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Emotion based Audio Player Using Mind Wave EEG Sensor

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Abstract: In this study, an attempt is made to develop an android based application that can play songs automatically, based on our emotional state. The application is connected via. Bluetooth to the mind wave Electroencephalograph (EEG) sensor which helps to determine the mood of a person based on the brainwave readings. Human brainwave consists of alpha, beta, gamma and theta waves. The EEG sensor can detect two states of mind active and sleepy. It determines the user's mood as active when the brain wave has excess beta waves and sleepy when the brain wave has excess alpha waves. Using this feature, it is possible to play a suitable song that is congruous to the user's frame of mind. The results obtained were analyzed using Naive Bayes classifier and this low cost implementation showed an overall accuracy of 97.5%.

Key words: Electroencephalograph (EEG), sensor, brainwave detection, alpha wave, beta wave, frame of mind

INTRODUCTION

Finding the right song to suit the human brain mood can be exasperating, especially if the playlist is too big. To avoid this unwanted frustration, it is possible to automatically select and play the favorite songs from the stored playlist with ease, based on the mood, instead of having to search for the songs manually. The smart headphone or audio player reads the user's brainwaves and picks the right tune for the user automatically. The smart headphone uses an Electroencephalograph (EEG) sensor to interpret our emotional state. The EEG sensor is synchronized with the application (Think2Play) that is created and installed in the user's android mobile.

In case of the human mood changes and if it wants a different song, the user has to blink rapidly. Doing, so, allows the EEG sensor to pick up a new set of signals and repeat the automatic song selection process again. Thus, information in the headphone is refreshed and the sensor scans the brain again, so that, the application can select a new song. By using the concept of signal processing along with the NeuroSky EEG sensor, numerous simple yet, effective smart Android applications can be developed. The sequence of actions performed by the application is as follows: the application is connected to the wireless NeuroSky smart headphones to detect any change in the brain waves. If a valid change is observed, the appropriate activity is performed based on the information received, the application can be programmed to behave in a certain manner.

Literature review: By Rebsamen *et al.* (2010) EEG based wheelchair application has been discussed to navigate in familiar environments. Motor imagery and direct brain-computer communication with an effective sensor based application is implemented by Pfurtscheller and Neuper (2001). Silva (2014) work mainly focusses on Bluetooth communication and with the help of that a brain wave controlled robot has been proposed. Millan *et al.* (2002) found a local neural classifier for the recognition of EEG patterns associated to mental tasks. This is best suitable for the classification of mental illness.

Millan *et al.* (2010) discussed the various challenges related to combining brain computer interfaces and assistive technologies state-of-the-art. P300-based brain computer interface and a prototype of a chinese speller has been implemented by Su *et al.* (2008). This application uses hardware oriented brainwave simulation. A conceptual study of alpha and beta EEG brainwave signal classification technique proposed by Zainuddin *et al.* (2014) formed the basis for the development of the proposed audio player. A survey on EEG based brain-controlled mobile robots was elaborated in the research by Bi *et al.* (2013). Kale *et al.* (2014) has proved that EEG based signals are very effective in robot navigation control and future realistic application. Solanki (2015) implemented a sensor based brain wave controlled robot which could perform many obstacle detection operation. Alpha, beta wave etc., classification is elaborately discussed by Jeffrey Fannin.

Human mind regulates every-day activities by means of electric waves which are registered in the brain, emitting tiny electrochemical impulses of varied frequencies which can be registered by an Electroencephalogram (EEG sensor). These brainwave patterns are categorized into four types as shown in Table 1.

The waves are categorised based on the frequencies, as gamma, delta, theta, alpha and beta waves. The gamma waves are used to indicate if a person is alive. Thus, they

Table 1: Categories of brainwaves

Brain waves	Frequency range (Hz)	Mood
Delta wave	0.5-4	Deep relaxation or sleep
Theta wave	4-7	Light meditation
Alpha wave	7-13	Deep meditation
Beta wave	13-40	Attention or active state

will not be considered for this application. From Table 1, we can make out exactly what state of mind a person is said to be in based on the brainwaves detected. As depicted, delta waves indicate a person being sad or in deep sleep. Theta and alpha waves, both signify a state of meditation where theta waves imply light meditation and alpha waves indicate deep meditation. Finally, beta waves denote an active or attention state. Alpha and beta waves are the most commonly observed waves in most cases. Hence, these waves are often used in studies and application (Pfurtscheller and Neuper, 2001). The proposed application also uses the alpha and beta waves to detect either active or relaxed state of mind.

