Hand Movements Prediction System

By Group 12

Guide : **Prof. Samreen Banu Kazi**

Group Members:

Master Farheen Adam	17CO05
Karia Janvi Vinay	18CO02
Shaikh Misbah Karim	18CO11
Chimaokar Shifa Shahnawaz	18CO12

Broad Area of Research

For our final year major project we propose to build a machine learning application to perform analysis of EEG(electroencephalography) signals to predict hand movements.

EEG signals record brain activity from the scalp using an EEG cap with minimal invasiveness.

Analysing these signals with respect to motor functions will allow us to predict motor functions just from the eeg recording.

Introduction

In a healthy person, the motor cortex is crucial for the planning, control, and execution of voluntary movements. But in case of people with disabilities either the brain is not able to communicate with the muscles or has lost control of them. In order to perform everyday tasks, the control of hand movements is of critical importance for patients .

EEG-based Brain Computer Interfaces allow for patients with disabilities to control the movements of artificial limbs or exoskeletons.

To aid these people, we propose to build a machine learning model to classify and predict hand movements based on EEG (electroencephalography) readings of able bodied people performing these hand movements.

Goals

- To build a machine learning model to predict multiple actions that a person performs with their hands given the EEG recording of said person.
- To build a website using Django framework to deploy our model and present the predictions to the user.
- To maximize accuracy and minimise latency.

Objectives

- Selecting a suitable dataset
- Preparing the data for further operations
- Channel Selection to make it easier to work with the data
- Feature Extraction to help in classification of the data
- Constructing a model to classify the data to predict various hand movements like grasping, lifting, replacing, etc

Review of Literature

Comparative Analysis of Various Filtering Techniques for Denoising EEG Signals

This paper compares the butterworth filter, adaptive least mean square filter and the wavelet transform for removing artifacts from the eeg recording.

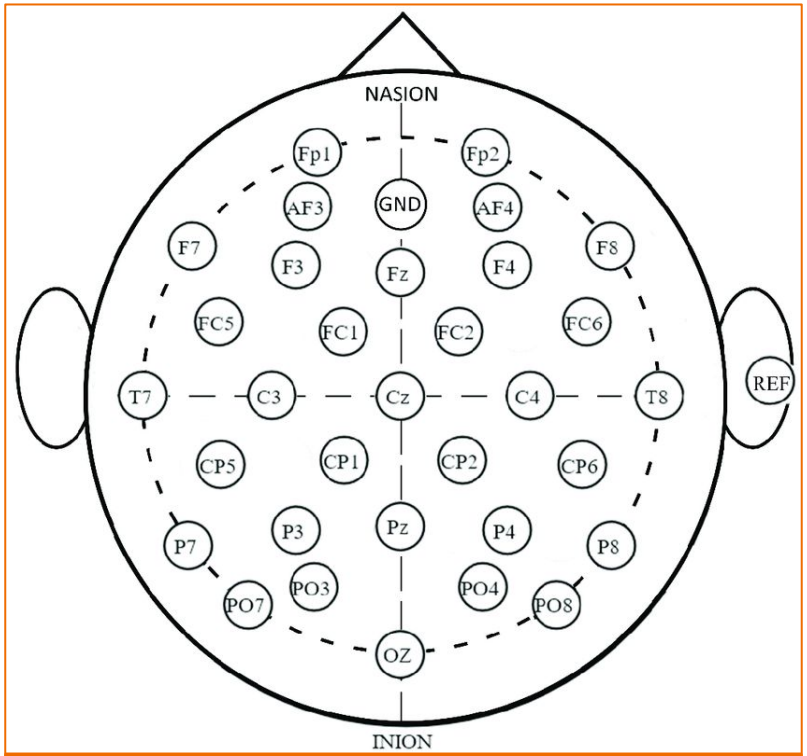
- **Advantages**
  - All three filters remove artifacts very well
  - The wavelet transform method yields the best result based on the peak signal-noise ratio and mean square error. The wavelet they have selected for this is bior2.6.
- **Disadvantages**
  - This paper uses sleep eeg and epileptic eeg recordings
- For our project we will be using wavelet transform to denoise eeg recording of motor functions as it can work on non-stationary signals too. And have selected the wavelet by comparing all wavelets that are used to perform discrete wavelet transform.

Review of Literature

Wavelet Transform Use for Feature Extraction and EEG Signal Segments Classification

This paper discusses the use of DWT for both preprocessing and feature extraction.

