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Subject-Independent Hand Gesture Recognition using Normalization and Machine Learning Algorithms

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Highlights

- Generalizability of subject-independent hand gesture recognition were investigated.
- A different strategy to normalize the EMG features was proposed.
- Hand gesture recognition accuracy improved significantly using the proposed normalization strategy.
- The developed approach of gesture recognition will be useful in biomedical application.

Abstract.

Hand gestures can be recognized using the upper limb's electromyography (EMG) that measures the electrical activity of the skeletal muscles. However, generalization of muscle activities for a particular hand gesture is challenging due to between-subject variations in EMG signals. To improve the gesture recognition accuracy without training the machine learning algorithm subject specifically, the time-domain EMG features are normalized to the area under the averaged root mean square curve (AUC-RMS). Results are compared with both original EMG features and EMG features extracted from the signals that are normalized to the maximum peak value. Ten male adult subjects age ranging 20-37 years performed three hand gestures including fist, wave in, and wave out for ten to twelve times. The four basic time domain features including mean absolute value, zero crossing, waveform length, and slope sign change were extracted from the active EMG signals of each channel. Five machine learning algorithms, namely, *k*-Nearest Neighbor (*k*NN), Discriminant Analysis (DA), Naïve Bayes (NB), Random Forest (RF), and Support Vector Machine (SVM) were used to classify the three different hand gestures. The results showed that the performance metrics such as accuracy, F1-score, Matthew correlation coefficient, and Kappa score were improved when using the both normalization methods compared to the original EMG features. However, normalization to the AUC-RMS value resulted in substantially more accurate gesture recognition compared to features extracted from signal normalized to maximum peak value using *k*NN, NB, and RF ($p<0.05$). The developed approach