Project Synopsis
on
Robot Car Control using BCI

Submitted as a part of course curriculum for

Bachelor of Technology
in
Computer Science

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2021-2022

DECLARATION

We hereby declare that this submission is our work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

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CERTIFICATE

This is to certify that Project Report entitled "**Robot Car Control using BCI**" which is submitted by **Shivam Jha, Priyanshi Vashistha and Rupal Garg** in partial fulfilment of the requirement for the award of degree B. Tech. in Department of Computer Science of Dr A.P.J. Abdul Kalam Technical University, Lucknow is a record of the candidates own work carried out by them under my supervision. The matter embodied in this report is original and has not been submitted for the award of any other degree.

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It gives us a great sense of pleasure to present the synopsis of the B.Tech Mini Project undertaken during B.Tech. Third Year. We owe a special debt of gratitude to Prof Raj Kumar, Assistant Professor, Department of Computer Science, KIET Group of Institutions, Delhi- NCR, Ghaziabad, for his/her constant support and guidance throughout the course of our work. His sincerity, thoroughness and perseverance have been a constant source of inspiration for us. It is only his/her cognizant efforts that our endeavours have seen the light of the day.

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Last but not the least, we acknowledge our friends for their contribution to the completion of the project.

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ABSTRACT

Brain-Computer Interfaces (BCIs) have been originally developed for improving the quality of life of severely motor-disabled people. The main objective of this study is to convert brain signals into that allows users to control socializing-related functionalities of the with their own brain signals. The BCI device has two functions. Firstly, it records the data reviewed at its electrodes, and secondly, it interprets or decodes neural signals. There are mainly two methods to associate named as non –invasive and invasive system. Our brain consists of neurons they transmit employing electrical signals and chemical messenger called neurotransmitter. Brain signals are segmented into four types theta, beta, alpha. The EEG signals used these brainwaves to read our brain activity. It interprets our thoughts into order to operate the external device. In today's changing world, technology plays a crucial and important role. Technology are developing daily and new things are always being introduced. The technology also helps the people with some disability and make them feel to be like the normal people.

This project "Robot Car Control using BCI" will help the motor-disabled people to move the car in the respective direction they want to move using the brain signals. It will be done using the brain signals generated. This signal will be decoded and then the Robot Car will move in the respective direction in which the person want to move.

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INTRODUCTION

Brain-Computer Interfaces (BCIs) have been originally developed for improving the quality of life of severely motor-disabled people. The main objective of this study is to convert brain signals into that allows users to control socializing-related functionalities of the with their own brain signals. The BCI device has two functions. Firstly, it records the data reviewed at its electrodes, and secondly, it interprets or decodes neural signals.

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Brain signals are segmented into four types theta, beta, alpha. The EEG signals used these brainwaves to read our brain activity. It interprets our thoughts into order to operate the external device.

PROBLEM STATEMENT

In today's changing world, technology plays a crucial and important role. Technology are developing daily and new things are always being introduced. The technology also helps the people with some disability and make them feel to be like the normal people.

This project "Robot Car Control using BCI" will help the motor-disabled people to move the car in the respective direction they want to move using the brain signals. It will be done using the brain signals generated. This signal will be decoded and then the Robot Car will move in the respective direction in which the person want to move.

It will be beneficial for the users that encounter traumatic brain injuries, muscle disorders, multiple sclerosis and so on.

OBJECTIVES

The main objective of this project is to control a robot car using Brain Computer Interface. This will work on the signals generated by our brain when we think of something and we will be using this signal to move the car according to the direction selection on the user interface.

It is possible by connecting the car and the headset with an android user interface via Bluetooth. This connection will the make the command transfer through our brain to the robot car. So we will do this by doing the signal analysis in the UI and generate the command that will be transmitted via HC 06 to the car controller and it will move.

