

Electro-Tactile Display Kit for Fingertip*

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Abstract—An electro-tactile display is a compact, lightweight, and low-energy device that provides distributed tactile feedback. In this study, we reviewed the components of an electro-tactile display, such as the high-voltage source and switching circuit, to realize sufficient miniaturization to be embedded in other haptic devices.

I. INTRODUCTION

Although many electro-tactile displays have been developed thus far [1][2][3], in this paper we reviewed a typical electro-tactile display kit fixed on the fingertip. The configuration of the device is shown in Figure 1. Considering the thick skin of the fingertips, an operating voltage of approximately 300 V is required, and the current source driven by that high voltage is connected to half-bridges (pairs of top and bottom switches). The output of each set of switches is connected to an electrode. By connecting one electrode to the current source/ground and all other electrodes to ground/current source, anodic/cathodic stimulation is achieved. Moreover, by rapidly changing the stimulating electrode, a spatial pattern can be generated.

While the electrode can be easily miniaturized, the switches cannot be miniaturized easily. Typically, high-voltage photocouplers or discrete transistors were used as switching elements, but in our previous case, we used a high-voltage MEMS driver IC, the HV507 (Microchip) to realize multi-channel stimulation in a compact size. However, the IC itself was not compact enough to be placed over a fingertip; therefore, the switching elements were placed on the back of the user's hand [3]. The electrical current limitation of the IC, which is around a few milliamperes, was also a concern.

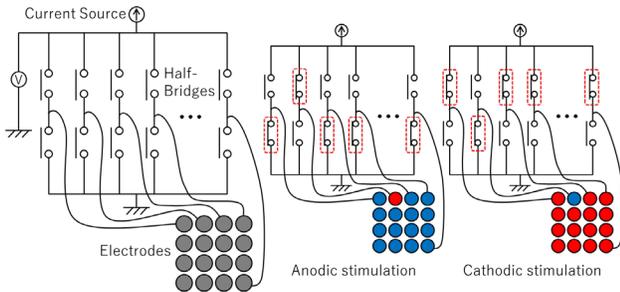


Figure 1. Typical configuration of an electro-tactile display

II. DEVELOPMENT

Figure 2. shows the developed electro-tactile display kit. An ESP32 microcontroller (ESP-32 DevkitC, Espressif Systems) was used to control and communicate with the PC

and eight HV513 (Microchip) chips were used as the switching part. Further, an electrode board comprising 7×9 electrodes at 2 mm intervals was also fabricated. The portion where the fingertip was placed was composed of the switching part and the electrodes with dimensions of 20×28.5×3 mm, which is small enough to be used as a wearable haptic display and to be mounted on other haptic devices. Figure 3. shows the output current for the command value. Although the maximum current value depends on the resistance of the load (due to the supply voltage limitation of 300V), a minimum current of 20mA can be stably output for a 10.2 kΩ load, which is ideal not only for electro-tactile display but also for electrical muscle stimulations.

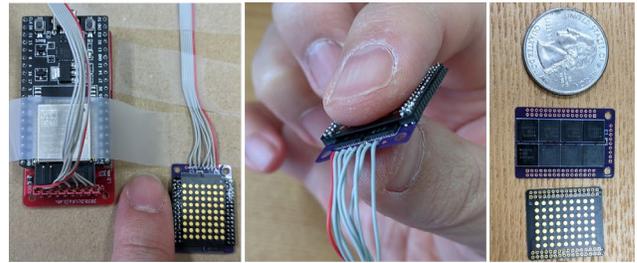


Figure 2. (Left) Overview of the proposed electro-tactile display kit. (Middle and Right) The fabricated switching board and electrodes

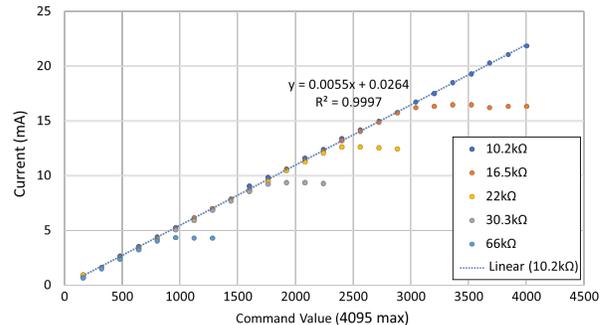


Figure 3. Output current for different loads

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