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RESEARCH ARTICLE

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IoT BASED DROWSINESS DETECTION, MONITORING AND CONTROLLING SYSTEM

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ABSTRACT
In this paper, a drowsiness detection system based on a brain-computer interface (BCI) headset or headband which has 3 electrodes is proposed here. The headset is mounted on the user's head to compute the brain wave frequencies from the frequencies. The signal received from BCI headset is processed to remove the external noise from the system. The computed frequencies is then compared with the threshold frequencies of the brain and a particular decision is taken like whether an individual is in an active state or in a drowsy state . If an individual is in a drowsy state, the brain wave sensor sends the detected data to the system and it is displayed on the LCD display. A particular alarm is generated on his/her Android phone to wake up the person. An individual user's sleeping pattern is stored on the cloud so that it can be used for analyzing an individual's brain state while working. This project is proposed with the aim of getting the work done within a particular time period and satisfaction of work.
Keywords: Brain Computer Interface (BCI), Brainwaves, IoT, EEG, Android Application, LCD Display.

I. INTRODUCTION

According to a study, an adult brain consists of about more than a 100 billion interconnected neurons. These neurons generate electrical charges when the brain is in working condition. These small electrical charges contributes to the generation of an electric field with fluctuating electrical potentials around our scalp which are typically in the microvolt range which can be measured using brain wave sensors. These electrodes or sensors that measure potentials can be placed on the scalp at different locations. This is based on some standard configurations. Those above measurements are called as Electro Encephalo Graphy (EEG). That is why the EEG signals are also termed as brain waves [1].

Electroencephalography, EEG is the device which is used to capture the activity of brain. All electrical activity of brain is recorded from the scalp which is placed at a particular position [1], thus EEG can be applied repeatedly without any risk to individual. The captured Brainwaves pattern normally ranges from 0.5 to 100µV by EEG, has a sinusoidal shape and they are measured from peak to peak value[2].

TABLE 1. EEG Brain Waves frequency table [2]

Name	Frequency
Delta	0.5 - 4 Hz
Theta	4 - 7 Hz
Alpha	7 - 13 Hz
Beta	Above 13 Hz

Humans tend to fall asleep after a hefty day. Due to a lot of work pressure, an individual might have to put extra efforts even after the working hours. In today's world it gets difficult to concentrate when the brain feels drowsy or sleepy. Using brainwaves, the drowsiness or sleepy state can be detected and the notification is sent to the user for keeping him or her awake.

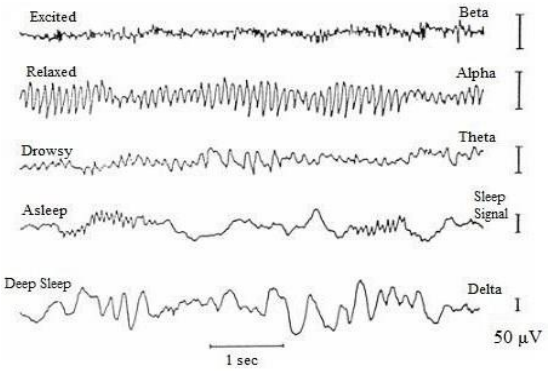
Internet of Things (IoT) has wide range of applications which includes a wide range of systems, sensors and networking products. IoT's advancements in the field of computational power, miniaturization of electronics, and network interconnections to provide everyone with a lot of applications that was not available earlier [3]. Sleeping patterns of every individual is unique, so that all the user data will be stored on the cloud. The data which is stored can be analysed on the basis of age group and graphs of sleep pattern that can be generated. So the user's sleeping data can also be used to determine his/her health conditions whether he/she is living a healthy life or not.

An Android Application will be created which will keep tracking the user's sleeping pattern. The user will have to set a timer, and in that time frame the module will perform its task. The data regarding the sleep pattern will be saved and will be used for future references [4] [5].

