MANTECH Publications

Journal of Current Trends in Electrical Engineering
Volume 1, Issue 2, May-August, 2016

Automatic Brainwave Regulation by Music on Cerebral Palsy Based on EEG

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Abstract

The approach is to automatically regulate the mood or brainwave of cerebral Palsy. An algorithm has been stated to analyse the brainwave signals from electroencephalogram (EEG). Also EEG-based brain-controlled mobile robots can serve as powerful aids for severely disabled people in their daily life, especially to help them move voluntarily. These music or sound tracks, selected based on the choice of the target people, Sample stored EEG data of different patients having different moods were used to verify the feasibility of the approach and the obtained results ensured its effectiveness. After verifying all the methods we get the most useful method which can be used more efficiently than others.

Keywords: *Brain-computer interface (BCI), Real time EEG data acquisition, Music Therapy & type, brain-controlled mobile robot.*

INTRODUCTION

The main aim of this Research is that it should be the useful technique especially for mentally disordered (Cerebral Palsy), completely paralyzed or severely disabled people who cannot physically do anything for their mental comfort unlike normal human being. For different internal and external reasons, their mood can change any time. Most of the time, neither they can express their emotion to their attendant, nor always, their near people can understand what to do for these people, how they feel, what type of music they need to or want to listen. They get lonely, sometimes unhappy or restless and some other times drowsy

untimely. We have attempted to make these unlucky people get relief from these sort of unpleasant mental states by automatically playing time-suitable music, such as relaxation music during excited or restless mood while motivational music for drowsy mood and so on.

Also Assistive robots can provide support for disabled people in daily and professional life.

Conventionally people take antibiotics to reduce stress which reflects in side effects. So we need to find some method which will reduce our stress with affecting our body[4].

Brain–computer interfaces (BCIs) have been developed to address this challenge. BCIs are systems that can bypass conventional channels communication (i.e. muscles and speech) to provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time[2].

An EEG-based brain-controlled robot is a robot that uses EEG-based BCIs to receive human control (here after, brain controlled robots refer to EEG-based brain-controlled robots only)[1].

Interaction of neurons in the brain takes place in the form of electro-chemical signals creating the brain electric and magnetic fields. Based on the frequency and amplitude range, these electric fields are classified into five different band limited signal patterns, known as the brain waves. These brainwaves are as follows: namely delta (δ), theta (θ), alpha (α), beta (β) and gamma (γ) in ascending order of their frequency ranges[1].

In these frequency regions different frequency defines different mood and accordingly the EEG will detect the brainwaves & do the respective operations on them.

Brain waves are sensed and transduced by placing electrodes on the scalp[1]. Traditionally, invasive and noninvasive electroencephalogram (EEG) techniques have been used to record these brainwaves for the diagnosis of some brain affecting diseases such as epilepsy, brain tumors, mental disorders, sleep pattern change, dementia, Alzheimer's Parkinson disease etc[2]. Here We chose music as feedback

keeping in mind that music can not only adjust mood but also ease pain, increase immune ability and has overall a great influence in human mind[3].

II. METHODS & RELATIONS

Brain is made up of billions of brain cells known as neurons. These brain cells use synchronized electrical pulses to communicate with each other. The combination of electrical activity of the brain produce wave like cyclic rhythms commonly known as brainwaves following are some of them:

Delta (δ) waves 0.5-4 Hz
Theta (θ) waves 4-8 Hz
Alpha (α) waves 8-13 Hz
Beta (β) waves 13-22 Hz
Gamma (γ) waves 22-30 Hz and above

