Introduction
A significant amount of research is currently being conducted in biomedical engineering and medicine regarding the development of brain-computer-interfaces (BCI) for the disabled. BCIs have been developed using electroencephalography (EEG) for a wide range of tasks [1]. These capabilities can potentially be used to allow those with significant disability the ability to live a normal and productive life. This is difficult as the signal produced from EEG has a very poor signal-to-noise ratio [2], thus requiring significant signal processing. This study assesses several different methods of feature extraction and classification including the Fast Fourier Transform (FFT) and Discrete Wavelet Transform (DWT), with classification being completed by various machine learning algorithms. The goal in this study was identification of isometric muscle flexion via EEG in order to evaluate these methods for potential use within a BCI control algorithm.

Methods
EEG data was collected from a healthy right handed adult male in the area surrounding the motor cortex during flexion of the biceps. This data was then exported to MATLAB\textsuperscript{™} where the data was segmented to separate flexion and relaxation, then processed with features being extracted according to the various methods being evaluated as shown in Figure 1.

Results
Features were extracted via either the Fast Fourier Transform to determine the power spectral density as in Figure 2, or via the Discrete Wavelet Transform as shown in Figure 3. These features were then classified via twenty-two different machine learning methods, with the most accurate results for each method described in Figure 1 being recorded for each machine learning method after five trials. These results are shown in Figure 4. The most accurate combination found was via method 4 using a Subspace Discriminant machine learning algorithm having an accuracy of 88.2%. In addition, 33 combinations of methods achieved an accuracy of 70% or greater, indicating they are viable methods.

Conclusion
The results of the study demonstrated that there are numerous viable methods for the classification and identification of muscle flexion features in EEG signals despite the poor signal-to-noise ratio inherent in EEG signals. In fact, many of the methods used were equal to or surpassed the accuracy of methods used in previous studies [1]. Additionally this study explored the usability of the Discrete Wavelet Transform, a relatively unused method for this particular application, and found that DWT is a viable method for this type of feature extraction in EEG. Ultimately the results of this study revealed there are numerous viable methods of feature extraction for the development of a BCI control algorithm, allowing for further development of technology used for prosthesis and rehabilitation.

References


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