Design of a Haptic Device Mimicking Index Finger Abduction Force

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Passive methods like Movement observation and motor imagery could serve as add-ons for motor training especially in early days after injury or during the resting periods between conventional rehabilitation therapy sessions. But the effectiveness of these passive methods has not been proven conclusively. The idea of the device is to apply forces by an actuator as a passive somatosensory input and see if it could have an effect on motor training.

Materials and Methods

The first prototype was designed to measure index finger abduction forces in the context of the envisioned sensorimotor task. With this abduction force application we wanted to determine some of the important aspects of human physiology like maximum frequency of force control and maximum rate of change of force. These aspects will be necessary for selecting an actuator in the future.

Pilot trials were done with one subject with the experimental set up shown in Figure 1. Force sensor was mounted on the device and specific visual feedback was designed in LabVIEW. The aim was to reach target forces which were 20%, 30% and 40% of the Maximum index finger abduction force at 0.5 Hz, 1 Hz, 1.5 Hz and 2 Hz frequencies. Error would occur if the subject could not reach the target force at a given frequency. Error % and force velocity profile (rate of change of force) were calculated for each frequency

Results

The upper limit for tolerable error percentage was kept at 80%. This limit was reached at 1.5 Hz trial. So 1.5 Hz could be the maximum frequency for index finger abduction force in context of our experiments. The force velocity profile was calculated at this frequency as rate of change of force would be the highest considering our upper limit. The maximum rate of change of force was 48.437 N/second.

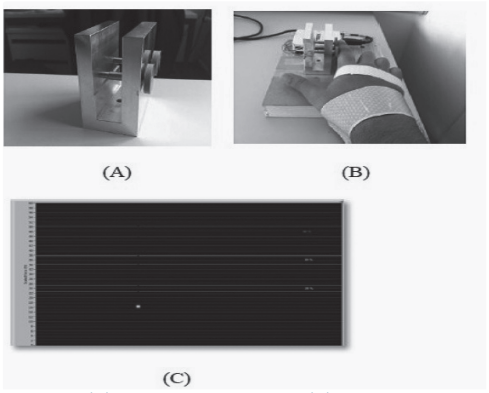

Figure 1: (A) 1st prototype design (B) Experimental setup (C) Visual feedback in LabVIEW

Discussion

Maximum frequency of 1.5 Hz and maximum force changing rate of 48.473 would be considered to select the actuator in the future. Trials with more subjects will be done to get rid of some inconsistencies in the results shown in Figure 2 (B).

References

K. Rosenkranz and J. C. Rothwell, “Modulation of proprioceptive integration in the motor cortex shapes human motor learning.”, The Journal of neuroscience?: the official journal of the Society for Neuroscience, vol. 32, no. 26, pp. 9000–6, Jun. 2012.

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