LITERATURE REVIEW

1. **A novel monitor for practical brain-computer interface applications based on visual evoked potential**

This study proposes and evaluates a novel monitor for generating visual-evoked potential (VEP) for daily use brain–computer interface (BCI) applications. The backlight of a conventional monitor was replaced with a matrix panel of LEDs to take maximum advantage of both the computer monitor and LED in generating VEP. This matrix contains 32 cells working independently at an adjustable range of flickering frequencies. The software was further developed to control the number of cells as needed. Thanks to this design, the monitor can work simultaneously as a conventional monitor and as a high-frequency visual stimulator. In total, this monitor provides up to 32 targets at all ranges of frequencies. The proposed monitor exhibits high performance in generating stable high-frequency VEP(34Hz-49.5Hz). This feature allows the monitor to cope with the main deficiencies of BCI devices such as the low number of targets, low-frequency stimulation, and lack of implementing an integrated system.

2. **An active recursive state estimation framework for brain-interfaced typing systems**

Typing systems driven by noninvasive electroencephalogram (EEG)-based brain–computer interfaces(BCIs) can help people with severe communication disorders (including locked-in state)communicate. These systems mainly suffer from lack of sufficient accuracy and speed due toinefficient querying to surpass a hard pre-defined threshold. We introduce a novel recursive stateestimation framework for BCI-based typing systems using active querying and stopping.
Previously, we proposed a history-based objective called Momentum which is a function ofposterior changes across sequences. In this paper, we first extend the definition of the Momentum, propose a unified framework that employs this extended Momentum objectiveboth for querying and stopping. To provide a practical example, we employ a language-modelassistedEEG-based BCI typing system called RSVP Keyboard. Our results show that proposedframework on average improves the information transfer rate (ITR) and accuracy at least 52%and 8.7%, respectively, when compared to alternative approaches (random or mutual information).

3. BciPy: brain–computer interface software in Python

There are high technological and software demands associated with conducting Brain–Computer Interface (BCI) research. In order to accelerate the development and accessibility of BCIs, it is worthwhile to focus on open-source and community desired tooling. Python, a prominent computer language, has emerged as a language of choice for many research and engineering purposes. In this article, BciPy, an open-source, Python-based software for conducting BCI research is presented. It was developed with a focus on restoring communication using Event-Related Potential (ERP) spelling interfaces; however, it may be used for other non-spelling and non-ERP BCI paradigms. Major modules in this system include support for data acquisition, data queries, stimuli presentation, signal processing, signal viewing and modeling, language modeling, task building, and a simple Graphical User Interface (GUI).

4. A deep neural network-based transfer learning to enhance the performance and learning speed of BCI systems

Brain–computer interfaces (BCIs) suffer from a lack of classification accuracy when the number of electroencephalography (EEG) trials is low. This is therefore during the learning of a BCI for a subject, there is no clear protocol to use the captured knowledge of other trained BCIs. To overcome this, we have proposed a new parallel deep neural structure containing long short-term memory and multi-layer perception. Furthermore, a subject-to-subject transfer learning is exploited to improve both performance and learning speed. First, the proposed combinatorial classifier is trained over different subjects, then for each new case, a copy of this learned network is adopted to be fine-tuned by the EEG features of the new subject. The proposed method is assessed on an EEG dataset of motor imagery movements and compared to the support vector machines. The proposed method provides superior classification results and significantly speed up the learning process of the deep network.

5. Neural activities classification of left and right finger gestures during motor execution and motor imagery

In this study, a new paradigm containing motor observation, motor execution, and motor imagery was designed to investigate whether motor imagery (MI) and motor execution (ME) of finger gestures can be used to extend commands of practical mBCIs. The subjects were instructed to perform or imagine 30 left and right finger gestures. Hierarchical support vector machine (hSVM) method was applied to classify four tasks (i.e., ME and MI tasks between left and right gestures). The average classification accuracies of motor imagery and execution tasks using fivefold crossvalidation were 90.89 ± 9.87% and 74.08 ± 13.42% in first layer and second layer, respectively. The average accuracy of classification of four classes is 83.06 ± 7.29% overall. These results show that performing or imaging finger movements have the potential to extend the commands of the existing BCI, especially for healthy elderly living.

