

# /ed [slæʃt] - Gut Feelings when Being Cut and Pierced -

Sayaka OOSHIMA<sup>1</sup>, Yasushi FUKUZAWA<sup>2</sup>, Yuki HASHIMOTO<sup>1</sup>  
Hideyuki ANDO<sup>3</sup>, Junji WATANABE<sup>3,4</sup>, and Hiroyuki KAJIMOTO<sup>1</sup>

1: The University of Electro-Communications, 2: Tokyo Polytechnic University  
3: NTT Communication Science Laboratories, 4: Japan Science and Technology Agency

## 1 Interface for internal bodily sensation

Vibration displays have been rapidly brought into every day life in the fields of communication and entertainment [1]. Notably, vibro-tactile feedback provided by game controllers has been intensively pursued to enrich haptic experiences in gaming. Haptic feedback in games is presented mainly to the hands with the game pad. However, though the game characters have a wide range of haptic experience in the virtual world, the feedback consists of simple shocks or vibration patterns. For example, though the characters in "Sword and Magic" are slashed by their enemies in swordfights, previous devices are not able to present realistic haptic sensations of such situations.

Here, we propose a novel vibro-tactile interface, called "/ed (slashed)", which can present haptic sensation of movement on the body's surface, such as that of being cut with a sword (Fig. 1A), and movement passing through the body, such as that of being pierced with a sharp object (Fig. 1B). Although body-worn haptic feedback devices (haptic vests) have been proposed [2], they cannot provide the new dimensions of haptic experience offered by our interface. With our interface, not only vibration patterns at a location, but also haptic movements on the body's surface (frontal parallel plane) and internal movements passing through the body (sagittal dimension) can be accomplished.

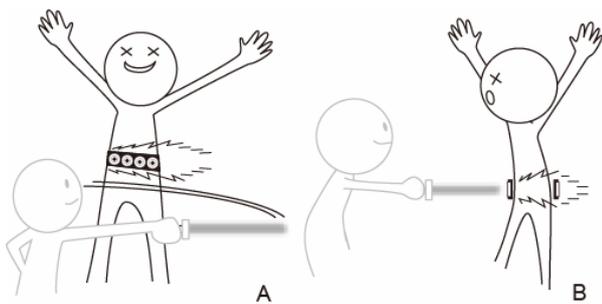


Fig. 1. Feelings of being slashed (A), and pierced (B).

## 2 Sensations of being cut and pierced

The interface is composed of several vibration speakers arranged in a line, and a visual presentation device. The speakers are attached to a belt with rings as shown in Fig. 2. The rings are used to confine the vibrations within each area. For demonstration: the user wears a head mounted display and wraps the belt around the waist as shown in Figs. 3(A) and 3(B). When a swordfight is presented with the display, the speakers are sequentially vibrated in tandem to the visual information. In addition, sound effects are presented in synch using the same speakers. Then,

the user perceives the series of vibrations and sounds as haptic apparent movement on or through the body. When the speakers on the front of the body are vibrated as in Fig. 3(C), the user can perceive the haptic movement on the abdomen surface as if he/she is being cut. When the speakers located on the front and back are vibrated as in Fig. 3(D), the user can perceive the haptic movement passing through the abdomen as if he/she is being pierced.

To determine the design principle of the interface, we performed psychophysical experiments. We specified the temporal interval between the vibration onsets and created the sound effects for realistic presentation of the sensations. Novel aspects of our interface are haptic movement presentation on and through the body and its design principle based on psychophysical experiments.



Fig. 2. Photo of the interface.

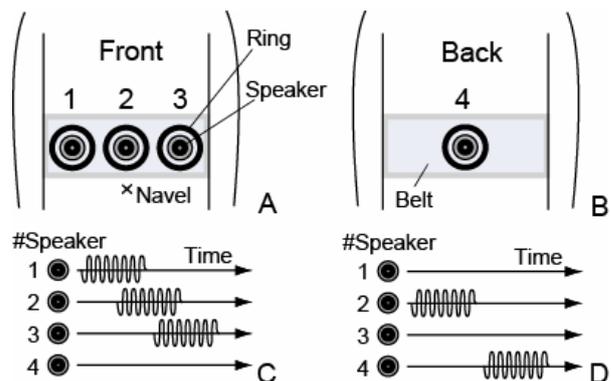


Fig. 3. How the interface is worn (A, B). Timing charts for being slashed (C) and being pierced (D).

## References

- [1] C. C. Collins: Tactile television - mechanical and electrical image projection, IEEE Man-Machine Systems, 1970.
- [2] J. B. F. van Erp: Vibrotactile spatial acuity on the torso: effects of location and timing parameters, WorldHaptics 2005.