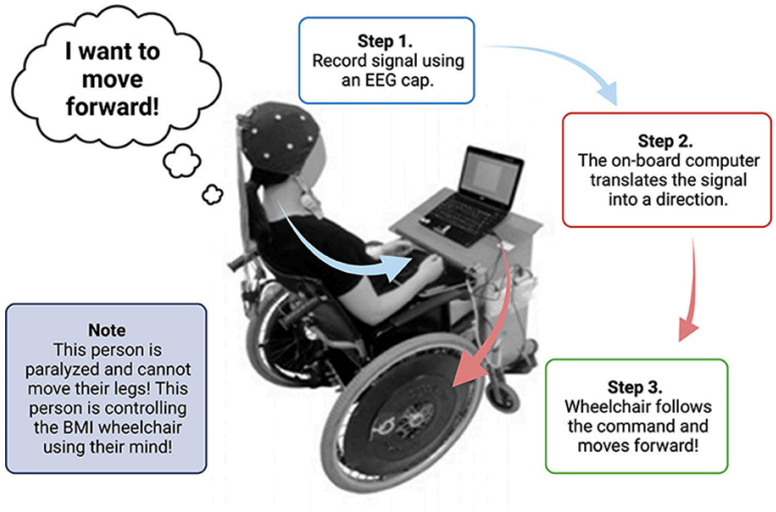
Control of a differential mobile robot using EEG and EMG signals

Abstract
This study introduces a hybrid EEG-EMG BCI system for robotic navigation. Motor imagery controls left and right movements, while jaw clenching via EMG triggers an emergency stop. The system offers an efficient, hands-free interface for assistive robotic applications.

Objective:

1. Moving the robot left or right using EEG (motor imagery)
2. Stopping the robot using EMG (Jaw clenching)

Motivation:
We aim to implement this idea on a wheelchair for a person with paralysis (below the head), restoring their independence and mobility.



Method:
EEG (Motor imagery) - Openbci (electrodes over motor area, (.,., , ,.,.))

channels:
green --- ch_4 left
red ---ch_7 left
orange --- ch_6 right
brown ----ch_8 right

Left hand imagery → Move Left
Right hand imagery → Move Right

https://docs.openbci.com/Cyton/CytonDataFormat/

EMG (Jaw Clenching) - Upside down labs

Jaw Clench → Stop Robot
https://docs.upsidedownlabs.tech/hardware/bioamp/muscle-bioamp-shield/index.html#step-6-visualise-emg-signals-on-laptop

Robot - Turtle bot 5

Procedure:

•Data Acquisition (EEG + EMG)

•Preprocessing (EEG)

