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Study on Brain Abnormalities Using IoT

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***Abstract* - It is important to understand the mechanisms of learning disabilities in order to evaluate electroencephalography (EEG) parameters. Diagnosis of abnormalities is one of the major continuously ongoing researches in medical science field. Brain Computer Interface for controlling elements commonly used at home. It includes EEG device needed to acquire signals associated to the brain activity. To understand the complex behavior of brain EEG is very effective tool. IoT revolution has made health care more advanced by narrowing gap between medical condition and the response from specialist. This paper mainly presents an idea related to brain by reforming the existing access control system detecting medical conditions and getting timely response from doctors in case of emergency.**

***Keywords* – Brain Computer Interface, Brain Signals, EEG, Home, Healthcare, IoT**

I. INTRODUCTION

Brain is a significant part of human being which controls entire parts of human body. Left side of brain controls the left part of the body and right side of the brain controls the right part the body. EEG (electroencephalography) is a test used to identify problems related to electrical activity of the brain. In neuroscience, the term brain connectivity refers to the interaction within different neural system in brain. Brain connectivity can be classified into functional connectivity, structural connectivity, and effective connectivity. Functional connectivity refers to temporal correlation between spatially remote/ unconnected neuro-physiological events. Structural connectivity is the connectivity of neural system that are physically or anatomically attached with each other.

The EEG signals are commonly decomposed into five EEG sub bands: delta, theta, alpha, beta and gamma as shown in Figure 1. Alpha waves are rhythmic and its frequency range is from 8 to 13Hz. Beta waves are irregular and its frequency range is 4 to 7Hz. Theta waves are slow and its frequency range is less than 3.5Hz. Gamma waves are the fastest brain wave frequency and its frequency range is from 31 to 100 with the smallest amplitude.

Brain Computer Interfaces (BCI) is defined as the communication systems that monitor cerebral activity to command for device control. The acquired signal is translated to external components. The integration of BCI and Internet of Things for smart home(SH) is emerging technique to make home environments comfortable and accessible, automating and optimizing the use of appliances like TV sets, air conditioners, light bulbs etc. Integration of EEG device with an IoT system based on the widely used.

Protocol termed as Message Queue Telemetry Transport (MQTT).

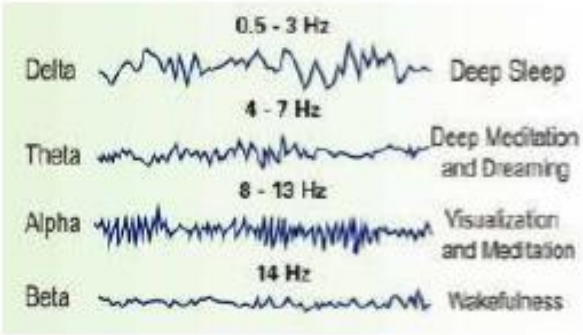

Figure 1. Normal EEG waves

II. RELATED WORK

Literature survey has been carried out for the pre-processing of EEG signals, features extraction, feature selection and classification methods. SVM are used to classify the epilepsy from EEG signals [2]. Cross correlation based LS-SVM [7][8] for improving the classification accuracy of EEG signals are used. ESP32 micro controller module [3] is used to analyze EEG device. MQTT protocol is used for message passing communications [1].

BCI to IOT ecosystems for SH devices [4]. EEG performed using one channel placed at the FP2 position according to the 10/20 system Stevenson N J [10] has

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developed the automated grading system for EEG abnormality in neonates. Multiple linear discriminant classifier are used to classify the EEG abnormality in neonates with HIE. Marcus [9] has presented the time-frequency distributions of EEG signals.

III. PROPOSED SYSTEM

To integrate BCI and SH, the system developed is shown in Figure 2. The main element of this system is the device for EEG data acquisition. The activity of user's brain activity is captured using a single channel, where the intension is to be captured based on the scalp's location. EEG data measurements are obtained with a sampling frequency of 128Hz in the frequency range from 4.7 to22Hz.

