REAL-TIME PROPORTIONAL MYOELECTRIC CONTROL OF DIGITS

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ABSTRACT

Current powered hand prostheses offer the potential of individual digit control. In practice, however, sequential control strategies are employed (e.g. grip control) which lead to under-actuation of the prosthesis. Arguably, adoption of proportional control strategies can improve the ease of use and naturalness of upper-limb prostheses. Previous work has demonstrated the feasibility of proportional finger control with invasive methods, that is, by using intra-muscular electrodes. Although it has been shown that it is feasible to reconstruct finger joint angle trajectories offline by using surface electromyography (sEMG), the real-time efficiency of such control systems has not been previously evaluated. In this study, we implemented a real-time, proportional finger joint angle controller for the 5 degree-of-freedom (DOF) IH2 Azzurra anthropomorphic hand, and tested its performance with ten able-bodied and two trans-radial amputee subjects. Myoelectric activity was recorded on the participants' forearm proximal to the elbow, by using 16 sEMG sensors, which were equally spaced around the subjects' forearm. The recorded EMG activity was used to decode the intended degree of individual finger flexion and thumb opposition by using a linear regression system (Wiener filter), thus mapping muscle activity to 5-DOF finger joint angles. Ground truth data were collected by using a data glove placed on the participants' contralateral hand. Two different sets of experiments were performed for both populations of participants. In the first experiment, participants were asked to modulate their muscular activity in order to control the robotic hand such that its posture matched a target posture presented to them on a computer screen. At the end of each trial, participants received a performance score that was based on the L_1-distance between the target and performed postures. The analysis of results from this experiment provides helpful insights into the mechanisms underlying the learning of controlling a 5-DOF robotic hand. In the second experiment, participants were asked to control the artificial hand to perform a pick-and-place task, again by modulating their muscular activity. Preliminary results from this part of the study shed light on the usability of proportional finger control for performing activities of daily living (ADL). We value the findings of our study as a valuable step towards the development of truly dexterous, non-invasive hand prostheses.