Soft robotic glove system controlled with amplitude independent muscle activity detection algorithm by using single sEMG channel

ABSTRACT

Arthritis, Parkinson's disease, Cerebral Palsy, natural aging and stroke are the main causes of arm impairment for an increasing part of the population. For instance, stroke affects 15 million people annually in the world causing upper limb disability, also about 78 million arthritis cases with grasping impairment are expected yearly in US by the year of 2040. Therefore, hand robotic devices can be essential tools to help individuals afflicted with hand deficit to perform activities of daily living in addition to the possibility of restoring hand functions by home rehabilitation. In this paper, a real time muscle activity detection algorithm has been developed to control a pneumatic actuated soft robotic glove intended for patients with grasping impairment. The algorithm employs two amplitude independent and computations efficient methods to detect weak and noisy muscle activities from surface electromyography (sEMG) signal obtained by a single channel located on the forearm. These methods are the first lag autocorrelation of the normalized sEMG signal and the modified SampEn method. The algorithm is also insensitive to the spurious background spikes that may contaminate the sEMG signal and deteriorate the performance of amplitude dependent detection methods. The merging of these two methods enables the algorithm to distinguish between hand open and hand close activities by using sEMG signal collected by only one channel. The efficacy of the algorithm has been evaluated on a healthy subject wearing the soft robotic glove, where the algorithm has recognized the hand close and hand open muscle activities with high accuracy. Employing single sEMG channel with computation efficient control algorithm leads to reducing the cost and the size of the soft robotic glove system and make it more practical for utilization in daily basis.

Keyword: Soft robotic glove; Surface electromyography; Muscle activity detection; Single sEMG channel