Optimized Design of Wearable EMG Armband-Based Neural-Machine Interfaces

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Electromyographic (EMG) signals carry neural control information and are widely utilized in neural-machine interfaces (NMIs) for applications such as prosthetic control and virtual reality. However, how to design a wearable EMG NMI for daily practice while maintaining high accuracy and efficiency in EMG decoding is underdeveloped. In this study we came up with a wireless 8-channel EMG band, combined with a machine-learning-based EMG decoding method. To optimize this wearable NMI design, we determined (1) electrode placement for maximal neural information extraction, and (2) machine-learning algorithm for accurate user intent recognition. With IRB approval, nine healthy subjects were recruited to perform five wrist/hand motions. The armband was positioned on the proximal or mid-forearm, and EMG signals were sampled at 1500 Hz. Nine decoding algorithms were tested, combining three feature sets (time-domain, autoregressive, and wavelet-based) and three classifiers (linear discriminant analysis (LDA), support vector machine (SVM), and multi-layer perceptron (MLP)). Classification accuracy for users movement intent recognition was assessed via within-subject cross-validation. Results of 2-way ANOVA revealed that classifier type significantly affected accuracy ($P<0.05$), while feature type did not. LDA outperformed SVM and MLP classifiers. Additionally, proximal forearm placement yielded higher accuracy than the mid-forearm (paired T-test, $P <0.05$). The best NMI design in this study achieved a classification accuracy of 98.00 ± 1.14%. In conclusion, placing the EMG band at the location with greater muscle mass and using a simple classifier and features were recommended for optimal wearable EMG NMI design for future real-world applications.

Awards Won:
Fourth Award of $600
Association for the Advancement of Artificial Intelligence: Honorable Mention (do not read aloud). Winners receive a student level membership. Information is included separately in the SAO Portal.