II.LITERATURE SURVEY

Brain computer interface (BCI), has been one of the most popular domains in computing in the recent years. BCI is a pathway which allows communication between computers and the human brain. We acquire real time EEG data with the device, Neurosky Mindwave Mobile, which uses a single dry electrode. Experiment for acquisition of data is carried on 40 subjects (33 male and 7 female). Feature extraction of EEG signals are done by statistical measures such as mean, standard deviation, maximum and minimum amplitudes. In this paper we explore the approach of ensemble learning with classifiers such as random forest classifier to build a BCI model to predict mental states as concentration and meditation. Analysis and results of our proposed model shows an accuracy of 75% using the above methodologies. This model is further implemented in the field of Internet of Things (IoT), for the application of home automation.

The concept of Google Cloud Messaging, C2DM & Xtify is explained in brief with their applications, procedure and working. The current application and usage of these technologies is also discussed with their future scope. We have implemented a basic notification application using Google Cloud Messaging where we were able to analyze and document results of the application developed in order to have a brief idea of the technology and study it in terms of future research to be carried out in the same domain.



III.EQUIPMENTS

Hardware

- Power Supply Unit
- IC7805 & IC7812(Voltage Regulators)
- Node MCU(Microcontroller)
- Brain Wave Sensor
- Relay Module
- Buzzer
- I2C Display(LCD display)
- Android Mobile Phone
- Breadboard
- Jumper wires
- Battery

Software

- MIT Application Inventor

- Arduino IDE1.8.5
- MATLABR2017
- Cloud Database(Fire Base)

IV.PROPOSED METHODOLOGY

The developed headset model will be designed according to the researched circuit diagram from the reference [5],[6],[14] . To get the clean EEG signal we will use Temporal lobe (T), Frontal lobe (F) and Parietal lobe (P). Temporal lobe is associated with processing sensory input to derived output, or higher meanings using visual memories, language and emotional association. Frontal lobe is the region where most of our conscious thoughts and decisions are made.Parietal lobe is all about integrating information stemming from external sources as well as internal sensory feedback from the skeletal muscles, limbs, head, eyes, otoliths etc. This headset will have 2 electrodes located 2 of them at position A1 and F3, and 1 of the electrode will be used as reference electrode.[11]

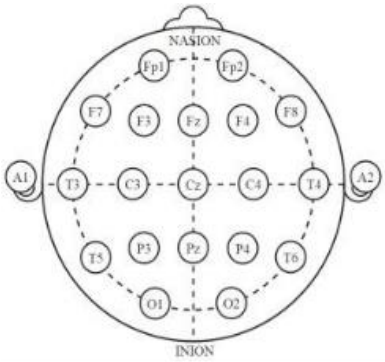
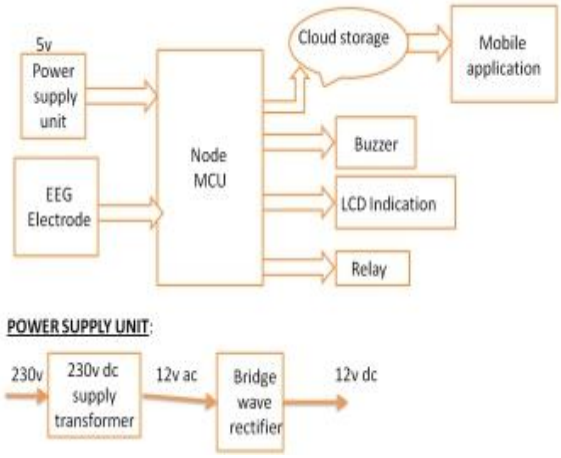


Fig. 1. Schematic diagram of the 10-20 electrode system

The EEG signal have several components which can be separated by the brain wave frequencies as these values are referred from Table.1 . The characteristic of deep sleep are Delta waves and those are high amplitude waves having a frequency ranging from 0 ≤*f* ≤4 Hz. Theta waves frequency band is for meditation, drowsiness or idling s occurs within the frequency band ranges from 4-8 Hz. Alpha waves has a frequency range of 8-14 Hz and takes place while relaxing or reflecting. Another approach to boost the alpha waves is to close the eyes. Beta waves falls in the range between 13-30 Hz frequency band and are features of the user being alert or active, they become present while the user is concentrating. Gamma waves in the range 30-100 Hz occurs during sensory processing of sound and sight. Lastly, mu waves occur in the 8-13 Hz frequency range while motor neurons are at rest [5].