MATERIALS AND METHODS

Most often when a user feels like listening to music, they may not be able to find a suitable song because they may be too indecisive in selecting a song and simply give up altogether. At present, the apps that help the user to choose music are based on the most frequently heard songs or usage patterns. The application that is being used to select songs that are more in-tune with the user 's emotional state. In order to avoid this unnecessary hassle and make human life simpler this idea of implementing the smart headphone using the Think2Play android application has been proposed. To implement this solution it is important to understand the composition and classification of the brainwaves. Human brain is made up of billions of brain cells called neurons which use electricity to communicate with each other. The combination of millions of neurons sending signals at once produces an enormous amount of electrical activity in the brain. Using sensitive equipment (such as an EEG sensor) it is easy to measure the electric levels over areas of the scalp. The combination of the various electrical activities of the brain is commonly called a brainwave pattern or brainwave because of its cyclic, 'wave-like' nature.

Now, these brainwaves are relatively hard to detect, as the signals are very weak. Thus, a highly sensitive device must be used. We make use of the MindWave mobile headset which is designed and developed at NeuroSky technologies. NeuroSky-enabled solutions deliver unique insights into body and mind that can motivate people to constantly innovate and develop new applications. The company's proprietary biosensor technologies provide foundation for analyzing biometric data, using Electroencephalogram (EEG) and Electrocardiogram (ECG) in a way that's never been practical before.

Table 2: Comparison of sensors

						Shapiro-wilk normality test	
Metric	Min.	Max.	Mean	SD	Skewness	W	p-values
NeuroSky MindWave							
Attention	0.05	74.79	19.05	12.95	1.2865	0.8780	0.1131
Meditation	0.31	49.79	25.35	17.75	-0.0150	0.9435	0.1405
Emotiv EPOC							
Attention	50.00	79.79	65.20	8.57	0.0028	0.8836	0.1878
Meditation	20.21	89.86	55.92	20.78	-0.0535	0.9394	0.1261

From the family of NeuroSky, the MindWave headsets are designed to be used by developers to easily and quickly work with complete EEG-monitoring products. The MindWave mobile headset turns your android phone into a brain activity monitor, using the Think2Play App. The headset safely measures brainwave signals and monitors the attention levels of individuals as they interact with a variety of different apps. This headset is useful for OEMs and developers building apps for health and wellness, education and entertainment. The comparison of NeuroSky MindWave and Emotiv EPOC sensors are displayed in Table 2.

The MindWave family consists of MindWave and MindWave mobile headsets. The MindWave is designed for PCs and Mac while the MindWave mobile is compatible with PCs, Mac and mobile devices like the iPhone, iPad and Android. If you want a mobile compatible device, check out the MindWave mobile. Both headsets share the following characteristics. The NeuroSky ThinkGear ASIC chip is priced to power mass adoption in health and wellness, educational and entertainment devices, popular EEG technology.

Think2Play application design: Using the smart headphones makes life easy. The workflow diagram is illustrated in Fig. 1. This smart system is made up of two parts: the Think2Play app installed in the user's android mobile a device, NeuroSky MindWave mobile headset, consisting of the Electro-encephalograph (EEG) sensor that is placed on the user's head and attached to the user's headphones.This device scans the user's brainwaves and interprets their emotional frame of mind.

Initially, once the user has downloaded the Think2Play application, they must tag the songs in their playlist as either being in the happy or sad category. Once this has been done for all the songs, we can begin using the actual application. Secondly, the EEG sensor from the MindWave mobile headset, scans the user's

brainwaves and detects the greater state (attention/happy or meditation/sad). Finally, based on the detected state of mind, a suitable song is played.

