CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Arjun S. Subramaniam

Project Number

S1424

Project Title

Think-To-Type: Recognizing Letters from EEG Patterns Using Machine Learning

Abstract

Objectives/Goals

The objective of this project was to determine a proof-of-concept in recognizing letters that subjects are thinking about based on their brain's EEG patterns. Our goal was to achieve satisfactory accuracy (>= 70%) in classifying three letters - A, B, and C, from a subject's brain waves.

Methods/Materials

Materials included the Biopac EEG Machine, which consisted of three electrodes attached to the scalp, and the accompanying software. In addition, the WEKA machine learning software was used for training and testing the algorithms. We collected data from three subjects and had each one sound out the desired letter in their head at regular intervals for a period of 10 seconds. After initial pre-processing, we performed a Fast Fourier Transform and ran the FFT data through several machine learning algorithms in Weka. Many iterations of this process were undergone due to the process of feature engineering, in which we tried an array of techniques, including but not limited to taking the log of, squaring, normalizing the data, and building a variance-based classifier.

Results

Through a feature engineering process, we found that taking the log base 10 of the data generally improved the accuracy across the board, while building a variance-based classifier, cross-correlating the time series data, squaring the data, and more did not improve accuracy. Four machine learning algorithms - Simple Logistic, J48 Tree, Random Forest, and Best-First Tree - stood out, and the J48 Tree yielded the best results, with 70.83% accuracy in two out of the three subjects and 53% accuracy in the other whilst taking the log of the data.

Conclusions/Discussion

We were able to achieve satisfactory accuracy and meet our goal in two out of three subjects where data collection was optimal. Limitations of this experiment include the EEG Machine's simplicity, as well as the feature extraction methods used in pre-processing the data. We conclude that these results are promising and pave the way for future experiments, focused on improving accuracy and developing real-time data processing methods, to improve upon our work. Potential applications include helping people with Locked-In Syndrome (complete paralysis) communicate, and replacing keyboards with wearable headbands for communication in the future.

Summary Statement

The focus of this project was to determine what letter a subject is thinking about based on his/her brain waves, thus creating a thought-to-type interface.

Help Received

My school's research teacher acted as a mentor for the project. My father advised me on the algorithms portion of the experiment.