

# DERIVING PROPORTIONAL CONTROL FOR PATTERN RECOGNITION-BASED FORCE MYOGRAPHY

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## ABSTRACT

Force myography (FMG) has been proposed as an alternative to electromyography (EMG) for controlling a powered prosthesis. Previous research has varied in sensor type and configuration, and in control signal processing approaches. Some groups have used low numbers of sensors, while others have included high density grids (HD-FMG). These HD-FMG systems have been shown to reach offline classification accuracies as high as 99.7% for up to 8 classes of motion. As has been shown, however, high offline classification accuracy does not necessarily ensure a high level of prosthetic device usability. One large factor that contributes to the usability of a device, beyond its classification accuracy, is the use of proportional control.

As a precursor to an ongoing real time usability study, this work focussed on developing a proportional control scheme for use with pattern recognition based HD-FMG. Initial pilot work employed the mean of all channel outputs, as has long been used for proportional control in pattern recognition based EMG systems. It was found, however, that the HD-FMG signal did not monotonically increase with increasing effort. This is understandable given the subtleties of muscle synergies and their resulting patterns of mechanical deformation during graded contraction. Here, a class-specific proportional control signal was computed using a regression model trained to map FMG levels to the position of a prompted target.

In order to evaluate the performance of these approaches, HD-FMG and load cell data were collected from 14 participants as they matched their effort to a visual target prompt. Subjects were prompted by a visual position prompt to elicit 4 different active classes of wrist motion with their wrist constrained in a load cell device. From these data, the two proportional control were computed, and compared to both the load-cell value and the position of the visual prompt.

Overall, the average classification accuracy between the 5 motions was found to be 99.9%. The mean value proportional control approach yielded an R<sup>2</sup> coefficient of determination of 0.453 with the visual prompt target. The regression based mapping approach resulted in an R<sup>2</sup> coefficient of determination of 0.875.

This work represents a step towards real-time usability assessment of a HD-FMG based control scheme. These results suggest that a class-specific regression-based proportional control scheme may be effective for use as part of a pattern recognition based system.