EMG MEASUREMENT AND GRASPING FORCE MEASUREMENT FOR HAND MOVEMENT IDENTIFICATION

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ABUSTRACT

Many forearm amputees live with prosthetic hands. Among them, while there is high demand for myoelectric prosthetic hands that can combine both appearance and functionality, they are not widely used for various reasons. Therefore, we considered it necessary to improve the usability of myoelectric prosthetic hands, and set our sights on developing a myoelectric prosthetic hand that can be operated intuitively using myoelectric signals. To this end, we aimed to estimate the movements of the hand and fingers from electromyograms.

In this study, we focused on grip grasping, precision grasping, and lateral grasping, which are necessary in many daily life activities, and measured EMG on the forearm during each grasping movement. Since we found that the accuracy of EMG measurement needed to be improved for motion discrimination, we evaluated the grasping motions that were performed by the subject's senses from the force applied to the object to be grasped. For this purpose, a load cell was built into the grasping object, and the accuracy of the experimental device was verified by comparing the measured values of the load cell with known loads. Then, using the fabricated grasping object, EMG measurements were performed at four different grasping forces: 25%, 50%, 75%, and 100%, based on the maximum grasping force that the subject could exert. Measurements were also taken in a blind state to evaluate the subject's sensation. The obtained results suggest that the integrated EMG changed with the change in grasp force, while the average frequency was less affected by the change in grasp force. In addition, it was shown that in the blind state, the variation of grasp force was large from measurement to measurement. Then, models of discriminators using the k-nearest neighbor method, support vector machines, and neural networks were created, and their accuracy was verified. When integral values were used as the feature values, the discriminator was able to discriminate with a high probability of about 90%, while the result was less than 80% when average frequency was used. Therefore, we considered that integral values are suitable for the feature values used in the discriminator.

As a result of this research, it was shown that it is possible to quantitatively evaluate the grasping force during movement by using a grasping object with a built-in load cell. This enabled the acquisition of training data without being affected by the subject's sensation. Furthermore, it was shown that three types of grasping motions and four states of inactivity can be discriminated by multiple algorithms. We believe that this research has enabled the development of a motion discriminator necessary for the control of myoelectric prosthetic hands that can perform multiple grasping movements.