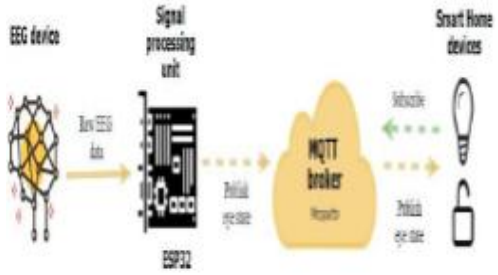

Figure 2. Scheme of the system developed for the integration of BCI and IoT

1. Analysis of EEG Signals

The main goal is to analyse the EEG signal for the detection of brain abnormalities. This system involves the process such as EEG signals pre-processing, feature extraction and classification in Figure 3. The first module deals with the EEG signals pre-processing methods. It is used to remove the noises from the signals. The next module extracts the EEG signals features from decomposed signal. The selected feature is given as inputs to the classification process. The classification method is mainly used to analyse the EEG signals and it classifies the signal into normal or abnormal. The raw data captured by the EEG device are then analysed by an ESP32 micro controller module [3] to determine the user state. As an example of application, classifications in open/close eyes are considered.

It is well known that EEG alpha activity (8-13Hz) increases for normal individuals during a closed eyes simulation and is suppressed with visual stimulation. The signal processing unit will be able to determine the user eye state considering the power of alpha and beta. Once the eyes state is determined by the system, it must be communicated to the different devices of the SH. For this purpose, the MQTT protocol is used. It is widely used communication protocol in IOT applications which applies the publish/subscribe pattern. This protocol traduces the user intentionality to control commands. For example, the state of closed eyes during a "a priori" fixed time interval could correspond to modify the environment (home or hospital room, for example) to a "sleeping" mode (then off light and TV etc.).

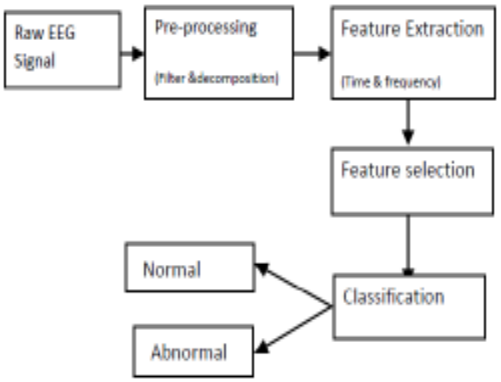

Figure 3. Frame work for analysis of EEG signals

IV. RESULTS

The raw EEG signal contains some noises that occur due to eye blinking, muscular art effects and deep breathing at testing time. The low pass filter is used to reduce the noises. Figure 4 shows the actual EEG signal

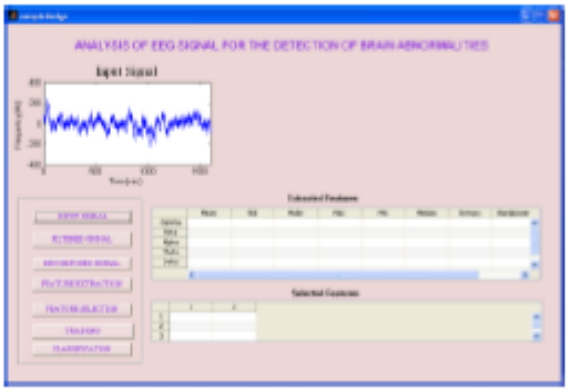

Figure 4. Input EEG signal

The x axis contains the time duration and y axis contains frequency. The EEG signals are non-linear; it represents time vs. frequencies. So the Time domain and Frequency domain features are extracted. The EEG signal contains five types of waves such as delta, Theta, Alpha, Beta and Gamma waves. The features can be extracted from the EEG signal in two different domains such as Time Domain Features (TDF) and Frequency Domain Features

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(FDF). Figure 5 shows the extracted features from the each decomposed signals. The time domain features such as mean, standard deviation, median, mode, max, min and entropy are extracted. The frequency domain features such as power and energy are extracted.