Node MCU will be used for computing the processed signals and as the threshold frequency or when the frequency range is sensed.Once the frequencies are computed it will first send the data on cloud and store it over there. Simultaneously, send a signal and the information or data to the users phone through android application which we create for waking up the user if he feels drowsy. After the sensing of the signal the buzzer indication is done. Major and the most important task is acquisition of signal precisely and properly. MATLAB Synthesis will be applied to remove the noise from the signals so to get a proper processed and a clean signal [7].

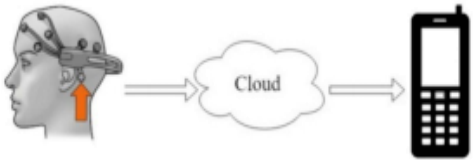


Fig. 4. Storing of Brainwaves Data on Cloud

The clean signal without distortions, any random signal or noise may cause more issues, as brain waves have very low frequencies [8],[9],[13]. Low frequencies are highly volatile to the some environmental conditions, so even slight disturbance leads to unpredictable effects. So, once the processed signals are fed to the micro controller, then it starts computing the signals by comparing

with the threshold frequency. Once, the threshold frequency level is achieved, the micro controller needs to send it to the mobile application along with the cloud service. Micro controller makes the frequency registration and communicates with the help of the WiFi Module. WiFi module is responsible for sending the signal to the mobile for notifying the user as well as to the cloud service for registering the user's sleeping state datas.

In the android application the user will be able to view his/her live status and it is very useful to alert them in a easy manner. Before the message is received, there will be indication of buzzer and the message will be displayed in the I2C(LCD Display).

V.CONCLUSION AND FUTURE SCOPE

An EEG-based Drowsiness Monitoring, Detection and Controlling Module was proposed for the people who wanted to stay awake for completion of work and also for the drivers who have to drive the vehicle for a whole night without sleeping for single second. They have to suffer a lot for completion of their pending work. Thus after a tiring day, it is very difficult to keep up and complete the work. The module which is designed , is used to sense and detect the mental state of an user with the help of Brain Wave frequencies. This designed Module monitors the Brain Wave frequencies and judges the state of the individual whether he/she is sleepy or drowsy. If so, it sends an alarm on the mobile device, which will alert the user using the buzzer indication and keep him or her awake for the pending work to be completed.

The user sets a timer on the mobile application, and the module is in ON state till the timer is on. The Mobile Application will also maintain the users sleep pattern, and this data will be stored on cloud. The Application will monitor the pattern and give suggestions.

There are many applications for the Brain Waves Technology. It can be applied in various medical fields to get an idea about the mental health of the patient. The proposed system contains an EEG module, cloud and a cellular device as physical devices. A new feature can be added in the mobile application where after starting the timer, by the user, the application will be able to play the alarm to wake up the user for maximum of five times only. If the alarm plays for five times, the timer stops automatically letting the user sleep.

Disturbing an already sleepy person with an alarm, time and again, would affect the health of the user. In addition to this, in the mobile application, a feature of live music streaming can be added with the help of cloud. The user can contentedly listen to the desired music while the timer is on and he or she has to complete a low pressure work like making a document, writing activity, etc. To make it a complete IoT application, the whole mobile device can be eliminated and the data storage, live streaming of music, and the notifying job can be done totally on cloud and on the headset itself.

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