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Feature Extraction from EEG Signal through One Electrode Device for Medical Application

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***Abstract*—In recent years, a vast researches are concentrated towards the development of EEG based human computer interface in arrangement to enhancing the quality of life for medical as well as non-medical applications. Industry and community of research has been attracted by wireless EEG devices and they are easily available in the market. Such technology can be incorporated to psychology, anesthesiology, and for real-time patients monitoring. The Neurosky Mind wave headset device was generally utilize to detect and measure electrical activity of the user's forehead and transmits the collected data wirelessly, to a computer for further processing. After processing data base, the signals are categories into various frequency bands for feature extraction. In this paper, we present the characteristics and specification of EEG based human computer interfaces for real-time applications. Furthermore, we discuss about the mental or behavior state of the person (Eye Blink, Meditation, Attention levels) through the NeuroSky Mind wave (MW001) device using Openvibe.**

Keywords: EEG Sensor, BCI, Signal Processing, Openvibe.

I. Introduction

Recently, a new attributes of human-centric or human computer interaction incorporated with digital media has been revolutionized the numerous fields including wellness and quality of life. Most importantly, such technologies are the key interest to vast potential for various medical applications. Monitoring brain activities with brain computer interfacing (BCI) has enabled a real-time healthcare monitoring application for many neurological disorder and disabled patients. This filed has the potential to shift clinic centric technologies to patient centric technologies by monitoring brain activities. Generally BCI utilized to performs four distinct tasks. Converting neurological input signals into electrical signals; extracting features; gathering important information; and combine all meaningful information for useful purposes [1]. Recent advancements in low-power, wearable embedded system technology, faster sensing and computing technologies aided with wireless communication have made possible the real-time brain activity monitoring [2]. Also the advance have been made in detecting neural signal and converting them into require signals which can governs the devices. In this scenarios, the information is transmitted either wired or wirelessly by user into computer system using a multiple distributed EEG (electroencephalogram) electrodes or sensors placed over human head [3]. In this scenario, the information is transmitted either wired or wirelessly by user into the Computer system using a multiple, distributed EEG (electroencephalogram) electrodes or sensors placed over human head. [3] [4]. In this paper, we study of human computer a interface which is based on real-time EEG recording [5] and its recognition. Also we have proposed a new algorithm for brain state recognition using Openvibe software. This algorithm includes concentration level recognition and behavior state and some innovative tools and methods are developed through integration for implementation of EEG-based interaction and immersion. This study should lead to EEG based applications Implementation like serious monitoring of patients. The Neurosky Mind Wave headset is to collected raw data from human brain. The accessed Data from the Neurosky headset are then plotted through the Application Program Interface of Neurosky Inc. using a processing based program. We assign a subject to perform facial gestures and mental activities tasks like smooth and fast opening and closing eye, blink, concentration and meditation. The real-time raw data was recorded during the subject performed these actions using Openvibe software, Further development of process based algorithms of concentration and meditation level of recognition for Medical applications.

II. LITERATURE SURVEY

EEG is the measurement of electrical activity in the brain from the scalp. The first neural activity of the human brain published in Hans Berger (1924) [2] using a simple galvanometer. EEG is generally described in frequency band vary of amplitude and frequency of the wave represent various brain states it's depend on internal brain behavior state and external simulation [3].In recent years clinical use of EEG 21 electrodes are used to identify 5 fundamental waves. Generally brainwaves are differentiate in five frequency bands they are Delta, Theta, Alpha, Beta and Gamma, Delta (0.1- 3.5Hz) is associate with deep sleep condition, Theta (4- 8Hz) is associate with dreams, imaginary, idling, drowsiness, Alpha (8-12Hz) Relaxed, Reflection and pattern appears in wakefulness, Beta(¿13 to 30Hz)alert, working active, busy, thinking and concentration and Gamma(30 to 100Hz) is associated with the rhythms for high level information processing in the shown table1.

