Media Player Using Brain-Computer Interface for Persons with Motor Disabilities

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Abstract — Media Player Using Brain-Computer Interface is a project that enables people with motor-disabilities to interact with a computer and allows them to select a song of their choice to play it. It uses Brain-Computer Interfacing to accomplish this. It measures brain waves originating from a person's mind with the help of an electroencephalogram (EEG). These measurements are taken with the help of electrodes attached to specific parts of the brain. Combinations of brain-wave patterns help us to analyse the mind of a person. The person with the disability is presented with the question, and given a set of options to choose from. The EEG apparatus measures the brain waves when the question is shown. These waves, when analysed, give us the correct answer. During the execution of this project, neither the necessary apparatus nor a test subject was available. Hence, this project uses a trained dataset which gives us the necessary brain-wave measurements. This will enable them to communicate with a computer, thus advancing research in the field of brain-computer interfaces. The end goal of this technology is to fully enable persons with impaired motor abilities to communicate with other human beings through a computer. This is necessary to facilitate the social inclusion of persons with motor disabilities. The technology will serve more important purposes like in case of emergencies, witnessing accidents, etc.

***Keywords* — Brain-Computer Interface, Electroencephalogram, MATLAB, Python, Signal Processing**

I. Introduction

People with motor disabilities suffer a lot in today's society with lack of access and sources. People with disabilities are restrained by society. Because of which, it is challenging for these people to stay up with our technologically advanced and active generation. Hence, we came up with this idea of a BCI based MP3 player which could help disabled people to cope with their surroundings. Not only disabled people but also normal people can get benefits using this software.

BCI reads the electrical impulses that are generated by the brain, which subsequently converts them into artificial motor functions. It is a system that enables someone to command a machine directly with their head. The device reads the input in the form of EEG signals from the patient's brain and then uses them to operate the media player.

Previously, there has been some research in this field which is relevant to the topic of this project. Madoš [1] talks about the 10-20 international system of electrode placement on the brain. It also provides a description of the EEG headset used in the implementation of their project. It discusses the interfacing of an Arduino board to the human brain via a host computer with the help of BCI. The aim of the project mentioned in the text is to recognise the facial expressions of the subject using BCI. Junwei [2] discusses the various frequency ranges measured for pattern recognition and analysis. The aim of the project mentioned in the text is to control a wheelchair with the help of BCI. Junwei provides the subject with a set of control options in the form of buttons on a joystick, similar to the project mentioned in this text which provides options to the subject to choose from. Junwei finds an average classification accuracy of 92.5%. Chavan [3] proposes a model for classifying EEG signals using a convolutional neural network (CNN) and a long short-term memory (LSTM) algorithm. Memmott [4] proposes an open-source software for BCI research. It compares various tools used for BCI research and uses an algorithm similar to Media Player using BCI. The software developed by Memmott also provides a signal viewer similar to other tools for BCI analysis. Faller [5] ventures into virtual environments and finds virtual environments to be effective in eliciting Steady-State Visual Evoked Potentials (SSVEPs) and aims to further improve the accuracy of SSVEPs. Folgieri [6] conducts two experiments in which she finds that each individual interprets music differently and the cerebral music tracks produced by each individual are different. Not only were the differences varying from subject to subject, but they also varied in the same subject after conducting repeated test sessions. The project mentioned in the text by Arora [7] uses Brain-Computer Interface, explains Fourier transformations and uses data filters in MATLAB.

II. Problem Statement

To control the media player using brain-computer interface (BCI) for people with motor disabilities to overcome their shortcomings.

This project helps in tackling the same problem and aims to make the lives of people with motor disabilities better by enabling them to communicate with other human beings.

III. Objectives

The main objective of this project is to play music according to the emotions of the patient with the help of a dataset. In this project we will study and analyse the dataset of the patient as the output totally will be based on this dataset, also will try to find out the exact parameter from the given dataset which provides the output according to the emotions of the patient. The next objective is to identify and influence a person's affective state based on choice of music and how listeners react to certain types of music, music that influences their emotional state can be chosen.

IV. Methodology

A. Hardware or Software Requirements

The coding language used in our project is Python. So, the basic requirement is a Python IDE. Ideally, using an EEG headset will be the best way to measure brain waves and will give us real-time data. However, as we are using Datasets for input, we will be using MATLAB for datasets visualisation.

