

# Non-Invasive Muscular Atrophy Causes Evaluation for Limb Fracture Based on Flexible Surface Electromyography System

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## S1. EMG Acquisition & Analysis

We use the ADS1299 biopotential measurement chip, which includes four Analog-to-digital converter (ADC) chips with 24-bit resolution, high input impedance, and low input noise, as the core chips of our data acquisition tool EMG32. Each channel is composed of two differential electrodes. A custom software is developed to accurately determine which of the two electrodes in each channel has fallen off which means we can obtain the best assessment effect by adjusting the position, increasing the intensity of the pressure, or other operations in real-time. With all 4 channels turned on, the sampling rate could reach 16k Samples/s per channel. We manage the data files on our laptop later. The raw data get sorted according to the channels and pass a 50Hz notch filter to eliminate the noise in the environment, and then a fourth-order Butterworth filter of 20–500 Hz band-pass filter is applied to adjust the signal to the range of the electromyography frequency.

## S2. Detailed Explanation of the Three Algorithms

Support vector machine (SVM) is a method of creating nonlinear classifiers by applying the kernel trick to the maximum-margin hyperplane [30]. This classification method is good for processing with small data sets, but large characteristic dimensions. It is effective even if there are lots of noises in the data. This characteristic perfectly suits our limited amount of data.

We also adopt the eXtreme Gradient Boosting algorithm (XGBoost) to help our classification. XGBoost is an optimization of GBDT (Gradient Boosting Decision Tree). It is highly efficient, flexible and portable, and is widely used in data mining, recommendation systems, and other fields [31]. It considers the special condition of sparse training data, you can specify the default direction of the branch for the missing value or the specified value.

K Nearest Neighbors algorithm (KNN) is a non-parametric pattern recognition method proposed by Thomas Cover and has been used for classification and regression [32]. Generally, the class of a sample is determined by the mode of the class of k adjacent samples. KNN is easy to understand and has a fast speed in the training process. When the data are stable and have few outliers, KNN can be quite suitable. It is suitable when the amount of data is small.

## S3. The Final Choice of the Hyperparameters

The table below shows the final choice of the hyperparameters.

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**Table S1.** Hyperparameters Of the Algorithm.

Classifiers	Hyperparameters
XGBoost	Booster = gbtree, Objective = multi: softprob, n_estimators = 100, max_depth = 6, min_child_weight = 1, gamma = 0, learning_rate = 0.3.
SVM	C = 10, gamma = 0.001.
KNN	K = 1, P = 12

**S4. Criteria of Classifiers' Performance**

The figure below shows the test outcomes for any study can either be true positive (TP), true negative (TN), false positive (FP), or false negative (FN), based on the real condition and the prediction.

<b>True Positive (TP):</b> <ul style="list-style-type: none"> <li>• Reality: Immobility</li> <li>• Prediction: Immobility</li> <li>• Outcome: Hit</li> </ul>	<b>False Positive (FP):</b> <ul style="list-style-type: none"> <li>• Reality: Nerve-injury</li> <li>• Prediction: Immobility</li> <li>• Outcome: Miss</li> </ul>
<b>False Negative (FN):</b> <ul style="list-style-type: none"> <li>• Reality: Immobility</li> <li>• Prediction: Nerve-injury</li> <li>• Outcome: Miss</li> </ul>	<b>True Negative (TN):</b> <ul style="list-style-type: none"> <li>• Reality: Nerve-injury</li> <li>• Prediction: Nerve-injury</li> <li>• Outcome: Hit</li> </ul>

**Figure S1.** The four possible results of the prediction.