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Drowsiness Detection and Monitoring the Sleeping Pattern using Brainwaves Technology and IoT

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***Abstract*— In this paper, a drowsiness detection system based on a brain-computer interface (BCI) headset having 3 electrodes is proposed. The headset is mounted on the user's head to compute the brain wave frequencies. The signal received from BCI headset is processed to remove the external noise. The computed frequencies is then compared by the threshold frequencies of the brain state and a particular decision like whether an individual is in an active state or in a drowsy state can be taken. If an individual is in a drowsy state, a particular alarm is generated on his/her Android phone to wake the person up. An individual user's sleeping pattern while working 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 an aim of getting the work done within a particular time period.**

Keywords—Brain Computer Interface (BCI), Brainwaves, IoT, EEG, Android Application.

I. Introduction

According to a study, an adult brain consists of about more than a 100 billion interconnected neurons. These neurons, when the brain is working, generate electrical charges. 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 sensors. These electrodes or sensors that measure potentials can be placed on the scalp at different locations based on some standard configurations. These measurements are known as Electroencephalography (EEG). That is why the EEG signals are also termed as brain waves [1].

Electroencephalographic, EEG is the device to capture the activity of brain. All electrical activity of brain is recorded from the scalp surface at a particular position [1], thus EEG can be applied repeatedly without any risk to anyone. The captured Brainwaves pattern by EEG normally range from 0.5 to 100µV, has a sinusoidal shapes and they are measured from peak to peak [2].

TABLE 1. EEG Brain Waves Signal [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, one may have to put in 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 we can detect this state and notify the user to keep him or her awake.

Internet of Things (IoT) has wide range of applications. IoT includes a wide range of systems, sensors and networking products, its 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 before [3]. Sleep patterns of every individual is unique, so all the user data will be stored on the cloud. This data can be analyse on the basis of age group and graphs of sleep pattern can be generated. So the users sleeping data can also be used for determine his/her health conditions whether he/she is leaving a healthy life or not.

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

II. Equipments

A. Hardware

- Arduino Microcontroller
- EEG Sensor
- WiFi Module
- Android Mobile Phone
- Breadboard
- Jumper wires
- EEG Electrodes
- Battery

B. Software

- Android Studio
- Arduino IDE 1.8.5
- MATLAB R2017

III. Proposed Methodology

The developed headset will be designed on depending on the researched circuit diagram from [5],[6],[14] . To get the clean EEG we will used Temporal lobe (T), Frontal lobe (F) and Parietal lobe (P). Temporal lobe is associated with processing sensory input to derived, or higher, meanings using visual memories, language and emotional association. Frontal lobe is the region where most of your conscious thoughts and decisions are made.Parietal lobe is all about integrating information stemming from external sources as well as internal sensory feedback from skeletal muscles, limbs, head, eyes, otoliths etc. This headset will have 3 electrodes located 2 of them at position T3 and F8, and 1 of the electrode will be used as reference electrode at Pz.[11]

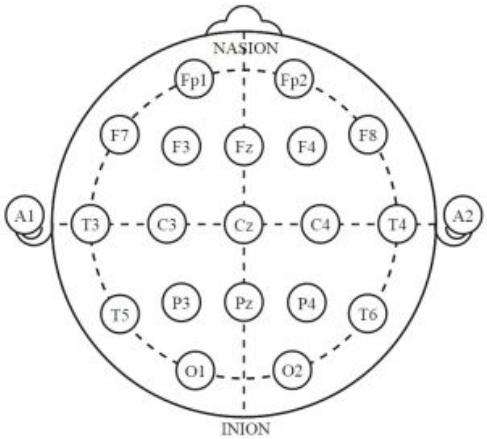

Fig. 1. Schematic of the 10-20 electrode system

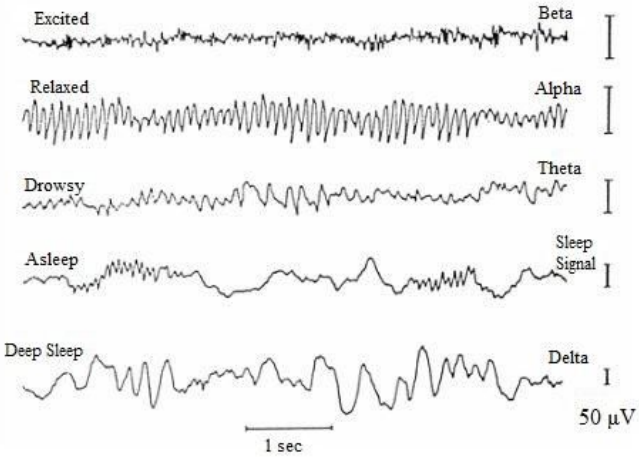

Fig. 2: EEG Wave Frequency Ranges

The EEG signal have several components which can be separated by the frequencies. The characteristic of deep sleep are Delta waves and those are high amplitude waves having a frequency ranging from $0 \leq f \leq 4$ Hz. Theta waves frequency band is for meditation, idling or drowsiness occur within the 4-8 Hz frequency band. Alpha waves has a frequency range of 8-14 Hz and take place while relaxing or reflecting. Another approach to boost alpha waves is to close the eyes. Beta waves falls in 13-30 Hz frequency band and are feature of the user being alert or active, they become present while the user is concentrating. Gamma waves in the 30-100 Hz range occur 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].