Now a day's great development in wireless EEG devices for patient monitoring, gaming and other applications in previously researchers are using wired EEG devices for patient monitoring but now a days easily handling through wireless EEG devices, but these device costs in thousand dollars [5] these EEG devices have been developed by Neurosky, OCZ

TABLE I. FREQUENCIES GENERATED BY DIFFERENT TYPES OF ACTIVITIES IN THE BRAIN

Frequency Bands (Hz)	Frequency Range
43.4-86.8	External Noise
30-43	Gamma
14-30	Beta
8.-13	Alpha
4-8	Theta
0.1-4	Delta

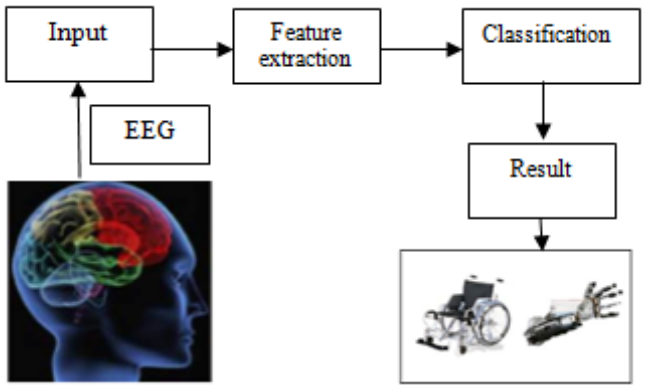

Fig. 1. Wired EEG system

technology, InteraXon, PLX devices and Emotiv systems [3] [4]

A. Wired EEG Device

Wired EEG device system shown in the above Figure 1 shows the conventional EEG based BCI system. Using EEG signals as an input to the system, the BCI system extracts feature signals from the EEG signals. Feature signals are the components of EEG signals which reflect subject's intention. Because these feature signals are often corrupted by noise or contaminated by an interfering signal, the informative signal features are hidden. To extract these feature signals and translate the command for external device, signal processing methods are applied such as feature extraction and classification.

B. Wireless EEG Device

Now a days researchers are using wireless devices because in wired devices system is very complex rather than wireless devices, In wireless EEG devices we do not use any wired connection for the data transfer in between system and hardware, we are using for data transfer Bluetooth and different types of communication protocols, wireless devices are using for mainly gaming, healthcare and other applications normally wireless device system can be shown in the below Figure 2.

III. METHODOLOGY

A. Utilized Resources: Hardware

The main hardware for used this study NeuroSky MindWave Device is a single-channel EEG headset it cost only around $100. The device consist of eight main parts ear clip,

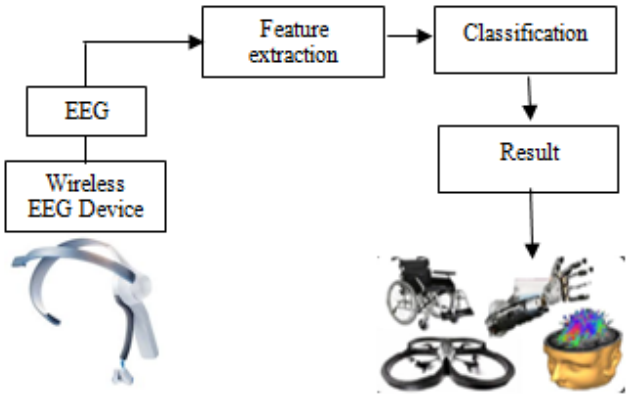

Fig. 2. Wireless EEG system

Fig. 3. Subject handles Neurosky Mindwave with Openvibe

ear arm, battery area, power switch, adjustable head band, sensor tip, sensor arm and think gear chipset [5] . The main principle of this operation is very simple, in this device we used two sensors to detect and filter the EEG signals. First sensor tip detects electrical signals from the forehead of the brain, it detects the signal from the forehead through the electrode positioning (FP1) according 10-20 system of the EEG [2] [6]

The second sensor Ear clip is useful to a ground reference in this chip think gear module allows filter out the electrical noise. Signals from this sensor receiving via electrode placed in left ear lobe, where the data obtained from the 512 Hz of sampling rate with each sample there is a 16-bit ADC resolution [6] we are observing above Figure 3. User handle Neurosky Device with the computer.