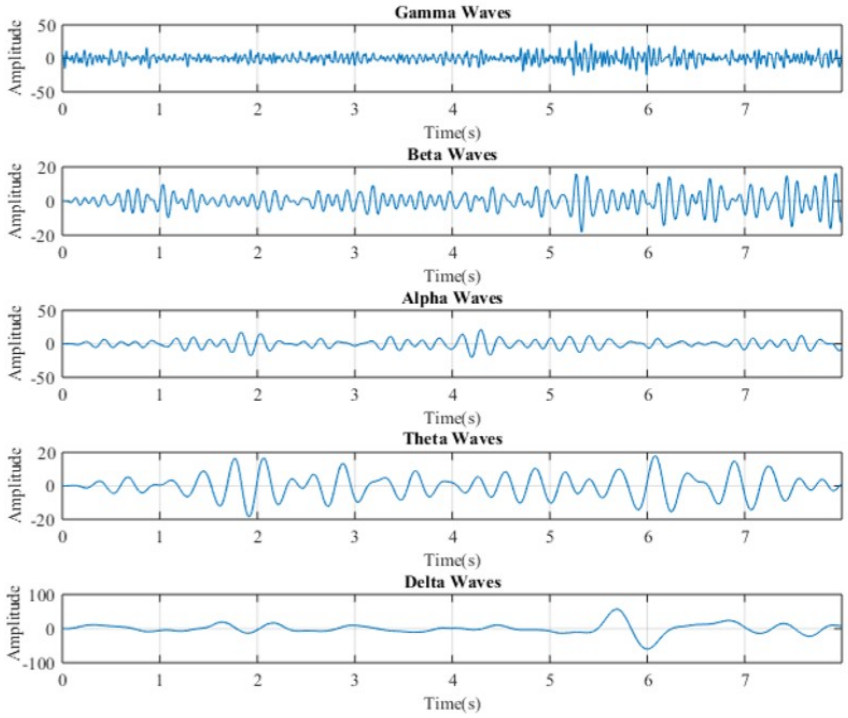

Figure 1

Proposed Method:

The system we proposed, is composed of signal Acquisition, buffering, MATLAB based processing and communication, and audio feedback blocks. A schematic the overall functional flow of the real-time music based wave regulation system is shown below: **See figure 2**.

The description & functions of these blocks and procedures an algorithm is stated in step by step way as explained below.

An algorithm to implement the proposed approach was developed as described in this section. Various samples of typical single channel EEG data, acquired from different people having different modes and same person for different modes, were loaded to MATLAB for analysis by using simple load command. The loaded data were further filtered with Butterworth filters to remove unwanted noises induced by powerlines, muscle activities etc. and then spectral analysis was carried out using fft algorithm.

Algorithm:

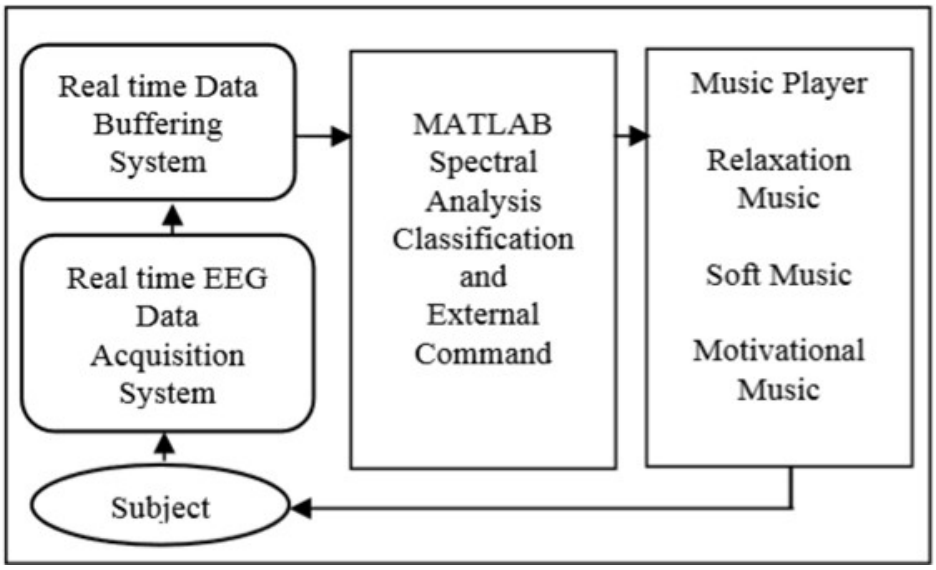

Figure2 Schematic of proposed method [1]