Assumptions: For the smart headphone to work properly some conditions have to be meet. The mobile device has to have the specific Think2Play App. installed in order to interpret the brainwaves.

The brain signals are very weak, thus, the EEG sensor has to be highly sensitive to capture the various signal effectively. The database should be regularly updated to include new songs and their signal tags. Since, the electrodes are delicate we must make sure that the headphone is handled with proper care because damage to the electrodes can cause signal loss or distorted signal storage.

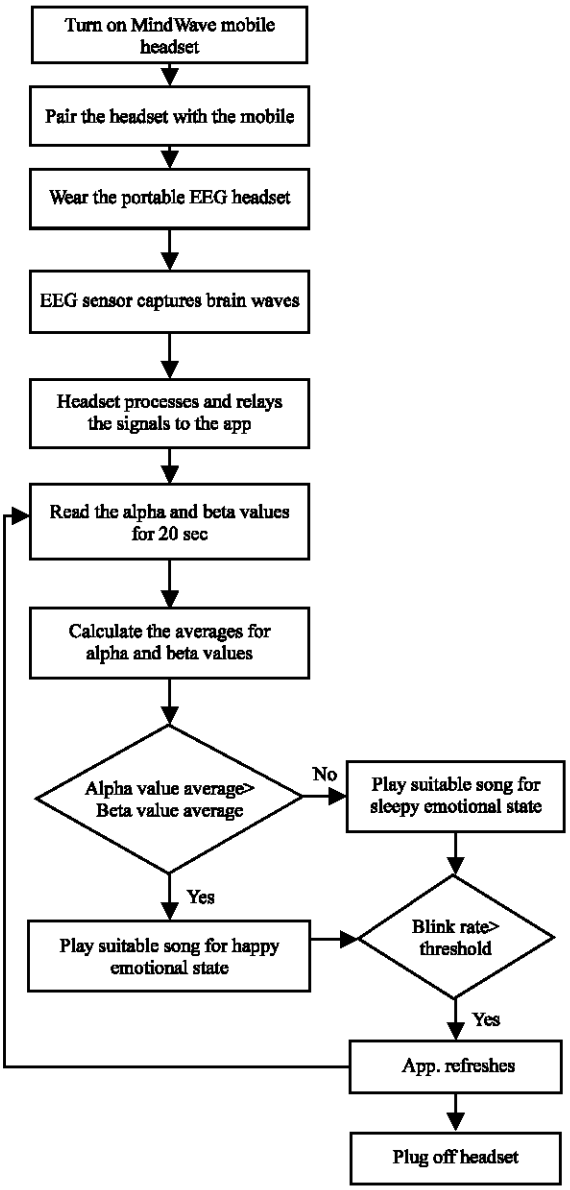

Fig. 1: System architecture-Think2Play

RESULTS AND DISCUSSION

The Think2Play application has been designed to run on an android operating system and developed using Android Studio 3.0. It has been tested to show an accuracy of 97.5% using Naive Bayes classifier. The application is tested on Samsung Galaxy Grand 2 Android mobile.

Figure 2 shows the initial user interface once the application is installed. It begins to pair via. Bluetooth, with the MindWave mobile headset in Fig. 3.

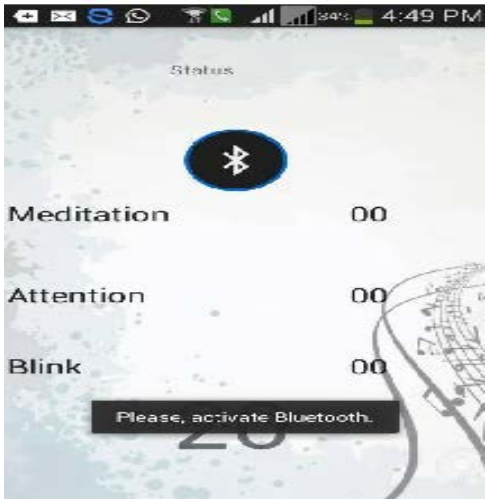

Fig. 2: Initial user interface

Fig. 3: Pairing using Bluetooth

Fig. 4: Timer initialization

Fig. 5: All state of brain waves

Alpha waves, ranging from 7.5-12 Hz are slower and associated with relaxation and disengagement. Paring is established and the 20 sec timer is started for detecting the brainwaves in Fig. 4 and 5 show all states of initial brain waves.