B. Algorithm

The system starts with the initialization of the media player. The next step is taking input from the user that is identifying the emotions through brain activity. The EEG signals given from the brain goes under processing and generates strings. If the strings are valid, the media player will act accordingly and if the string is invalid the user will have to give the input again. The media player can operate 4 functions that are Play, Pause, Next, and Previous. Pause is for stopping the current song being played. Next is for moving on to the next song. Previous is to move to the previous song.

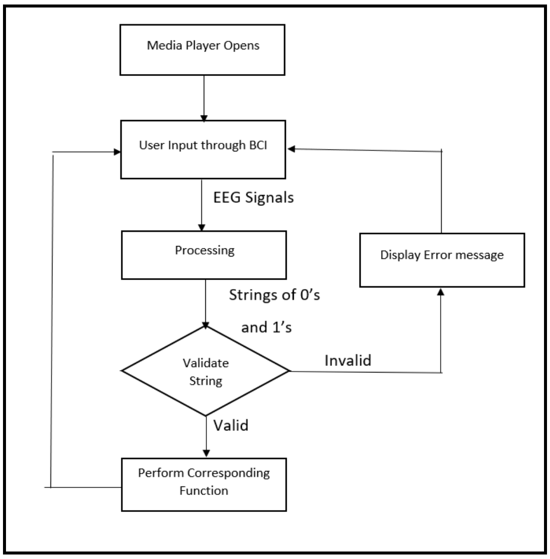

Fig. 1. Flowchart of the working of the system

V. Results and Discussions

This text discusses the existing problem and purpose of the project and tells us the significance of employing BCI in music players to enable computer communication for those with severe movement disabilities. Additionally, it contains information about the system and explains how it functions with the suitable algorithm. The paper also examines the system's scope and how it should effectively expand to multiple dimensions in the future.

VI. Maths

Brain-Computer Interface captures signals from various regions of the brain with the help of electrodes. These signals are classified into 4 different kinds of waves, conventionally named alpha (α), beta (β), delta (δ) and theta (θ). The signals are classified into these categories based on the power of each wave collected by the EEG apparatus. This data is then put through an autocorrelation function

$$R_x(t) = E[x(t) \cdot x(t + \tau)] \quad (1)$$

where $x(t)$ refers to the signal sequence. This function is used to determine the Power Spectral Density (PSD), which then brings us to the Fourier transform defined by

$$S_x(t) = \int_{-\infty}^{\infty} R_x(\tau) \cdot e^{-2\pi i f \tau} d\tau \quad (2)$$

This Fourier transform obtained by the equation is observed over a certain period of time. This time frame is shifted throughout the wave. The average of these Fourier transforms gives us the PSD. This method is known as Welch's Periodogram. The time frame can be adjusted to have a window of less duration in order to obtain more resolution as EEG waves are generally very noisy. After plotting a PSD (in dBm) vs. frequency (in Hz) chart, we find that low frequency waves have higher power and vice versa.

VII. ADVANTAGES

1) The music player is easily scalable. The system can be extended to other more important functions as this technology grows further.

2) The system has high performance. The accuracy of our music player is upto 75%, making it reliable.

3) Initially, BCI required a complex system to work. But, due to advancement in technology, the hardware part of this system has been simplified. The software part is also quite simple, as we are using python and its basic libraries in it.

4) It is an efficient means of communication with a computer system, since the user does not have to operate it physically.

5) It does not require much training of the user before usage. Since the Music player is BCI based, the user just has to think about the desired choice and the system will measure the brain waves and perform the expected function.

VIII. FUTURE SCOPE

This idea of the Media Player using BCI software has further scope of expansion in the future. Not only will this help those who are physically unfit or handicap, but also it will entertain other people.

This will include the extension of the same paradigm to other software, which we can customise and make a whole new functionality with advancement in this field of technology. Hence, in the future, the operation can be tweaked to produce more accurate results. Even if there aren't as many applications for this project right now, it could lead to more advanced research in the future. This research could lead to the discovery of new methods. This will extend the same paradigm to other software, which we can customise and use advanced technology to create entirely new software.

IX. CONCLUSION

A system to play music using Brain-Computer Interfacing was developed. The user will be able to perform various actions like Play, Pause, Next song, and Previous song according to their emotion.

X. ACKNOWLEDGEMENT

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