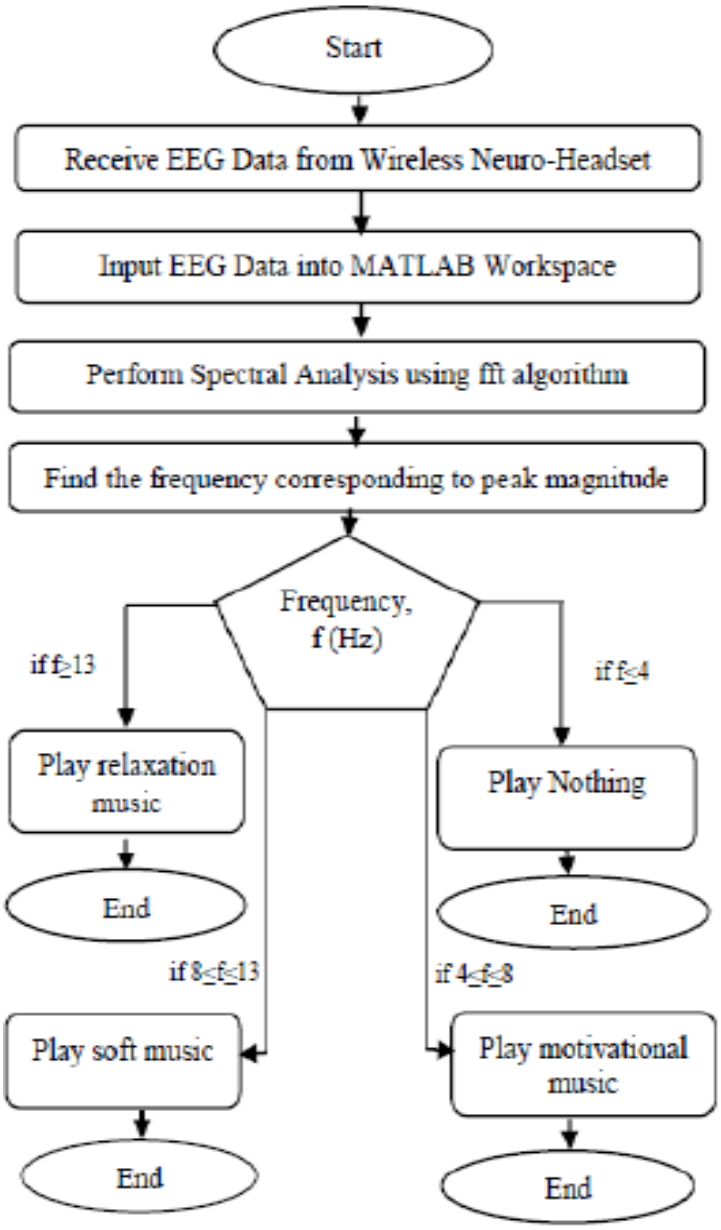

Figure 3 Flowchart of the algorithm

The frequency corresponding to the peak amplitude was found out using simple looping and logical commands to determine which brain wave band (δ, θ, α, β, γ) was dominant.

Depending on the frequency ranges the type of music is played 1as explained in the algorithm.

If the f<4 then there should not be any need playing music because generally in this range the person is in deep sleep.

If the f>13 then the person is in stressed condition so there is need of playing some relaxation music to control his/her mind state.

If 8<=f<=13 then the person is in stable state so here some soft kind of music can be played.

If 4<=f<=8 then the person is felling low in this frequency band so it requires some motivational music to control his mind state.

In real time applications, these music tracks would dynamically be changed based on the dominant band of the subject's brainwaves which in turn would adjust the subject's mood as audio feedback.

The type of music is arranged in the Music library a kind of data base accordingly the music will be played.

