

Electro-Encephalogram (EEG) Signal Acquisition, Analysis and Alert System for Epilepsy

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Abstract—Aim of this project is to develop rescue system for the person suffering from epilepsy neurological disorder by measuring the EEG of the person. The Electro-encephalogram(EEG) is the brain signal containing valuable information of normal or epileptic state of the brain. During the event of epilepsy, the neurological activity of the brain is higher thereby increasing the surface potential. These potentials are measured continuously and analyzed with abnormal EEG of epilepsy by having the threshold value of the potential. An alarming message is sent to doctor or patient's relative using GSM (Global system for Mobile Communication) when the person is found abnormal. The location of the patient is determined using GPS (Global Positioning System) for the rescue operation.

Key words: EEG, Epilepsy, Signal, Analysis, GSM, GPS

I. INTRODUCTION

Epileptic seizures are the result of transient and unexpected electrical activities of brain. About 70 million people in the world suffer from epilepsy. Some of them can be controlled by medicine or brain surgery, while the rest 30% of patients cannot be treated effectively by available therapies [2].

The physical symptoms of seizure can range from none to unprovoked muscle contractions, numbness, visual anomaly, loss of memory and loss of consciousness. Such episodes can be of very short duration or can be continuous until intervention occurs [1]. One of the commonly used methods of diagnosing epilepsy is by measuring brain electrical activity with scanning electroencephalography or EEG signals.

The general trend in developing embedded biomedical devices for health monitoring has focused on analysis of signals for visualization purposes or development of high accuracy detection algorithms using complex signal processing and statistical computations, without considering the real hardware implementation constraints [1],[2]. An important consideration in implementing wearable embedded devices is battery life. On the other hand, accurate analysis of different biomedical signals can easily lead to a high degree of computational complexity and requires significant processing power.

This paper presents design, implementation and evaluation of embedded low-power hardware for accurate automated detection of epileptic seizures and alerting the patient's doctor or relative after finding the abnormality.

Epileptic seizures give rise to changes in certain frequencies bands, such as δ (0.4–4 Hz), θ (4–8 Hz), α (8–12 Hz), and β (12–30 Hz) bands [4]. In this project the EEG signal from the patient is obtained using brain wave sensor which is single channel and gives discrete values of the EEG as its output.

II. NEED FOR THE PROJECT

As per the survey since 1% of the total world's population suffer from epilepsy, many patients find themselves difficult during the event of epilepsy to get back to their normal state. This happens when the patient is away from home and when he or she is alone, nobody is there (no man's area) to help for them to recover during the occurrence of epilepsy.

Hence the proposed system developed consists of Embedded hardware which can acquire the EEG of the patient continuously and when the person is found abnormal, the system sends the message to patient's relative or doctor using GSM, so that care taker may know the state of patient and move for his/her rescue. Also the exact location of the patient is found using GPS.

Several methods proposed earlier are designed for the detection of Epilepsy when the person is stationary (only for analysis purpose) and doesn't aim in rescue of the patient.

III. IMPLEMENTATION

Fig.1 shows the block diagram of the prototype developed. It consists of Brainwave EEG sensor for the EEG signal acquisition from the subject, Bluetooth module for the transmission of data to the microcontroller, ARM microcontroller for signal analysis, GSM and GPS modules.

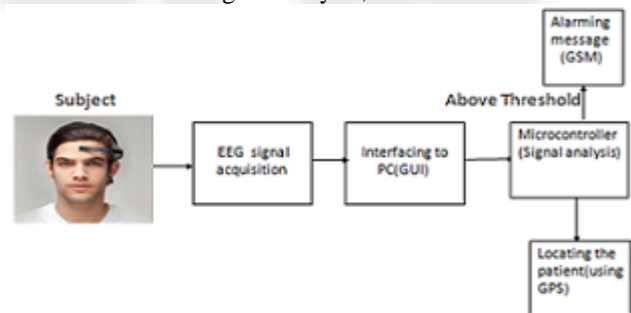


Fig. 1: Block Diagram of the proposed system

Circuit is supplied with 12V DC power supply along with variable voltage regulator for a constant supply of 3.3V and 5V for microcontroller and GSM module respectively.