Thinking of something peaceful with eyes closed should give an increase of alpha activity. Several studies have found a significantly rise in alpha power after smoking.

Finally, according to the monitored brain signals either happy songs for attention state (Fig. 6) or sad songs for meditation state (Fig. 7) are played.

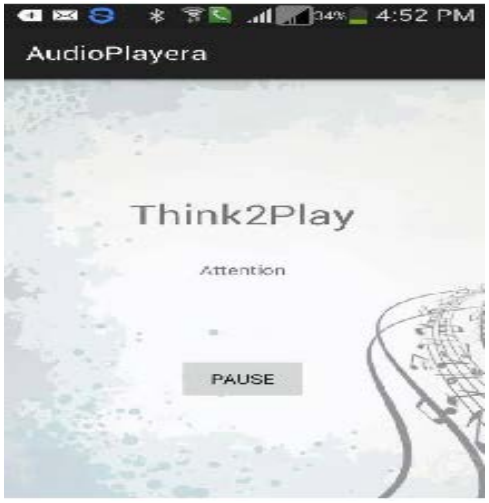

Fig. 6: Attention state

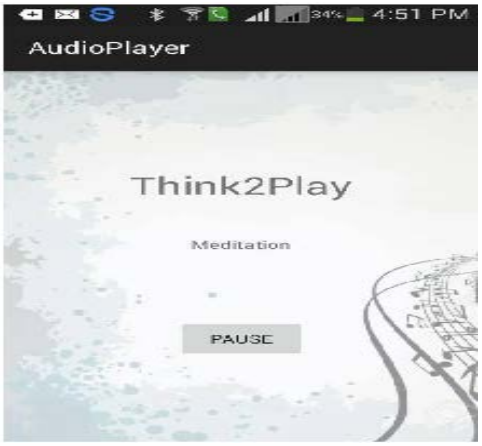

Fig. 7: Meditation state

Beta waves are in the frequency range of 12 and 30 Hz but are often divided into 1 and 2 to get a more specific range. The waves are small and fast, associated with focused concentration and bestdefined in central and frontal areas. When resisting or suppressing movement, or solving a math task, there is an increase of beta activity as per Naive Bayes classifier, the mean accuracy of 97.5% has been shown in Fig. 8 for attention state and meditation state is shown in Fig. 9.

Theta waves, ranging from 3.5-7.5 Hz arre linked to inefficiency, day-dreaming and the very lowest waves of theta represent the fine line between being awake or in a sleep state. Theta arises from emotional stress, especially frustration or disappointment. It has also been associated with access tounconscious material, creative inspiration and deep meditation.

Figure 10 shows that the human brainwave is connected via. the EEG sensor and attention, meditation and blink state is detected and after that it will show the attention values and blink values of brain wave sensor.

In Fig. 11 the attention and blink values analysis interms of graph will be generated and there are two signals generated in the graph namely the black color signal is for blinking level and the red color signal is for attention level.

