Designing a full-body customizable haptic interface using two-dimensional signal transmission

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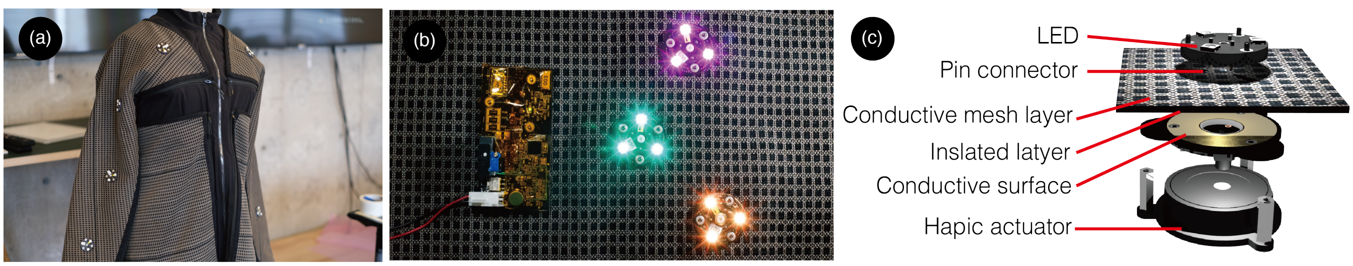

Figure 1: (a) Full-body haptic interface, (b)Haptic modules on the conductive textile. (c) The system of conductive textile and haptic module.

CCS CONCEPTS

• **Human-centered computing** → **Haptic devices**.

KEYWORDS

wearable, vibrotactile, haptic

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0.1 Introduction and Motivation

The concept of spatial computing has a high potential to augment our lives. We can imagine the expansion of the concept of spatial computing in the future as the expanded visual space will blend into our daily lives. In such a future, how do we feel and interact with another reality that overlaps with real space? We have researched this question from an approach using a haptic interface. We previously developed the Synesthesia Suit[Konishi et al. 2016]. This is a full body haptic suit that extends the VR experience of the game "Rez Infinite". It delivers the visual and musical experience of "Rez" to the whole body, and provides haptic feedback. However, the Synesthesia Suit is difficult to walk around in a physical space, due to the thick cables required for its operation. Basically it is especially suited for VR gaming and it was difficult to apply to spatial computing experience.

We develop a new wearable interface, which apply to spatial computing experience as shown in Fig.1(a). From our previous research and knowledge, we concluded that such a new interface satisfies the following requirements: a degree of flexibility similar to that of ordinary cloth that does not affect the user's body movement, a wireless connection that enables walking freely in space, a variation

of haptic feedback, and customizable position and number of haptic feedback modules based on the sense and preference of each user. We uses two-dimensional signal transmission technology to enable all of the above requirements.

1 DESIGN AND FUTURE WORK

We designed the system based on the two-dimensional signal transmission(2DST) technology[Noda and Shinoda 2018]. The system is consists of clothing made of a double-sided conductive textile and multiple haptic modules attached to it as shown in Fig.1(b). The conductive textile is a flexible, functional material that can be sewn like ordinary cloth. It consists of two layers, a conductive mesh made of metal thread on the front side of each layer and an insulated fabric on the back side. The 2DST technology makes this conductive textile function as both a power supply and a communication path. We designed this interface like ordinary clothing using this conductive textile. We also designed a special haptic module for rendering haptic feedback as shown in Fig.1(c). This haptic module can be freely attached to the textile by user's own hand, and it can be individually controlled. The haptic module consists of two parts: an upper part containing three LEDs, and a lower part containing a communication circuit and haptic actuator. Conductive surfaces are applied on each part of the modules. It is wired by sandwiching the conductive mesh of the conductive textile between the two parts of the module.All haptic modules are controlled by the master module attached on the back side. Fig.1(b) shows how the master module and haptic modules work on the conductive textile. The master module works via wireless communication with a PC using Bluetooth. It enables the user's free physical movements in space. The memory installed in the module can store 254 types of acoustic-tactile data with a sample rate of 8000 Hz, PCM, 4sec maximum. The module is designed to represent visual information, too. As with haptic data, the module also stores the blinking patterns of the LEDs, thus enabling a visual expression of haptic feedback. We are working on an Mixed Reality application that can tactilely sense objects and environments that exist in expanded visual space in order to enhancing the spatial computing experience.

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