B. Utilized Resources: Software

Now a day more simplify signal processing and data analysis through the Openvibe software [7], it's a computing language using software programming designed for data analysis, computation and visualization [8]. Openvibe allows 2D and 3D visualization of data through the topology. In this scenario Openvibe in processing EEG signal, Normally EEG machines electrodes placed on the head of the subject and transmitted

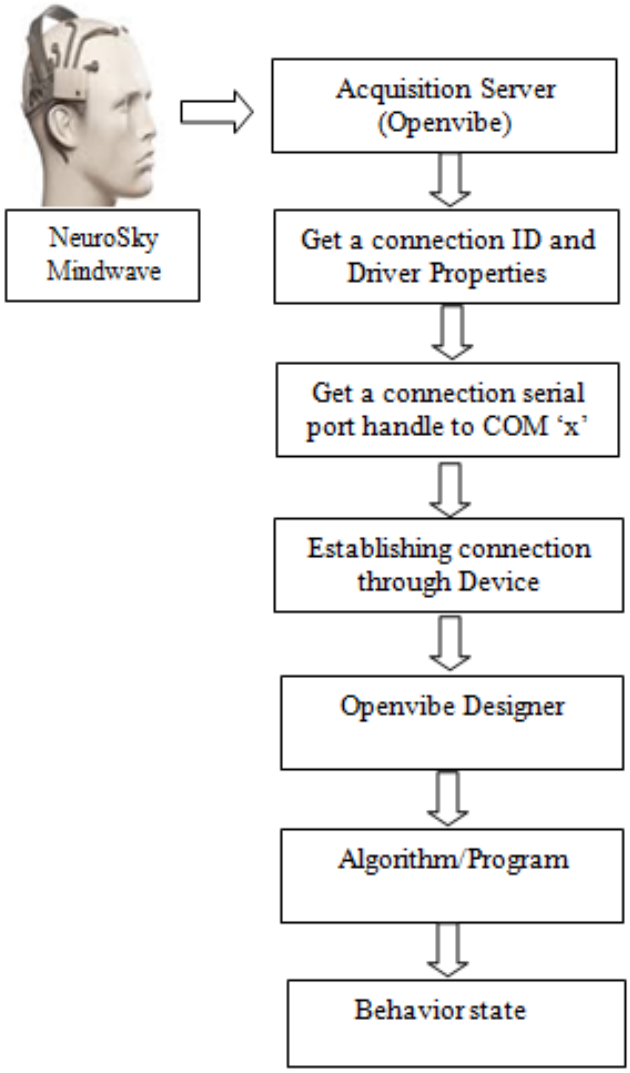

Fig. 4. NeuroSky MindWave Communication protocol

data to computers these signals huge external noise, artifacts and interference, these issues Openvibe software easily tackled.

First we setup the Neurosky Mindwave device to the computer for acquiring brain signal according to the above Figure 4. In the next step acquiring server of Openvibe with Neurosky device and device properties its transfer the data with pairing with Bluetooth of the system/laptop, it's allow the Bluetooth connection its send the data through the packets of our raw data.

Next step we are design an algorithm in Openvibe designer for behavior state/mental state of the user and its give appropriate below results.

IV. RESULT AND DISCUSSION

First we setup the Neurosky device setup with Openvibe software, Openvibe is a mathematical and graphical programming language. In this simple design we are easily drop and drag inserting options in this software, first initiate in acquisition server of Openvibe software applying Neurosky