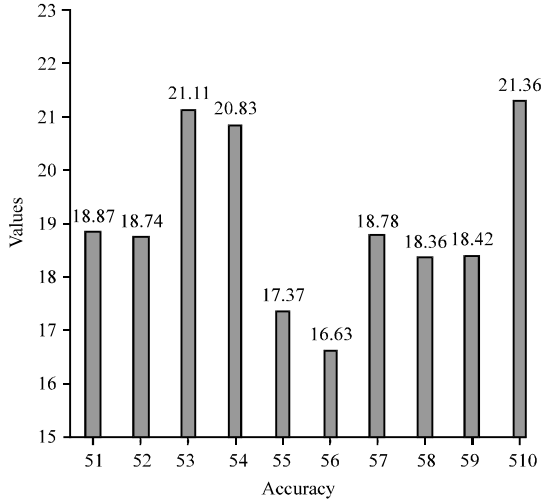

Fig. 8: Mean recognition accuracy of attention state

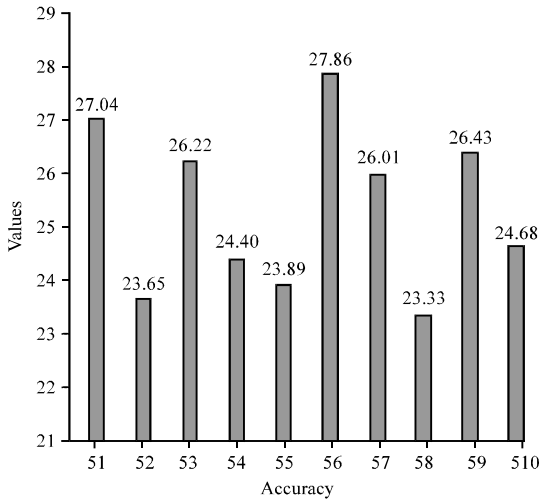

Fig. 9: Mean recognition accuracy of meditation state

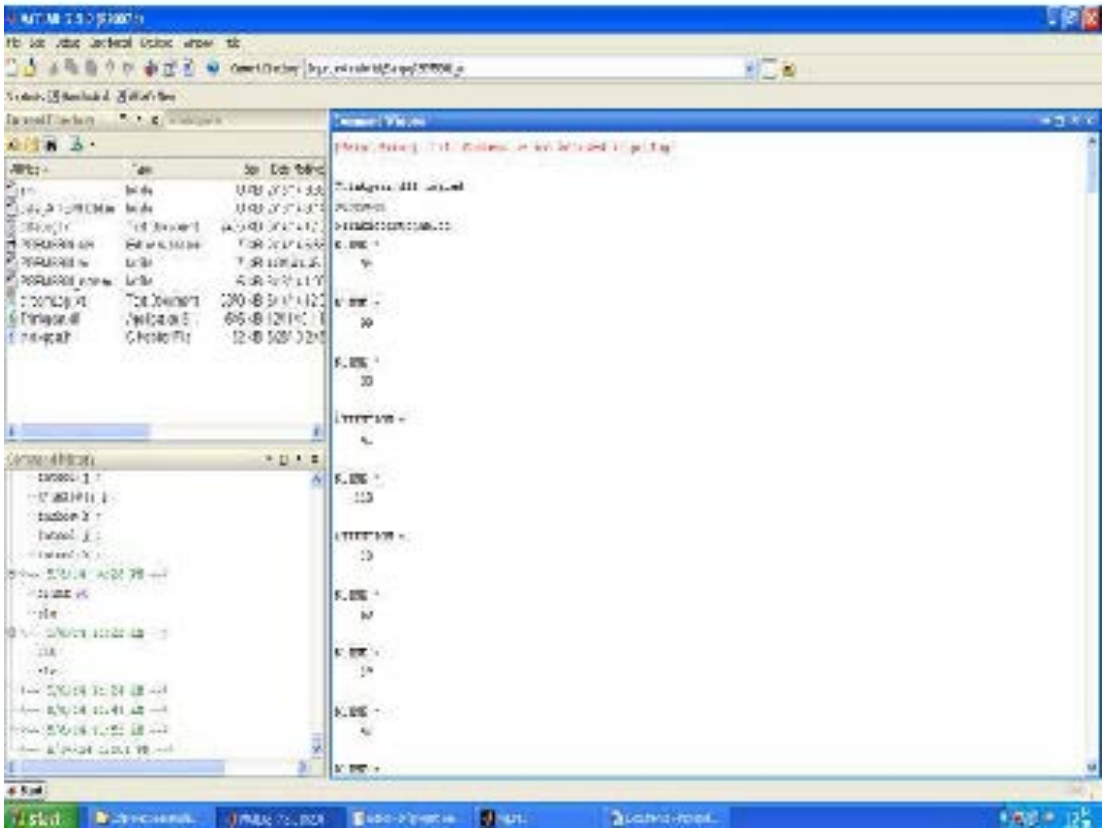

Fig. 10: Performance of EEG sensor with all states simulation

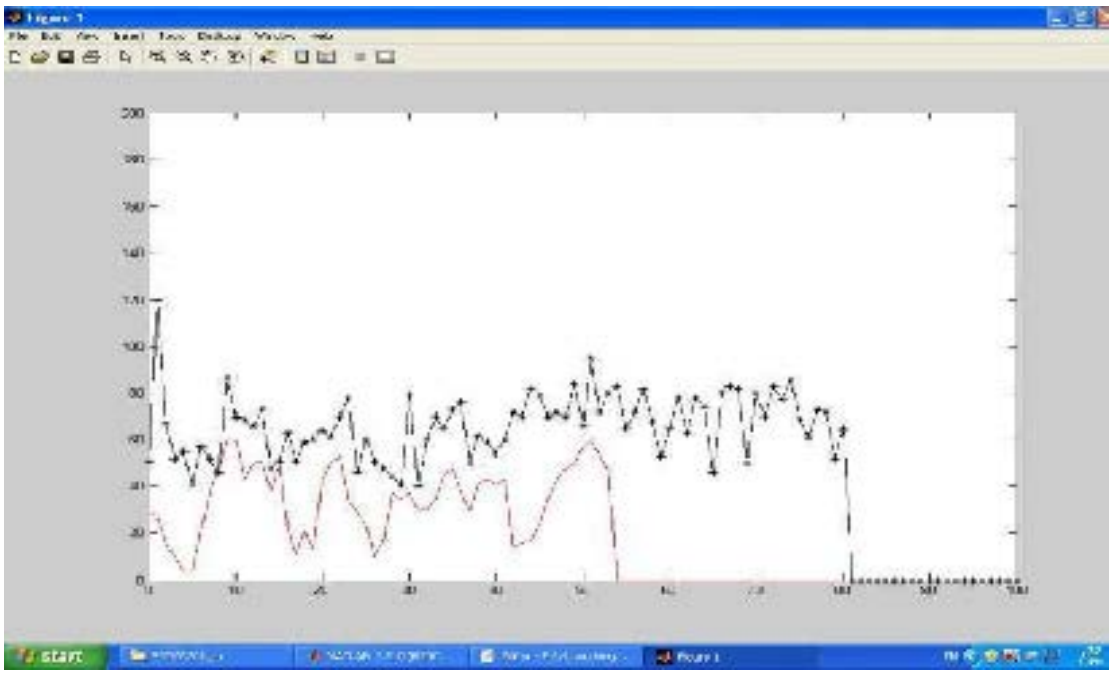

Fig. 11: Analysis of brain wave signals

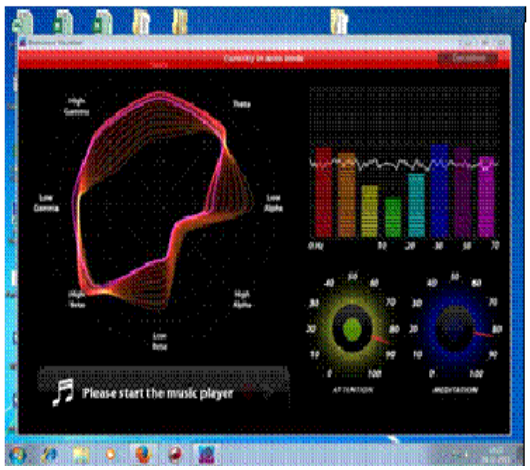

Fig. 12: Visualization of brain wave

The actual visualization of the brain wave signal for the implementation of the audio player indicates the blink, attention level and meditation levels are shown in Fig. 12.

CONCLUSION

The smart headphones developed can be used to make process of selecting a song more fun and easy with a guaranteed degree of accuracy. This small application can pave the way for more innovative application development that can consider a wider array of emotions apart from just the happy and sad states such as, sleepy, depressed, stressed, etc. Also, the accuracy can also be improved by using different algorithms apart from the standard ones used in the NeuroSky MindWave mobile headset.

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