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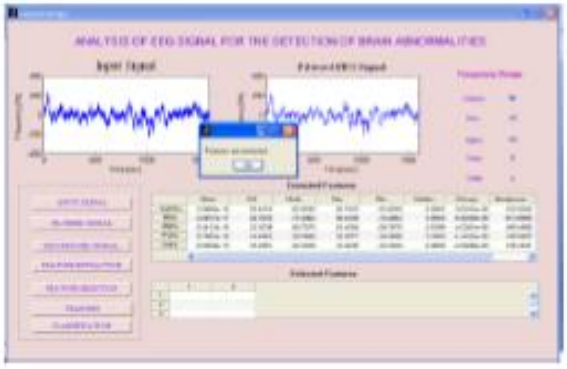

Figure 5. Extracted Features

The two methods for determining the eye state: method 1, which obtains the alpha and beta bands using band pass filters and then computes the β/α ratio; method 2, which computes the Fast Fourier Transform (FFT) of the acquired signal for the frequencies corresponding to alpha and beta bands and then computes the β/α ratio. Figure 6.1 and Figure 6.2 shows the values for closed and open eyes averaging all these trials from the training period and also the threshold levels obtained for everyone. As you can see in the subfigures corresponding to both methods, there are significant differences between participants.

The performance of the proposed models is evaluated using the following statistical measure. The accuracy of a classifier on a given test dataset is the percentage of test dataset that are correctly classified by the classifier. Accuracy= ((TN+TP) / (TN+TP+FN+FP)) X 100% Where, TP – True Positive (An Abnormal signal is correctly identified), TN – True Negative (A Normal signal is correctly identified), FP – False Positive (A Normal signal is incorrectly identified), FN – False Negative (An Abnormal signal is incorrectly identified).

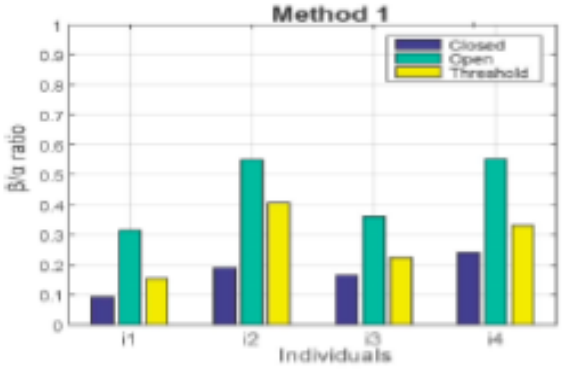

Figure 6.1 β/α ratio of each eye state for method 1

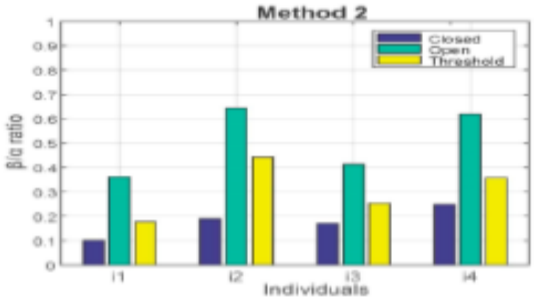

Figure 6.2 β/α ratio of each eye state for method 2

V. CONCLUSION

The proposed system for extracting EEG signals by integrating BCI and IOT is formed by a single channel EEG device, a signal processing module to determine the user's eye state and the MQTT protocol for the distribution of the extracted knowledge among the connected devices. As part of our future work, extending the algorithm for multi-channel EEG signal classification would strive for the robustness of the system. The performance of the classifiers is to be augmented by adding more patients and creation of larger data-base in co-operation with relevant medical instructions.

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