A Non-invasive Electromyographic Interface for Hand Gesture Recognition with Active Noise Suppression Using a Combined Biosignal Processing Algorithm

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I created a universal electromyography interface with active noise suppression for recognizing hand movements because I'm interested in Human Machine Interfaces. This device could have broad application in medical and industrial environments. But my initial investigation revealed there are significant signal processing quality issues to be overcome. I collected electromyography data about 8 hand movements from 15 volunteers by safely attaching to their arms a special sleeve that I made with sensors tracking muscle movement. I recorded the data output for offline analysis. Based on additional research and analysis of the data, I wrote or found software to process signals with different methods: Filtration - Affine Projection Algorithm (APA) adaptive filter; Detection - Smoothing using a combination of RMS (Root Mean Square) and EMA (Exponential Moving Average) filters, followed by a simple threshold detector; Identification of class features - Signal statistics and statistics of signal components in the time-frequency domain; Classifier - LDA. Then I ran the resulted data through an algorithm I wrote and then optimized the hyperparameters of the selected signal processing methods according to criteria like quality of filtration, quality of muscle activity detection and accuracy of movement classification. Adaptive filtering paid off, showing the best results in terms of root-mean-square error (~144) metric combined with fast stabilization of 25 ms. The classification of statistical features based on LDA is best implemented on small datasets. The result is signal recognition good enough to implement in an MVP in areas like prosthetics, remote robotic surgery and even sign-language recognition.

Awards Won:

First Award of $5,000

American Statistical Association: Certificate of Honorable Mention