack physical constraints, leading to phenomena like finger penetration through virtual buttons that diminish user immersion. Existing solutions use vibration feedback [1] or ultrasonic feedback [2] to alert users when their fingers contact virtual buttons. However, these methods have practical limitations. Vibration actuators are typically rigid structures with a certain volume, which may interfere with optical hand tracking systems in commercial VR hardware. Meanwhile, the bandwidth of actuators commonly used for fingertip vibrotactile feedback is relatively narrow, making it difficult to achieve rich tactile perception. As for ultrasound feedback, the ultrasonic focusing array requires physical space within the interaction space, which inherently limits the user's free movement. This method has relatively poor resolution and feedback strength when applied to fingers.

An ideal scenario would involve a skin-conforming, miniaturized tactile interface that delivers precise feedback while maintaining compatibility with commercial hand-tracking systems [3]. This study presents a conformable electrode array based on flexible printed circuit boards, featuring optimized surface apertures that ensure conformal skin contact while maintaining compatibility with optical hand-tracking systems. This integrated interface achieves real-time electrotactile feedback synchronization for virtual button interaction through fingertip electrodes. When a collision event occurs between the user's finger collision body and the virtual keyboard collision body, the tapping content is displayed on the display, and the circuit is controlled to provide electrical signals to the fingertip electrodes, generating electrotactile feedback sensation (see Fig. 1 and demonstration video). Real time current collection is achieved by adding a DAQ card (USB 6003, NI Inc.) and limiting the current to below 1 mA through software. When it exceeds 1 mA, the program enters the protection mechanism and changes the voltage amplitude to 0 V to protect user safety. This device provides tactile perception without reducing the performance of optical hand-tracking systems.

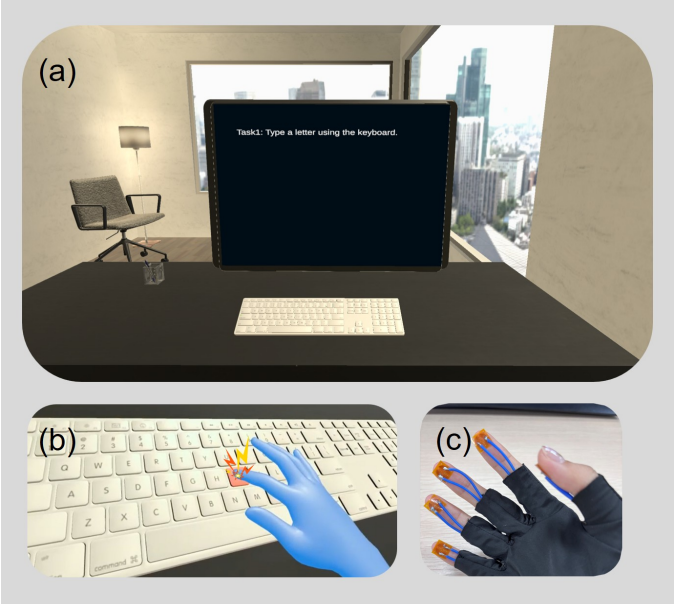

Fig. 1: Overview of the electrotactile interaction system. (a) The virtual environment during text entry task. (b) Synchronized electrotactile feedback and visual key highlighting during virtual interaction. (c) Physical image of wearable electrotactile interface.

References

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