Brainwave-Controlled Robot Car

4G06 Capstone Project - Goals and Description

Group 11

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Brief Description

Electroencephalography (EEG) is an electrophysiological monitoring method which records electrical activity of human brains [1]. Recently, the associated electroencephalogram technologies have been developed and improved in a rapid speed and they have become familiar among the public. An EEG tracks and records brain wave pattern [2]. Commercial devices have become more affordable and software applications such as meditation apps have been developed such that EEG can help and improve people's life.

Our project - Brainwave-Controlled Robot Car - aims to utilize brainwave sensors, which collect simple commands such as forwarding/backwarding and left/right, and make a robot car execute the desired movements accordingly.

Goals

The primary goals for the project

Our project consists of five components (See Figure 1): Raw EEG data input, Data pre-processing, Machine learning model, Arduino programming, and Moving the robot car. Each component should be working by the end of the development upon the presentation. To be more specific, the goals are listed below.

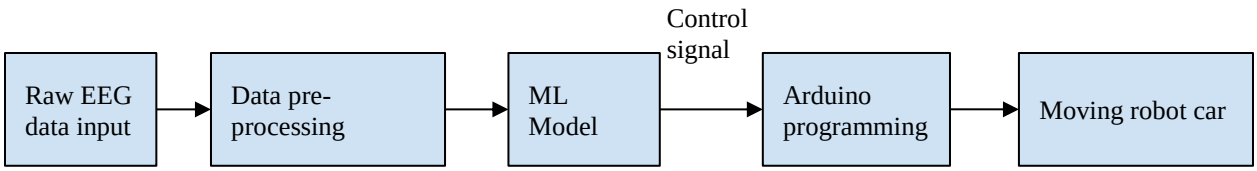

Figure 1

1. The system will collect the brainwave signals using a commercial brainwave sensing headset (e.g. Muse, Mindwave, etc.).

The EEG signal data should be transmitted from the sensing device to the software application. The data set should be large enough for further manipulation.

2. The software application in our system will pre-process the raw data gained from the sensing headset such that the EEG will start to show patterns and tendencies.

Noise sources should be identified, and the associated data should be filtered. The processed data for a specific command should be somehow consistent. The EEG data collected from different individuals are expected to vary in a reasonable range.

3. The software application will use machine learning models to map the brain signals to control signals (such as forward/backward, left/right, and stop). Thus, one will be able to control the robot car by the brainwave in real time.

One control signal to be produced per command. The mapping accuracy should achieve at least 65%.

4. In our project, a small robot car will be made and controlled by the Arduino board. The Arduino board will be programmed such that it will receive the control signals and direct the movement of the car.

The Arduino board should be successfully programmed. The robot car should be able to move after receiving the control signals.

5. The cost for developing the entire project such as the hardware including brainwave-sensing device and the robot car should be less than 750 dollars.

Second level goals for the project

6. We aim to increase the accuracy of controlling the robot car by digging deeper into the performance of different machine learning models and data pre-processing techniques. We plan to develop different models (SVM, DNN, 1-D CNN, Decision tree, etc.) with different data pre-processing techniques and compare their prediction correctness and speed.

7. We aim to provide opportunities for each team member to gain the experience of developing a machine learning based project. Everyone could get a chance to contribute to each phase of the project development life cycle.

Required Hardware

1. Brainwave sensing device:
    a. Muse
    b. Mindwave (alternative)
2. Robot car microcontroller:
    a. Arduino
    b. Raspberry Pi (alternative)
3. Backend server:
    a. Laptop localhost
    b. Commercial cloud service (alternative)

References

1. “Electroencephalography,” *Wikipedia*, 12-Oct-2018. [Online]. Available: https://en.wikipedia.org/wiki/Electroencephalography.
2. *Brain wave sensing - IEEE Conference Publication*. [Online]. Available: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7030595 (from https://ieeexplore.ieee.org/abstract/document/7030595.