Bandpass filter (8-30Hz- mu + beta band)- PSD

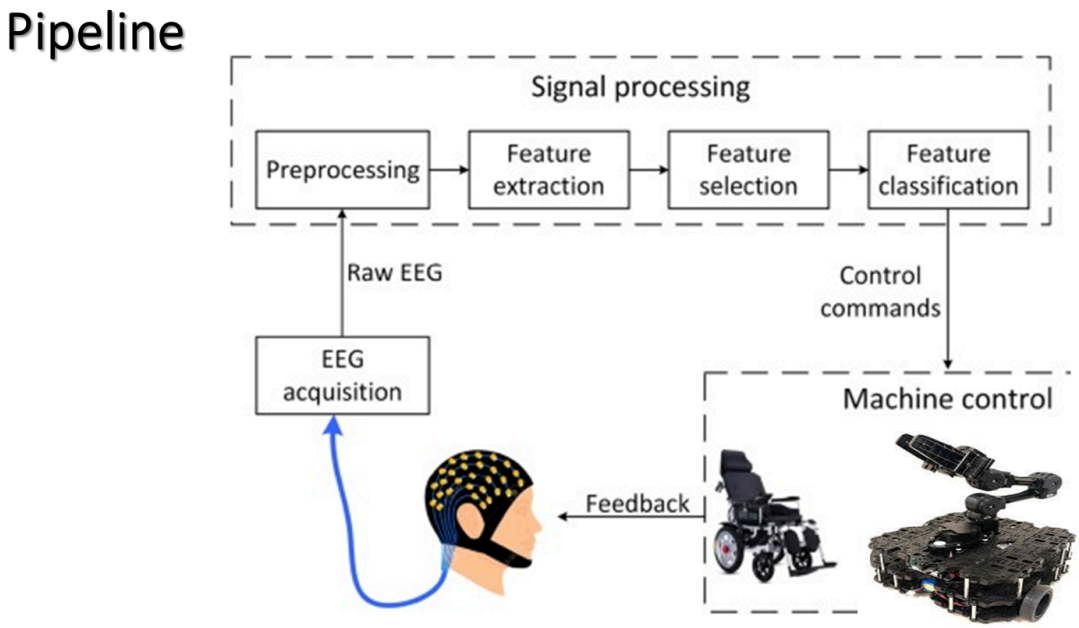
•Model Training

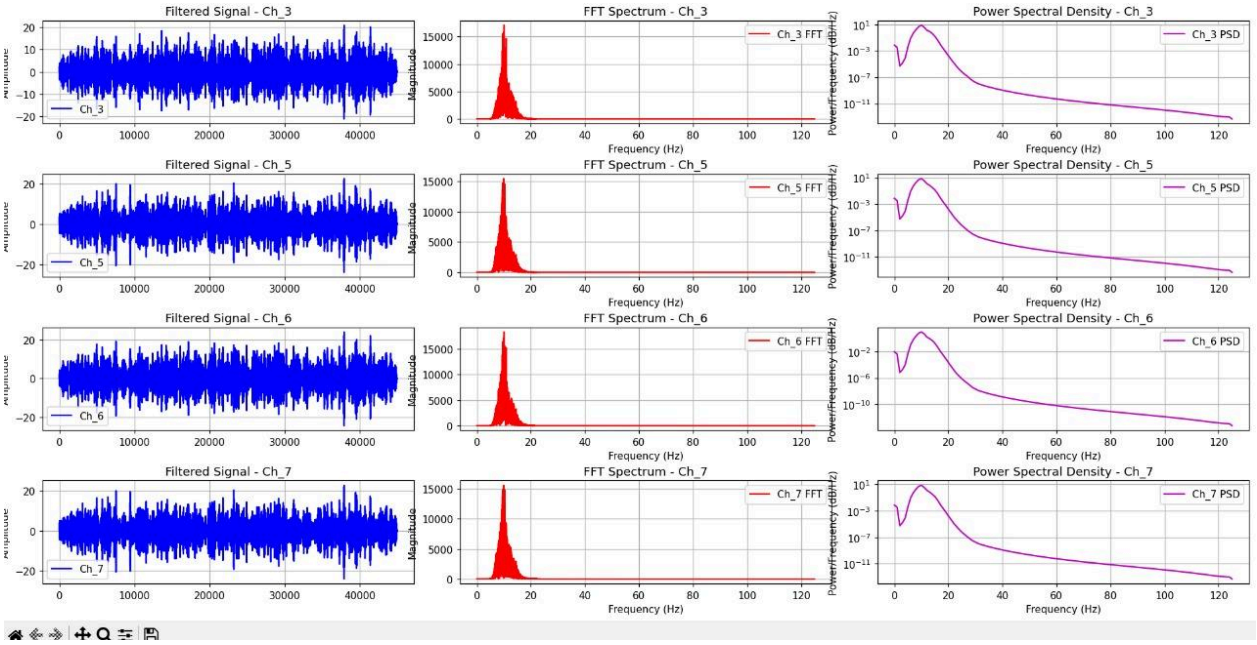
Random Forest classifier

•Testing

