Abstract

Localized muscular fatigue is monitored by the human brain and adjusts muscle output to avoid muscular failures. In situations such as athletic training, injury prevention, physical therapy, ergonomic studies, and diagnosing neuromuscular disorders a computerized algorithm to detect muscular fatigue can be of great use. In this work an algorithm is developed to accept electromyography (EMG) data from 24 different users over time. The EMG data is monitored from the surface three quadriceps which are the vastus lateralis, vastus medialis, and rectus femoris. The output of the algorithm predicts the state of fatigue in real-time. All data studied in this research are based on 50% maximum voluntary contraction (MVC) muscle activities. This work discusses the granularity of fatigue detection possible, different machine learning algorithms, different training methods applied to the algorithms, and new feature vectors input into the algorithms in order to find the optimal combination of parameters that yields the best results. The algorithms discussed in this work used multi-class supervised learning techniques with labeled data based on 50% MVC muscular activity. Two different training methods were compared. The first method assessed trained the algorithms to a specific user, while the second method trained an algorithm to generalize to all subjects. A Hidden Markov Model (HMM) with 13 baseline features and training on individuals was found to be the most promising method for fatigue detection. From the 13 baseline features used in these algorithms, 9 features were introduced in this work and validated by comparing new features to known successful features such as the mean frequency of the EMG signals. The final algorithm posed in this research provided a 71.7% accuracy of detection on a 3-state of fatigue system using an HMM. Based on metrics discussed in this work, the average uncertainty of the final model had a response time of $\pm$ 4.20 seconds. The other algorithms studied included a Logistic regression model, Decision tree model, and a Support Vector Machine (SVM).