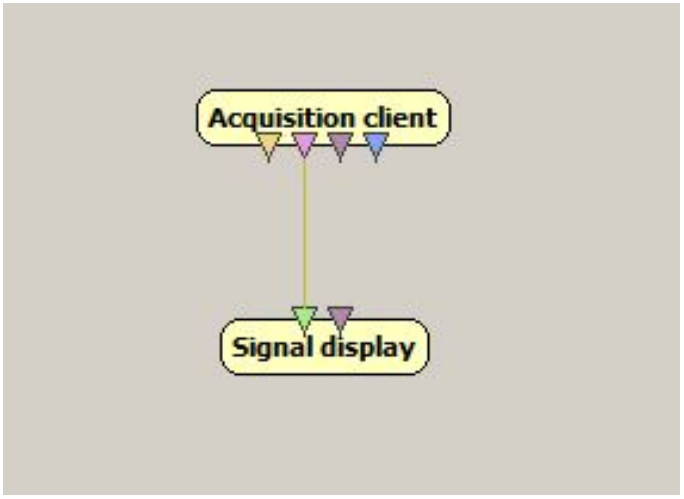

Fig. 5. Algorithm for Raw signal in Openvibe

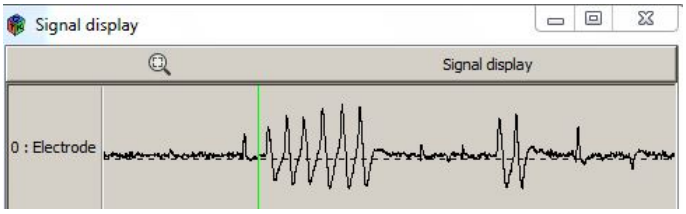

Fig. 6. Raw signal through Neurosky Mindwave

device, sample per count is 32,connection port is 1024 and sampling frequency of the device 512 than open the openvibe designer for programming we design a simple program in the below figure 5. for obtaining Raw signal of a user normally neurosky mindwave device as a single electrode (Fp1) on the forehead we are inserted and observing the raw signal on fig 5. In this raw signal we are observe of a user eyes close, open its gives accurate signal.

We obtain through this program a single electode raw signal for the electrode on forehead device (Fp1) its gives proper result Figure 6. for eye detection,user attention and meditation level.

Normally EEG signal will be characterized through the features in different frequency bands, in the same raw signal we are divided into frequency bands and observe the Neurosky Mindwave device gives proper result it gives presence of EOG artifacts through the device eye movements/blinking below 4Hz shown in the below Figure 7. Next we design algorithm using Openvibe software shown in the below Figure 8. first we acquire signal from acquisition client, it's client based server in this scenario we are using as a client Neurosky Mindwave device its gives sampling frequency 512 Hz and data block size is 32 per samples per second, next step normally EEG signal has a non- stationary signal it's contain lots of noise we remove such noise using filter in this our design we are using band pass filter for extracting frequency bands, its eliminate noise of the signal.

Than we are giving signal through epochs are it's divided through time based epoch its gives every second 512 samples and blocks of 32 samples (32/512 = 1/16).