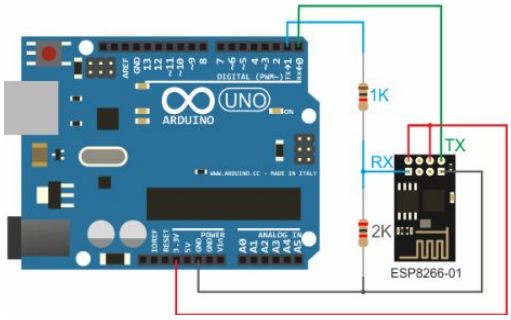

Fig. 3. Arduino Uno connection with Wi-Fi module.

Arduino Uno MicroController will be used for computing the processed signals and as the threshold frequency is achieved, a system notification will be send on the user's phone. Once the frequencies are computed it will first send the data on cloud and store it over there. Simultaneously, send a signal on the users phone if he drowsy to wake him up. Major and the most important task is of 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].

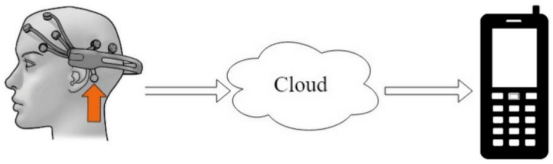

Fig. 4: Storing of Brainwaves Data on Cloud

The clean signal with no distortions, any random signal or noise may cause a lot of issues, as brain waves are very low frequencies [8],[9],[13]. Low frequencies are highly volatile to the environmental conditions, so even a slight disturbance will lead to unpredictable results. So, once the processed signals are feeded to the microcontroller than it starts computing the signals with the threshold frequency. Once, the threshold is achieved, the microcontroller needs to send it to the mobile application along with the cloud service. Microcontroller makes the frequency registry and communicates with the WiFi Module. WiFi module is then responsible for sending the signal on to the mobile to notify the user as well as on to the cloud service registering the users sleep data.

In the android app there will be overall three main activities. The Home, the Timer and User Activity. The "home" activity will consists of list view which contains time in hours, showing whether the user was working at that particular time or not, and whether the user completed his/her work in that defined amount of time or not.

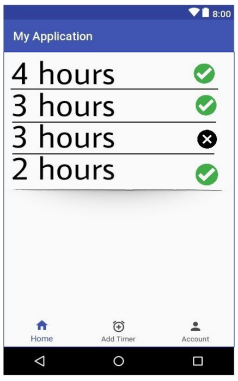

Fig. 5. Mobile Application Home activity screen

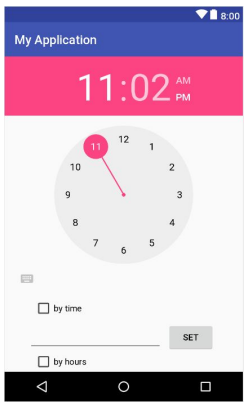

Fig. 6. Mobile Application Timer activity screen.

The "timer" activity will contain the checkboxes ('by hours' and 'by time'), by clicking on the 'start' button depending on which checkbox is selected the clock will start working. And "timeCounter" activity will appear which will show progress bar with how much time is completed. The user can click on 'cancel' button and the timer will be stopped and will be marked as cross in "home" activity. Whenever the user is sleepy the alarm will start and 'stop' button will appear to stop the alarm.

The "user" activity will contain "register" and "login" activity, when user is not logged in to the system. And also he will be asked at "home" activity to register. In "register" activity the user will be asked details which database need. The unique id will be given as login id and username will be the password (during logging in to the system). Once the user is logged in, this activity will show content like how much sleep user should have and how many hours user should work.

IV. Conclusions and Future Scope

An EEG-based Drowsiness Detection Module was proposed for the people who after a hectic day, still have pending work to do, and need to stay awake for the same to be completed. Thus after a tiring day, it is difficult to keep up and complete the work. This module will detect the mental state of an individual with the help of Brain Waves. The Module monitors the Brain Wave frequencies and judges whether the person is sleepy or drowsy. If so, it sends an alarm on the mobile device, which will alert the user 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. 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 accordingly.

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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