

A review on surface electromyography-controlled hand robotic devices used for rehabilitation and assistance in activities of daily living

ABSTRACT

Introduction: Spinal cord injuries, traumas, natural aging, and strokes are the main causes of arm impairment or even a chronic disability for an increasing part of the population. Therefore, robotic devices can be essential tools to help individuals afflicted with hand deficit with the activities of daily living in addition to the possibility of restoring hand functions by rehabilitation. Because the surface electromyography (sEMG) control paradigm has recently emerged as an interesting intention control method in devices applied to rehabilitation, the concentration in this study has been devoted to sEMG-controlled hand robotic devices, including gloves and exoskeletons that are used for rehabilitation and for assistance in daily activities.

Materials and Methods: A brief description is given to the previous reviews and studies that have surveyed the robotic devices used for rehabilitation; a comparison is conducted among these studies with respect to the targeted part of the body and the device's control method. Important issues about controlling by sEMG signal are accentuated, and a review of sEMG-controlled hand robotic devices is presented with an abbreviated description for each endeavor. Some criteria related to sEMG control are specifically emphasized, for instance, the muscles used for control, the number of sEMG channels, and the type of sEMG sensor used.

Discussion: It is noted that most of the sEMG-based controls for the devices included in this study have used the nonpattern recognition scheme due to the weak sEMG signals and abnormal pattern of muscle activation for stroke patients. In addition to sEMG-based control, additional control paradigms have been used in many of the listed robotic devices to increase the efficacy of the system; this cooperation is required because of the difficulty in dealing with the sEMG signals of stroke patients. Most of the listed studies have conducted the experiments on a healthy subject to evaluate the efficacy of the systems, whereas the studies that have recruited stroke patients for system assessment were predominately using additional control schemes.

Conclusions: This article highlights the important issues about the sEMG control method and accentuates the weaknesses associated with this type of control to assist researchers in overcoming problems that impede sEMG-controlled robotic devices to be feasible and practical tools for people afflicted with hand impairment.

Keyword: Robotic gloves; Hand exoskeleton; Electromyography; sEMG; Rehabilitation