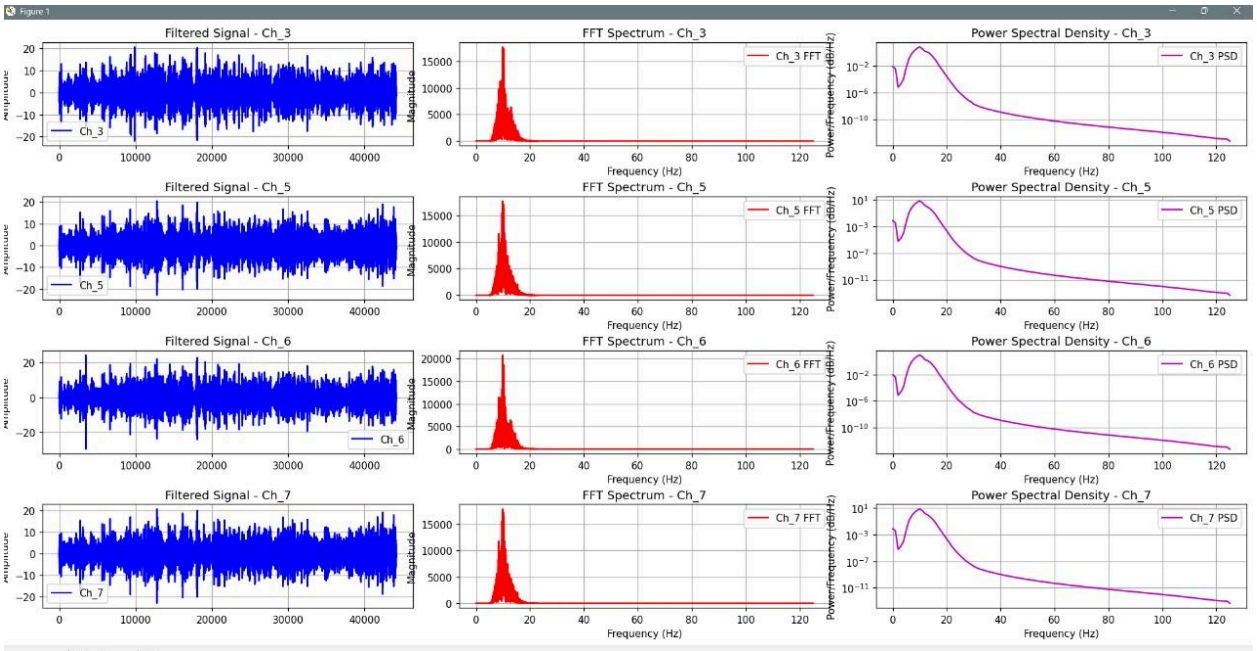
Accuracy- 78%

•Model Deployment on robot

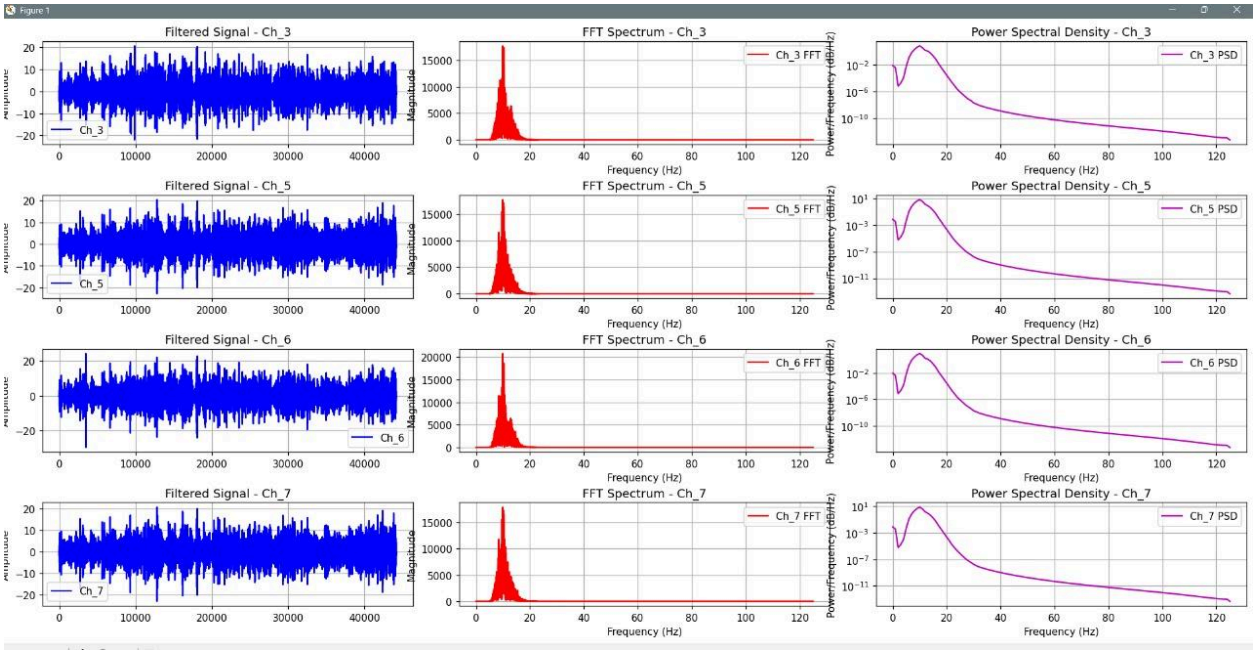




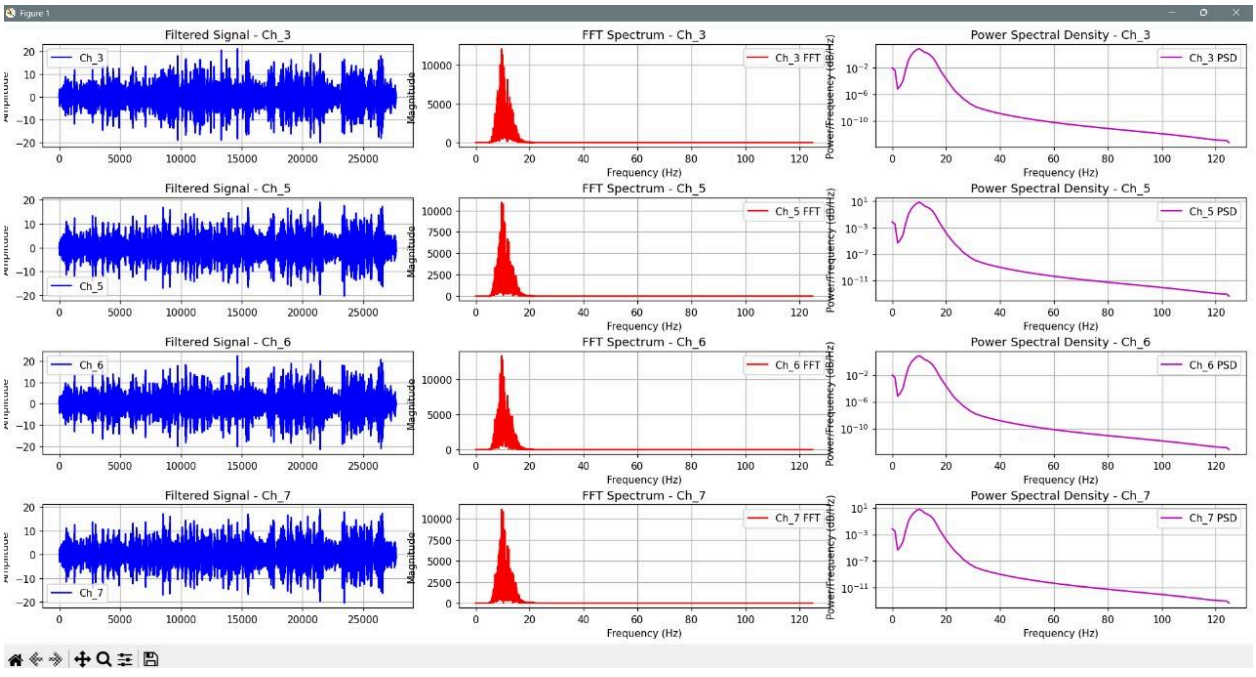
LEFT HAND



BOTH HANDS



RIGHT HAND



RESTING STATE

Results:

78% Accuracy

Discussion:

Limitations:

- Big dataset required to train the model.
- Enough User’s training required with visual feedback.
- Time constraint