- **Advantages**
  - DWT can be used for selecting features in the time and frequency domain efficiently.
- **Disadvantages**
  - The main drawback comes due to the high dimensionality of the eeg signals
- A big reason behind the high dimensionality of EEG signals is the multiple channels and noisiness of the data. To combat this we can denoise the eeg signals and reject channels that we do not need (i.e. select only the channels corresponding to the motor cortex.)



Montage for 32-channel eeg electrodes

Location of Motor Cortex

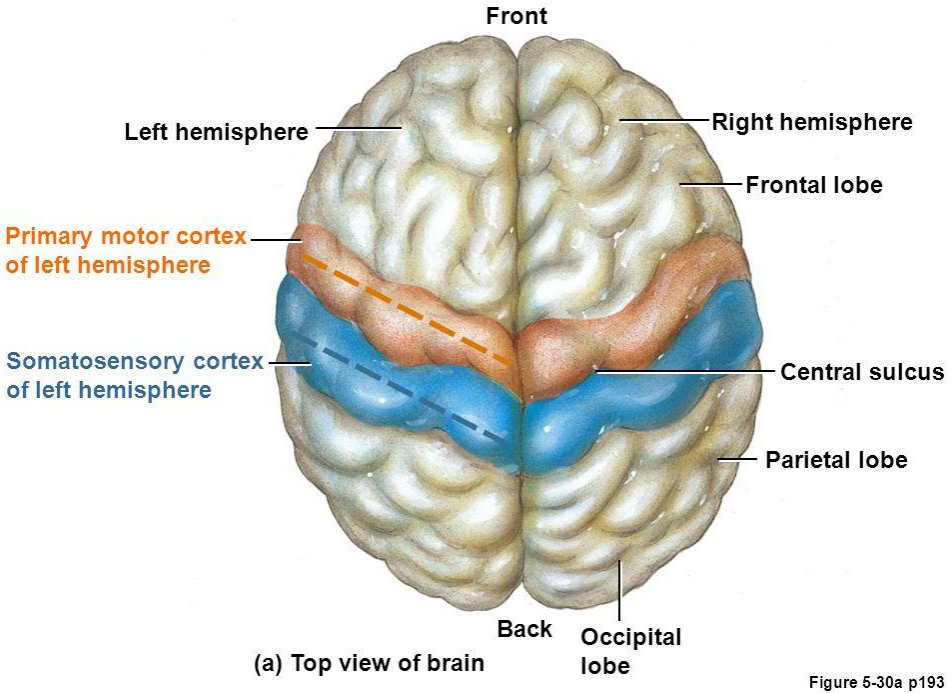


Figure 5-30a p193

Review of Literature

EEG Based Motor Imagery Classification Using SVM and MLP

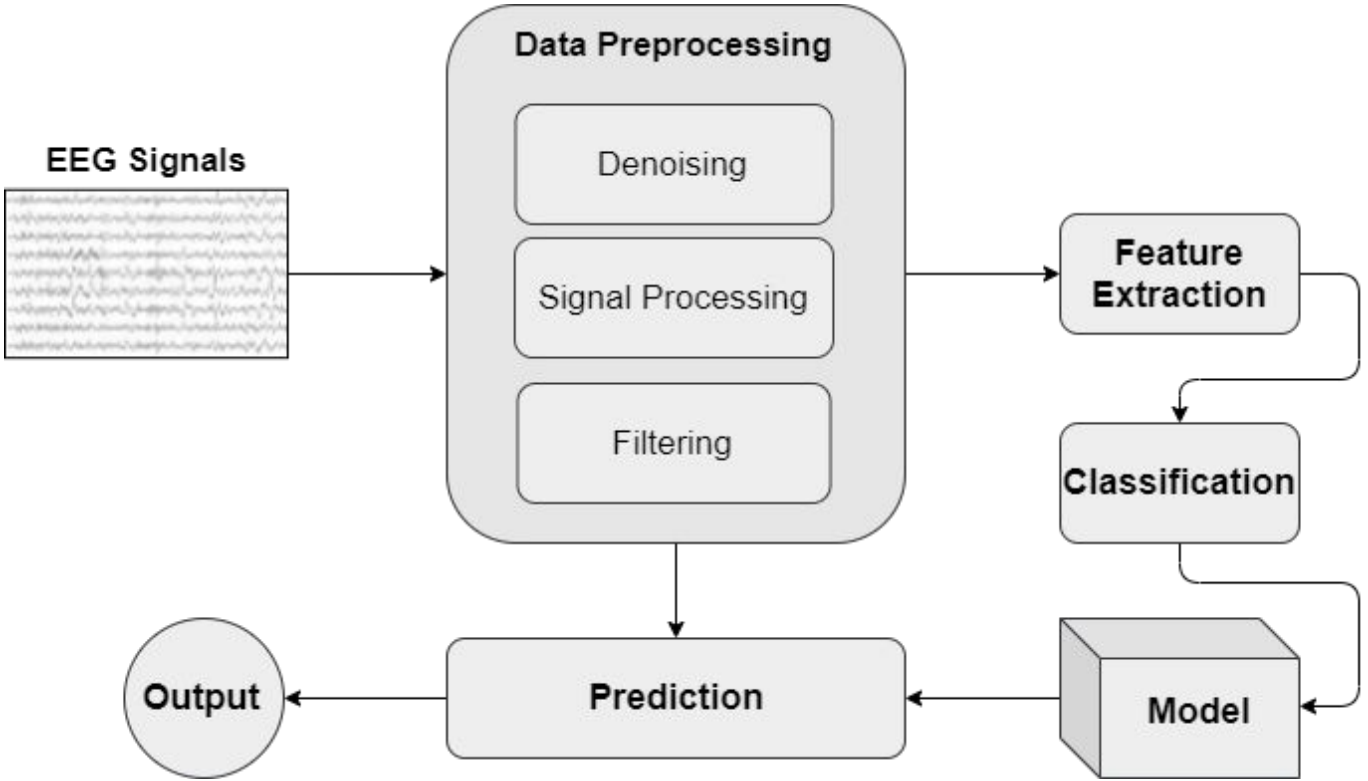
This paper explores classification of MI - EEG data using support vector machines and multilayer perceptrons.

