

PossessedHand

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1. Introduction

Human have the dexterous fingers because of many muscle actuators in the forearm that are used for communications, playing and so on. If a device can control human hands, the device can be useful for HCI(Human-Computer Interface) application's output. Many devices and systems that directly stimulate a user's fingers have been researched. However, users prefer to avoid wearing devices on the palm and the back of the hand because he skin on the area is important sensor for communication, touching, playing musical instruments or in other performing arts. To solve these problems, we develop PossessedHand that can control a user's hand without covering the hand. PossessedHand can be used for controlling finger joint movements; it operates by applying an electrical stimulus to the muscles in the forearm with noninvasive electrode pads.

2. System Configuration

PossessedHand consists of a pulse generator (micro-controller and switching board) and two forearm belts, which have 28 electric pads (Figure 1). Each muscle is stimulated via the pads. Functional Electrical Stimulation (FES)[1] is adapted to the electric stimuli of PossessedHand. The applied stimulation pulse frequency was set to 40Hz, and the pulse width was 0.2 ms, and the pulse height (voltage) was in the range of 15-42 V. By applying the electrical stimuli to the forearm muscles, PossessedHand can control hand motions of 16 finger joints.

3. Auto-calibration System

A controlling the muscles requires special knowledge for the system setting because positions of the stimulation, the stimulation level and timing differ greatly in individuals. We introduce an automatic calibration system that stimulates all of pattern of the pad's positions and the stimulation levels and estimates relations between the finger movements and the pattern. On this calibration system, users can use PossessedHand without any special knowledge. Figure 2 shows the controlled finger joints with this system.

3. Application

Finally, we also introduce an application about playing a musical instrument, the Koto. The Koto is a traditional Japanese stringed instrument. Kotos are about 180 centimeters wide and made from paulownia wood. Koto has 13 strings that are strung over 13 movable bridges along the width of the instrument. Players can adjust the string pitches by moving these bridges before playing. A koto player uses all fingers to pluck the strings. The player puts three different picks on the thumb, index finger, and middle finger, respectively. In playing koto, it is important when and which finger should be moved because each finger produces different sound and has a different playing style.

It is difficult for performers to use visual or sound guides for the support of the Koto performance, because the performers should read a Koto score and listen to their own performances during their performances. On the score, string numbers, timings and finger numbers are written. Almost beginners can't read the string numbers, timings and finger numbers at the same time. Then, PossessedHand directly tells the finger number and timing to the performers

In our experiment, we checked that beginners could get the rhythm and make fewer mistakes by wearing PossessedHand. Four beginner subjects tried to play the koto by wearing PossessedHand. The subject played 24-bar. For 9 times, the subject alternated between normal playing, supported playing with Metronome and PossessedHand. Figure 3 shows the errors of the performance. This result indicates PossessedHand decreases the errors and supports the musical performance.

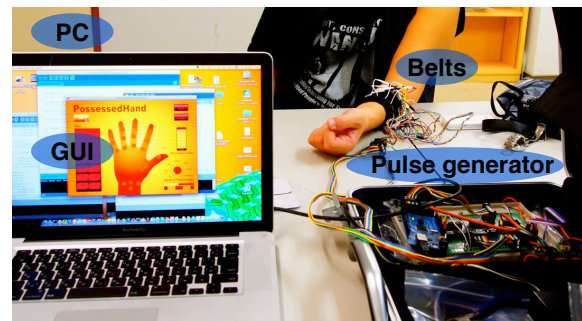


Figure 1. Prototype of PossessedHand.

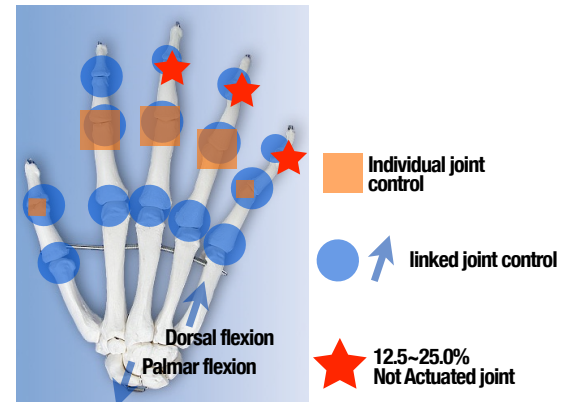


Figure 2. Controlled joints with PossessedHand.

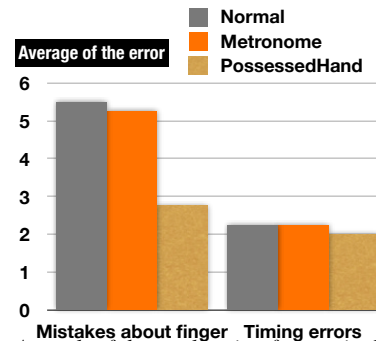


Figure 3. A result of the application for musical performance.

References

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