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Preliminary Study of Hand Gesture Classification in Upper-Limb Prosthetics Using Machine Learning with EMG Signals

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Abstract : There is an increasing demand for prosthetics capable of mimicking natural limb movements and hand gestures, but precise movement control of prosthetics using only electrode signals continues to be challenging. This study considers the implementation of machine learning as a means of improving accuracy and presents an initial investigation into hand gesture recognition using models based on electromyographic (EMG) signals. EMG signals, which capture muscle activity, are used as inputs to machine learning algorithms to improve prosthetic control accuracy, functionality and adaptivity. Using logistic regression, a machine learning classifier, this study evaluates the accuracy of classifying two hand gestures from the publicly available Ninapro dataset using two-time series feature extraction algorithms: Time Series Feature Extraction (TSFE) and Convolutional Neural Networks (CNNs). Trials were conducted using varying numbers of EMG channels from one to eight to determine the impact of channel quantity on classification accuracy. The results suggest that although both algorithms can successfully distinguish between hand gesture EMG signals, CNNs outperform TSFE in extracting useful information for both accuracy and computational efficiency. In addition, although more channels of EMG signals provide more useful information, they also require more complex and computationally intensive feature extractors and consequently do not perform as well as lower numbers of channels. The findings also underscore the potential of machine learning techniques in developing more effective and adaptive prosthetic control systems.

Keywords : EMG, machine learning, prosthetic control, electromyographic prosthetics, hand gesture classification, CNN, computational neural networks, TSFE, time series feature extraction, channel count, logistic regression, ninapro, classifiers
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