- **Advantages**
  - Both the SVM and MLP give good classification.
  - The energy-entropy feature is very efficient for classification.
  - MLP is found to be better than SVM based on accuracy.
- **Disadvantages**
  - Higher dimensionality is a matter of concern for EEG data classification
  - SVMs cannot be used for multi label classification.
- Our prediction task involves multi-label classification, for this we will be performing binary classification on each label using decision trees and then concatenating the results of all the labels.

Summary of Literature Review

Features	Paper 1	Paper 2	Paper 3	Proposed System
a. Denoising	yes	no	no	yes
b. Feature Extraction	no	yes	no	yes
c. Classification	no	no	yes	yes

System Architecture Design



Details of Requirements with Justification

- **An internet connection** for visiting our website.
- **A sampled dataset of EEG recordings** to provide input to our system.
- **An EEG cap** to record brain activity of user.

Roles and Responsibilities

MEMBER	Farheen Master	Janvi Karia	Misbah Shaikh	Shifa Chimaokar
ROLE	Team Member	Team Leader	Team Member	Team Member
RESPONSIBILITY	Design, Hosting	Django	Front End	Machine Learning

Relevance to Social Benefit of Proposed Idea

This project aims to bridge the gap between the able bodied and the disable people.

We perform our daily rituals with our hands almost without even noticing, things like opening doors, picking something you dropped, brushing your teeth, holding your pen etc. now imagine doing all of that without using your hands.

This is the reality for some people be it for whichever reason.

Being able to predict hand movements from brain activity can help to develop better prosthetics.This will grant disable people better mobility and autonomy in their day to day lives.

Market Potential of System

- Currently, there are no realistic, affordable, most importantly **non-invasive**, or low-risk options for neurologically disabled patients to directly control arm prosthetics with their brain activity.
- So far we only have a few laboratory tests to detect and understand EEG signals.
- Exploring the relationship between EEG signals and hand movements can prove to be crucial in developing prosthetic devices that can be controlled through brain activity with minimal invasiveness.
- This may also allow us to further our understanding of EEG signals themselves.

IMPLEMENTATION

- Front-end : HTML, CSS, JS & Bootstrap
- Data Preprocessing :
  - Signal Denoising using DWT
  - Channel Selection
- Feature Extraction : DWT
- ML :
  - Decision Tree Classifier
- Back-end : Django
- Hosting : on Heroku

https://aiktchelpinghands.herokuapp.com/

Conclusion

Using signal processing, and machine learning we can help disabled people overcome their disabilities and bring some normalcy into their day to day lives.

Restoring a patient's ability to perform basic activities of daily life with a brain-computer interface (BCI) prosthetic device would greatly increase their independence and quality of life.

Analysis of EEG signals is therefore very important in developing such devices.

Future Scope

- The accuracy can be improved by employing deep learning techniques.
- The time taken for prediction can be reduced further.
- Various brain computer interfaces can be developed based on our model.
- Better and more interactive prosthetics can be made.

References

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THANK YOU