6. A functional BCI model by the IEEE P2731 working group: data storage and sharing

The IEEE P2731 working group is in the process of developing a functional model so that virtually any BCI system could be described according to it. In this paper, we want to stimulate the discussion for the definition and selection of the information that should be stored in a file for effectively allowing the sharing of BCI data and tools amongst researchers. Establishing these requirements and procedures will accelerate BCI development and lay the foundation for accessible and scalable BCI technology as well as provide the foundations for the definition of a standard file format.

7. Controlling a Smartphone with Brain-Computer Interfaces: A Preliminary Study

Nowadays, smartphones are essential parts of our lives. The wide range of functionalities that they offer to us, from calling, taking photos, sharing information or contacting with people, have contributed to make them a useful tool. However, its accessibility remains restricted to disabled people that are unable to control their motor functions. In this preliminary study, we have developed a Brain-Computer Interface system that allows users to control two main functionalities of our smartphones using their own brain signals. In particular, due to the importance of the socializing apps in today's world, the system includes the control of social networking and instant message services: Twitter and Telegram, respectively. The system has been tested with 10 healthy subjects, who were asked to perform several tasks, reaching an average accuracy of 92.3%. Preliminary results show that users can successfully control the system, bridging the accessibility gap in smartphone applications.

8. Deep Learning Algorithm for Brain-Computer Interface

Electroencephalography-(EEG-) based control is a noninvasive technique which employs brain signals to control electrical devices/ circuits. Currently, the brain-computer interface (BCI) systems provide two types of signals, raw signals and logic state signals. -e latter signals are used to turn on/off the devices. In this paper, the capabilities of BCI systems are explored, and a survey is conducted how to extend and enhance the reliability and accuracy of the BCI systems. A structured overview was provided which consists of the data acquisition, feature extraction, and classification algorithm methods used by different researchers in the past few years. Some classification algorithms for EEG-based BCI systems are adaptive classifiers, tensor classifiers, transfer learning approach, and deep learning, as well as some miscellaneous techniques. Based on our assessment, we generally concluded that, through adaptive classifiers, accurate results are acquired as compared to the static classification techniques. Deep learning techniques were developed to achieve the desired objectives and their real-time implementation as compared to other algorithms.

9. EEG-Based Neurohaptics Research: A Literature Review

T Neurohaptics is the field of study that strives to understand the complex neural representation provoked in response to tactile and/or kinesthetic stimuli. This field has garnered a noticeable attention over the past decade not only in neuro-scientific research but also in medical, marketing and engineering fields. In this paper, we review existing literature on Electroencephalography (EEG)-based neurohaptic studies charting out the main themes and significant findings. Furthermore, we provide a brief review of the EEG analytical methods commonly utilized in the neurohaptic domain. Also, we present a case study with the complete flow of conducting neurohaptic research studies. Lastly, we discuss limitations and provide directions for future neurohaptic research, such as: modeling quality of haptic experience, improving neurohaptic systems and neurohatpics in virtual reality.

METHODOLOGY

To develop this project, we will have to go through these phase:

- We have to receive the signals generated by the brain using EEG.
  Electroencephalography (EEG) is a method to record an electro-gram of the electrical activity on the scalp that has been shown to represent the macroscopic activity of the surface layer of the brain underneath. It is typically non-invasive, with the electrodes placed along the scalp.
- Then we will send this signal to the BCI simulator and interpret the data from it.
- Then we will pass the data to the UI which will convert the data given to it to the desired output.