Music library
Relaxation Music • Track 1 • Track 2 • ------ • Track n
Soft Music • Track 1 • Track 2 • ---------- • Track n
Motivational Music • Track 1 • Track 2 • ---------- • Track n

Figure 4 Music Library [1]

Performance Evolution:

Table 1:

Sample	δ Wave	θ Wave	α Wave	β Wave	γ Wave	Music Played
1	5%	10%	15%	50%	20%	Relaxation
2	8%	17%	45%	20%	10%	Soft
3	10%	60%	15%	10%	5%	Motivational
4	20%	28%	30%	20%	2%	Soft
5	60%	20%	10%	9%	1%	No Music
6	15%	17%	48%	12%	8%	Soft

A result is developed of different patients of different mental states. Results for six such sample data are summarized in TABLE I. When these samples were loaded to the MATLAB program we developed, it was observed that the music tracks corresponding to dominant band were playing expectedly in the audio player as mentioned in the table. For dominant δ band (during deep sleep), no music was playing. In real time system, these music tracks would act as audio feedback to the real subjects and adjust their moods thereby. The spectral resolution of different bands, along with the raw EEG signal of such a typical sample of 20ms duration is illustrated in above table.

All the signals were amplified before being passed to a computer via Bluetooth. The main work of our study was to analyze the EEG signals from the electrodes in 16 positions, as the International 10-10 system's appointed position of FP1, FP2, F7, F8, F3, F4, T3, C3, C4, T4, P3, P4,T5, T6, O1, O2. They represent the left hemisphere (left temporal area), the right hemisphere (right temporal area), the former hemisphere (frontal), rear hemisphere (parietal occipital region) and other brain regions [6].

The electrods arrangement is done as shown below:

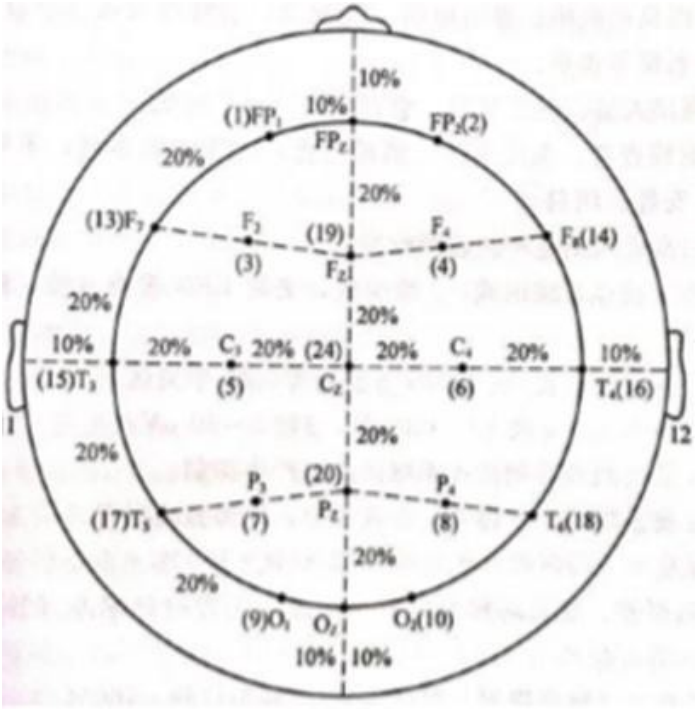

Figure 5 EEG Electrodes arrangement [2]

They represent the left hemisphere (left temporal area), the right hemisphere (right temporal area), the former hemisphere (frontal), rear hemisphere (parietaloccipital region) and other brain regions [6]. All electrodes had the central zenith (Cz) for reference. The recorded data then passed a 0.1 ~ 48Hz bandpass filter, with the sampling frequency of 256Hz. Electrodes arrangements are shown in Fig.

To test the effectiveness of the approach, relative power spectral densities were calculated using Fast Fourier Transform (FFT) algorithm which is as shown below:

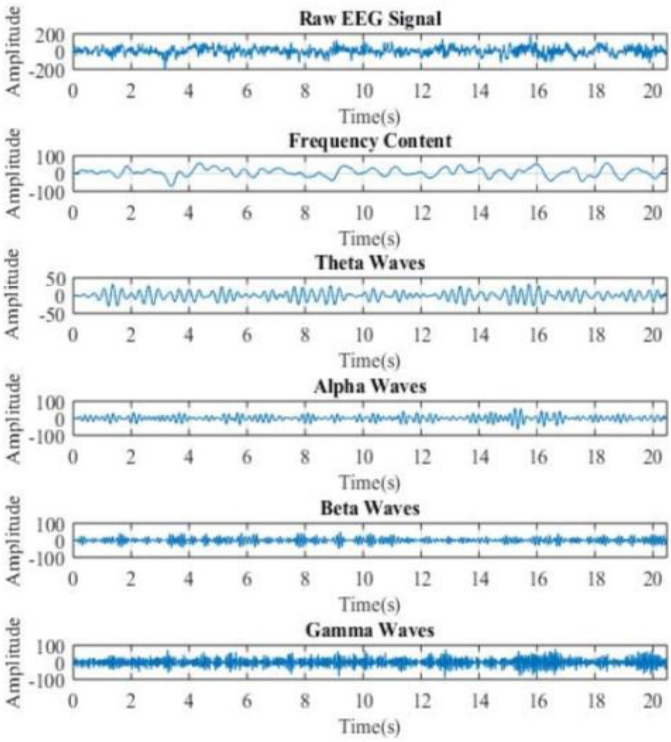

Figure 6

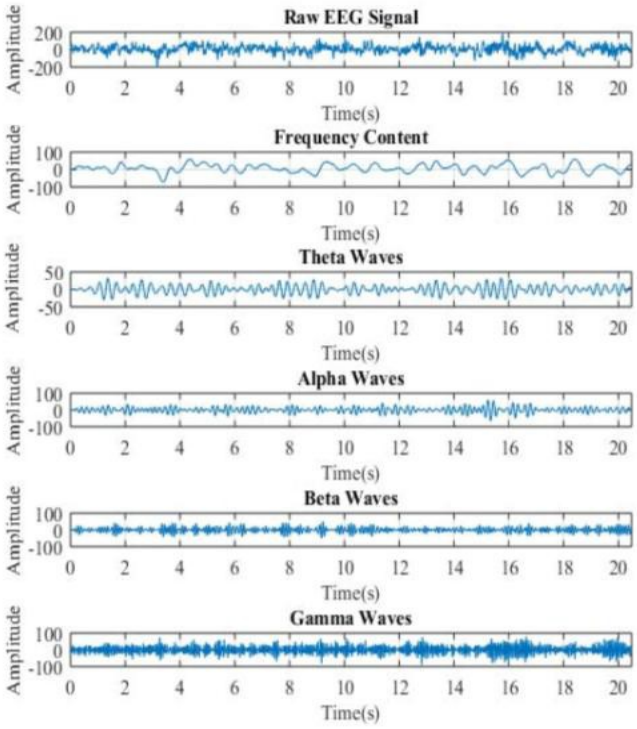

Figure 7

Table 1

Sr. No.	Survey Table		
	Method	**Author**	**Conclusion**
1	Real Time EEG Based Automatic Brainwave Regulation by Music	Alamgir Hossan	Though we proposed the approach for real time applications, we could not implement it in real time because we could not afford to have real time EEG acquisition system at the time of experiment.
2	IOT for Music Therpy	Yogesh Pingle	IOT will be the most used techonology in future. So it will be helpful for all the normal as well as abnormal peoples.
3	EEG-Based Brain-Controlled Mobile Robots	Luzheng Bi	As it is the brain controlled robots which are useful for the disabled people especially. But Some users cannot produce the necessary brain activity patterns for a particular kind of BCI systems they need to get trained for this.
4	The Effects of Different Types of Music on Electroencephalogram	Xu Wang3, Ye Duan3	It is a survey regarding EEG that how the EEG got affected by music.

III. DISCUSSION AND CONCLUSION:

In this work, an approach is designed to adjust the mood of different physically and mentally disabled people by music. The feasibility and effectiveness of the approach were verified. Not only music, any kind of entertainment, along with or instead of music, can be selected for the library.

Though we proposed the approach for real time applications, we could not implement it in real time because we could not afford to have real time EEG acquisition system at the time of experiment.

However, we verified the system's performance by offline data which ensured the effectiveness of our approach The signals we used were collected with few channels thus covering a small area of the brain, more realistic brain signals collected through many channels that cover large area would give more accurate insight of the brain and then a more appropriate feedback could be given.

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