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Paper Title: A haptic device-based reproduction system of active finger movement and its evaluation using sensory evoked potentials

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Abstract

To develop an experimental system that could be used for physiological experiments on voluntary finger movements in humans, we developed an experimental system that could record active finger movement trajectories and reproduce them as passive movements using SPIDAR-GCC, an inexpensive and easily customized with driven 6-DOF force sensing device. This experimental system could reproduce passive movement with the same trajectory as the active movement, making it possible to perform physiological experiments such as electromyography (EMG), electroencephalography (EEG), and electrical stimulation of sensory nerves under the same conditions between active and passive movements and compare them. The accuracy of this experimental system was verified using finger trajectories during active and passive movements, finger EMG signal, and sensory evoked potentials (SEPs) derived from median nerve stimulation of the wrist that could be measured from EEG. The results showed high-precision agreement of finger trajectories between both movements, detection of EMG only during active movements, increasing in signal-to-noise ratio of SEP with electrical stimulation above motor threshold, increasing movement efficiency as the experimental time progresses, recording of the N20/P25 component of SEPs and features differences, and stability of the stimulation. These results suggested that this experimental system could reproduce passive movements with the same trajectory as active movements with high accuracy and was an effective physiological experimental system for elucidating the neural control mechanisms of active and passive movements.