DIAGRAMS

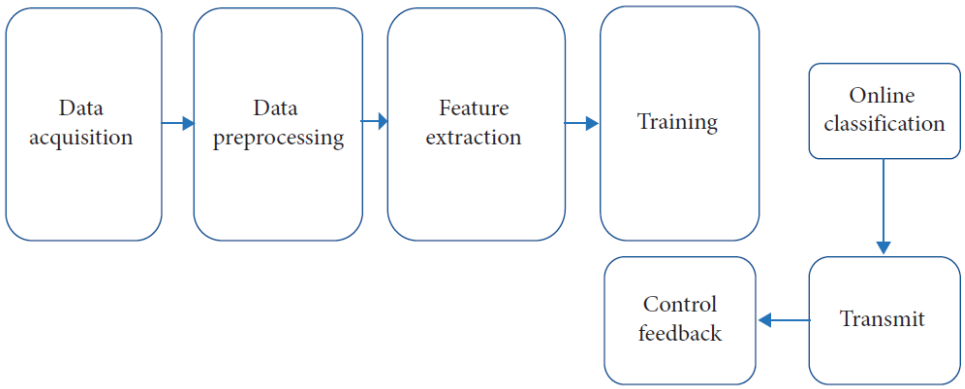

Figure 1: BCI Block Diagram

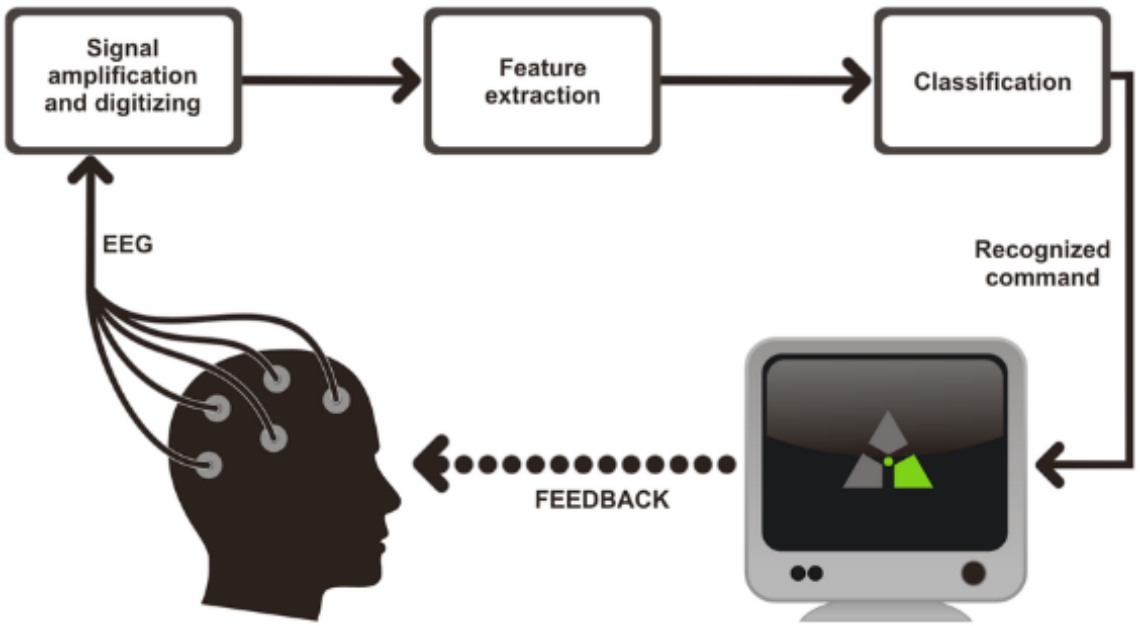

Figure 2: Brain signal recorded on the scalp through electrode, amplified and then classified and recognize the command

OUTCOME

Research Paper

We will be publishing the research paper on the topic **"BCI"** with some new features and enhancement.

The research paper will contain all the development phases and in detail study about the technology used. It will also contain the algorithm used and about the future scope of the project.

Patent

We will also patent the new idea we get by developing this project.

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