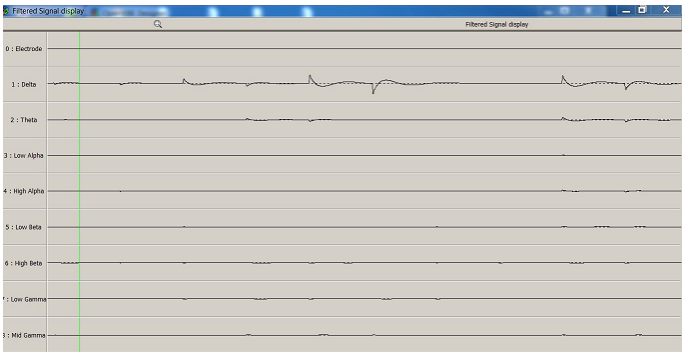

Fig. 7. Frequency Band Spectrum

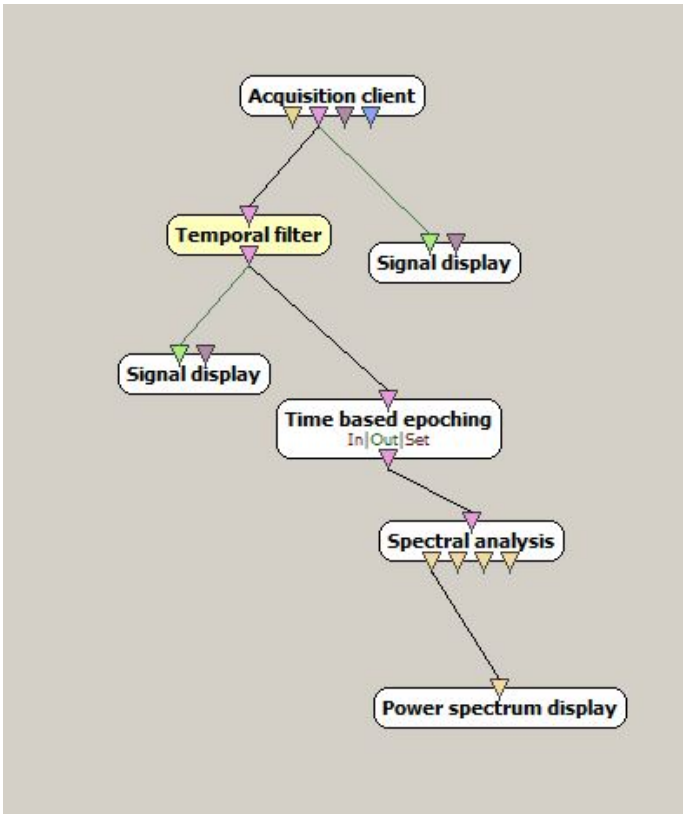

Fig. 8. Algorithm for PSD

Next we are apply this signal to spectral analysis in this box applying amplitude in spectral analysis settings than we are forwarded signal to spectral density, this scenario we are giving subject to handle four ways, first subject to relax state and eyes close than observe power spectrum shown in below Figure 9. When subject in eyes close and relax we are observe it's effected in theta waves, normally theta waves function is when we are in associated dreams and meditation.

Next we are observing subject when eyes open and relax basically when subject eyes shown in the below Figure 10 open it's effected delta wave normally delta waves are giving continuous attention task and eye blinking.

From the Results can conclude that this device can be used for learning the subject and improves his/her attention level, meditation level and eye blink status.

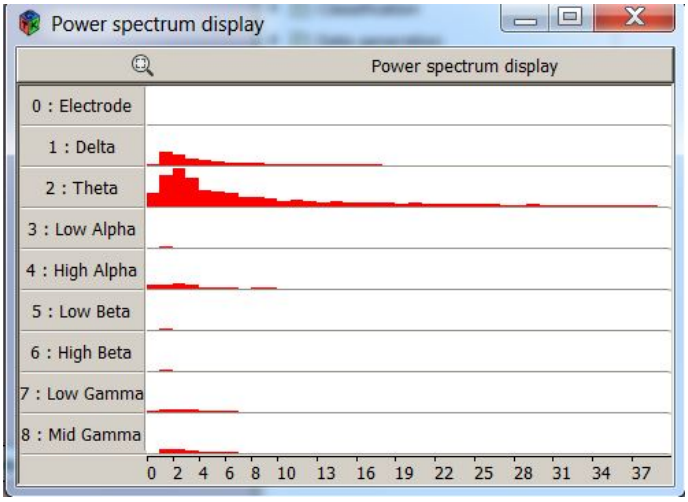

Fig. 9. Subject's Eyes closed

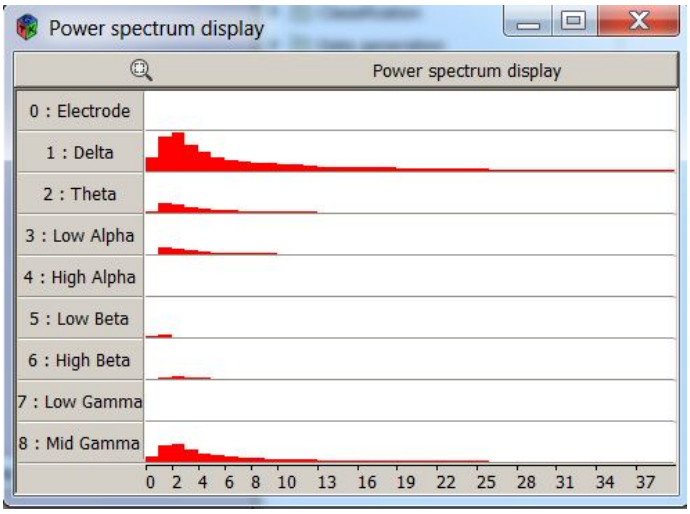

Fig. 10. Subject's Eyes Open

V. CONCLUSION

Generally, health care provider/ doctors/ nurses are able to get the status of the patient's health only after the occurrence of the emergency. We want the relevance data of patient's disease status before and after the occurrence of any emergency like heart attack, brain injuries, etc. Literature suggests that proper analysis of brain signal will be very helpful for the improvement of medications. Our proposal, to somewhat enhance the level of medication given to patient will be done by the knowledge of what has happened in neuron activity. In this research work, we have proposed user meditation/concentration, Eyeblink level using single electrode Neurosky Mindwave (MW 001) device, first we observe the raw data for a certain time period and design in Openvibe for meditation through the insertion device on the forehead and pair the device observe the relaxation level in the future scope we are designing for emotion recognition.

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