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ADVANCED EMG AMPLITUDE PROCESSING USED IN CONSTANT-FORCE EMG-TORQUE ESTIMATION

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AIMS: Advanced EMG amplitute (EMGamp) processors that incorporate signal whitening and multiple-channel combination have been shown to improve EMGamp estimation significantly. In this study, we compared the performance of EMG-torque estimators with and without these recent EMGamp processors.
METHODS: Fifteen healthy subjects (eight male, seven female) produced constant-posture, nonfatiguing, force-varying contractions about the elbow while torque and biceps/triceps EMG were recorded. Four biceps and four triceps EMGs were acquired using conventional bipolar electrode-amplifiers. EMGamp was related to torque using a linear FIR model in which total joint torque was formed from a flexion torque contribution (related to biceps EMGamp) subtracted from an extension torque contribution (related to triceps EMGamp). EMGamp was estimated in four manners: 1) single channel, unwhitened, 2) single channel, whitened, 3) multiple channel, unwhitened and 4) multiple channel, whitened.
RESULTS: As shown in the Figure, both whitening and multiple-channel combination reduced EMG-torque errors and their combination provided an additive benefit. Using a 15th-order linear FIR model, EMG-torque errors with a four-channel, whitened processor averaged 7.3% of maximum voluntary contraction (or 78% of variance accounted for). By comparison, the equivalent single-channel, unwhitened (conventional) processor produced an average error of 9.9% of maximum voluntary contraction (variance accounted for of 55%).
CONCLUSIONS: It was hypothesized that higher fidelity (i.e., lower noise) EMGamp processing would reduce the errors in EMG-torque prediction. Our results show that both EMG signal whitening and multiple channel combination - methods previously shown to improve EMGamp estimates - lead to reduced EMG-torque prediction errors. The lowest errors result when the two techniques are used in combination.

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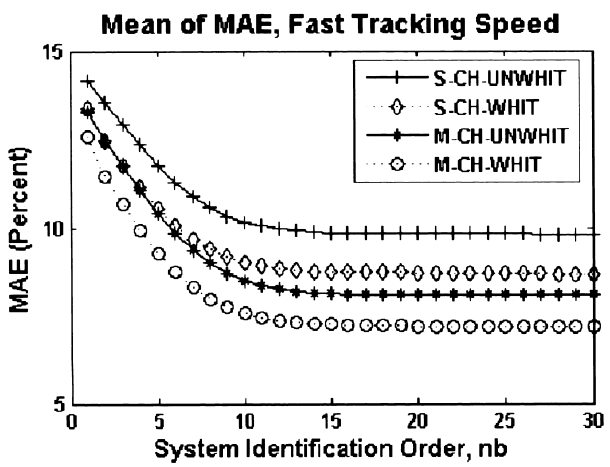

Mean values of mean absolute error (MAE) results, as a function of the system identification model order, for each of the four EMGamp processors. All errors normalized to twice the torque at 50% flexion MVC. Each value in each plot is the average of 180 test recordings