

LINEAR, KURTOSIS AND BAYESIAN FILTERING OF EMG DRIVE FOR ABSTRACT MYOELECTRIC CONTROL

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ABSTRACT

Introduction:

Signal processing of sEMG is currently the most prevalent method used to control active hand prostheses. For control purposes sEMG is typically transformed into a feature space representation prior to presentation to a controller or classifier. In this study we compare three signal processing techniques for myoelectric control based on low level EMG contractions: mean-absolute-value (MAV), a Bayesian estimate of the EMGs 'neural drive', and sequentially updated real-time Kurtosis.

Method:

Tests were performed while ten participants learned to control an abstract myoelectric-controlled interface (MCI). EMG was recorded from the abductor pollicis brevis (APB) and the abductor digiti minimi (ADM). Features were calculated over a 750 ms window and updated continuously. Participants used isometric muscle co-contraction to control the position of a 2-D cursor toward pseudo-randomly presented targets. Cursor position was determined solely by muscle activation estimates. After each trial participants received a score indicating how well they were able to hold the cursor within the target area. Participants performed 4 blocks of 72 trials. Trials were visually inspected for artifacts, all artifact free trials were used in further analysis.

Results:

The Linear filter outperformed the Kurtosis based method and produced similar percent hold rates to the Bayesian method tested, as shown in Figure 1. Rates of improvement in overall score were more apparent in the Bayesian and Kurtosis filters, while improvement in target hit rate was largely restricted to the Bayesian filter. Differences in hit rate may have been attributable to the Kurtosis and Linear methods being sufficiently similar for participants to generalise between the two. In contrast, optimal co-contraction behaviour for the Bayesian filter is likely to be different as was the rate at which the cursor moved.

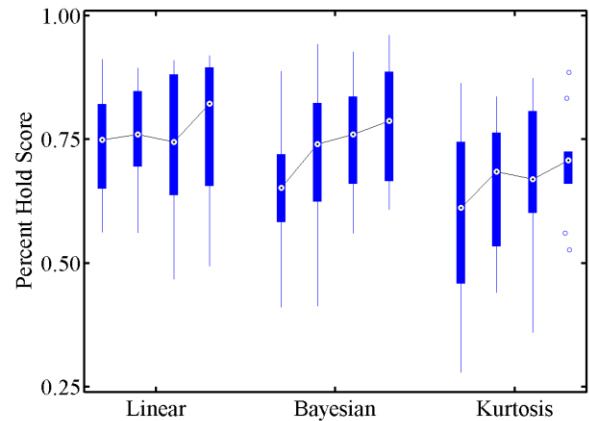


Figure 1: Percent hold score over runs for the Linear, Bayesian and Kurtosis filters.

Despite significantly less efficient trajectories, the Bayesian filter showed a reduced time required to reach individual targets. Participant performance was analysed with respect to Fitts' Law. Analysis showed decreasing accuracy relative to speed for each filter type. A significant correlation found between participant accuracy and overall cursor speed for the MAV filter, suggesting participants were able to make a speed accuracy trade-off. These results suggest that the slower pace of cursor feedback provided by the MAV filter more readily allows for adaptation in participants control strategy.

Conclusion:

Results demonstrate that linear methods can outperform more complex filtering techniques, and that real-time kurtosis may be used as an activation estimator.