sEMG-based hand posture recognition and visual-feedback training

J. M. Kim, B. M. Koo, S. M. Yang, Y. J. Nam, Y. H. Kim

Purpose sEMG-based recognition system provides the intuitive and accurate classification of various gestures and useful for human-computer interaction. Especially, recognition of hand postures is often suggested as the interaction protocol of rehabilitation systems or robotic orthosis for the elderly and disabled [1]. However, the variability of the sEMG signal was caused by the individual differences and the change of the force or proficiency. In this study, the hand posture recognition algorithm was developed using sEMG sensors, and the visual-feedback training was performed to improve the classification performance. **Method** Four healthy adults and a forearm amputee participated in this study to perform twelve hand postures (Rest, Hook, Spread, Scissor-sign, Finger pointing, V-sign, O.K.-sign, Cylindrical grasp, Spherical grasp, Lateral pinch, Palmar pinch, and Tip pinch) [2]. Commercial sEMG sensors (Delsys Trigno; 1926 Hz) were placed on the nine forearm muscles of the healthy adults (FDS, ED, EDM, EP, FCR, FCU, ECR, ECU, BRD) and the eight forearm muscles of an amputee (based on 3D reconstruction data from MRI; BRD, FCR, ECR, ED, ECU, FDP, FDS, FCU) (Figure 1). A LabVIEW-based radar plot was used for hand posture training (1 day for the healthy adults and 5 days for the amputee) to minimize the variability of the sEMG signal. In the session for recording the sEMG signal, all participants repeated the hand postures 10 times with 20% MVC [3]. The 10-fold cross validation was performed on the ANN classifiers with the feature vector of MAV or the Hudgins' set (MAV, WL, ZC, and SSC) [4] on MATLAB. **Results and Discussion** The classification accuracy was improved by increasing the number of training data in both trained and untrained sessions (Table 1). ANN classifiers of the healthy adults with MAV showed the classification accuracies of 84.3% and 85.8% in untrained session and trained session respectively. The classification performance was improved as 88.4%(untrained) and 91.6%(trained) by the Hudgins' set. In untrained session of the forearm amputee, poor classification accuracies appeared in both MAV(31.7%) and the Hudgins' set(33.0%). After the 5 days training, MAV and the Hudgins' set showed the classification accuracy of 76.3% and 84.7% respectively. In this study, the Hudgins' set and the posture training were useful to improve the classification accuracy. Furthermore, the great improvement of the classification performance appeared in the forearm amputee with an appropriate posture training (day 5). These results supported that the posture training with visual feedback had an effect to minimize the variability of sEMG signals.

References

[1] Xu, H., & Xiong, A. (2021). Advances and disturbances in sEMG-based intentions and movements recognition: A review. IEEE Sensors Journal, 21(12), 13019-13028.

[2] Kim, J., Koo, B., Nam, Y., & Kim, Y. (2021). sEMG-Based Hand Posture Recognition Considering Electrode Shift, Feature Vectors, and Posture Groups. Sensors, 21(22), 7681.

[3] Kim, S., Kim, J., Koo, B., Kim, T., Jung, H., Park, S., ... & Kim, Y. (2019). Development of an armband EMG module and a pattern recognition algorithm for the 5-finger myoelectric hand prosthesis. International Journal of Precision Engineering and Manufacturing, 20(11), 1997-2006.

[4] Hudgins, B., Parker, P., & Scott, R. N. (1993). A new strategy for multifunction myoelectric control. IEEE transactions on biomedical engineering, 40(1), 82-94.

Keywords: sEMG, recognition, hand posture, amputee, visual feedback training

Address: Department of Biomedical Engineering and Institute of Medical Engineering, Yonsei University, Republic ok Korea

Email: younghokim@yonsei.ac.kr

Acknowledgement This research was funded by The Bio & Medical Technology Development Program, grant number NRF-2017M3A9E2063270, through the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT and the Institute of Civil Military Technology Cooperation funded by the Defense Acquisition Program Administration and Ministry of Trade, Industry and Energy of Korean government under grant No.21-SF-GU-07.

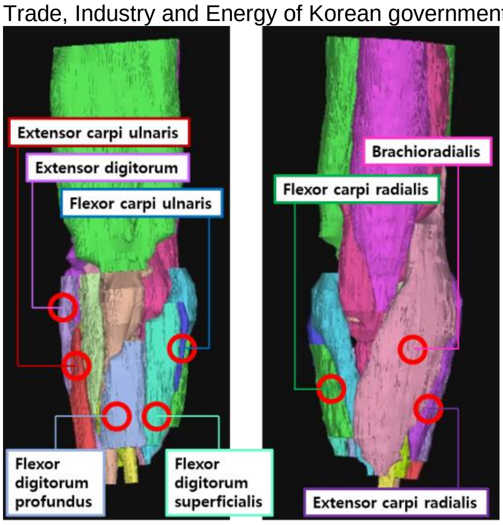

Figure 1 3D reconstruction data of the forearm amputee

Table 1 Classification accuracy of the subjects (unit: %)

Subject	Training	MAV	Hudgins
Healthy	Untrained	84.3 ± 7.4	88.4 ± 7.2
	Trained	85.8 ± 6.0	91.6 ± 5.7
Amputee	Day 1	31.7 ± 31.0	33.0 ± 29.6
	Day 2	50.1 ± 31.3	48.1 ± 30.9
	Day 3	59.7 ± 25.6	66.7 ± 22.8
	Day 4	80.5 ± 17.5	85.0 ± 13.0
	Day 5	76.3 ± 18.3	84.7 ± 13.4