The Neurosky Brainwave sensor shown in Fig.2 is used for the signal acquisition from the subject.



Fig. 2: EEG sensor

The Raw wave value of the sensor is a signed 16-bit integer that ranges from -32768 to 32767. The Brain Wave Sensor is interfaced to PC with the software package Microsoft visual C# 2013. EEG signal analysis, GSM and GPS operations are done using Embedded C Microcontroller programming under the platform of Keil micro vision.

Epilepsy data for testing of the developed hardware is obtained from physiobank database[15].This database, collected at the Children's Hospital Boston, consists of EEG recordings from pediatric subjects with intractable seizures. Subjects were monitored for up to several days following withdrawal of anti-seizure medication in order to characterize their seizures and assess their candidacy for surgical intervention.

Recordings, grouped into 23 cases, were collected from 22 subjects (5 males, ages 3-22; and 17 females, ages 1.5-19).All the data files are stored in .edf(European data format) format. All signals were sampled at 256 samples per second with 16-bit resolution. The International 10-20 system of EEG electrode positions and nomenclature is used for these recordings.

On the basis of the data and the knowledge obtained from the neurology doctor from the hospital of Spandana Mental Health Care, Bangalore, the characteristics of the EEG during the occurrence of Epilepsy was known.

The amplitude characteristics(spikes) that occur during Epilepsy was found to be $120\mu\text{V}$, $140\mu\text{V}$, $150\mu\text{V}$ and $160\mu\text{V}$ for four different patients.(normal amplitude value of EEG is 50 to $80\mu\text{V}$) for the duration of 3 to 4 seconds. An average of $140\mu\text{V}$ was considered as a threshold value of the potential above which the person is regarded as abnormal. The flow of execution of the entire process is as shown in Fig.3. Firstly,the GSM and GPS modules are initialized in order to ensure the availability of the network.

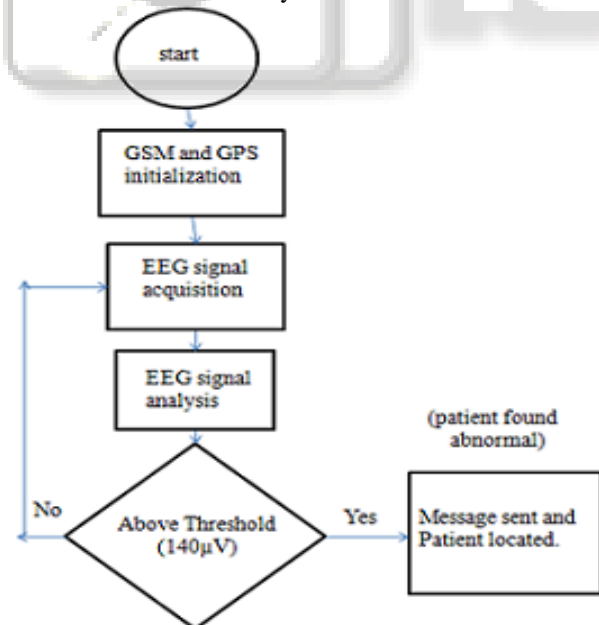


Fig. 3: Flow of Execution

Consequently, the EEG signal from the subject is obtained from sensor and transmitted to the microcontroller via the Bluetooth (during real time). But for the EEG epilepsy data analysis purpose, the recorded data from physiobank database is given as the input to microcontroller. During the occurrence of epilepsy, the spike recorded is compared with the threshold value of the potential for

epilepsy. After determining the abnormality, the state of the patient is known since the system sends the message to care taker along with latitude and longitude GPS values in order to determine exact location of the patient. If found normal, the process continues by acquiring the EEG signal for analysis.

IV. RESULTS

The prototype of the developed hardware is shown in Fig.4.

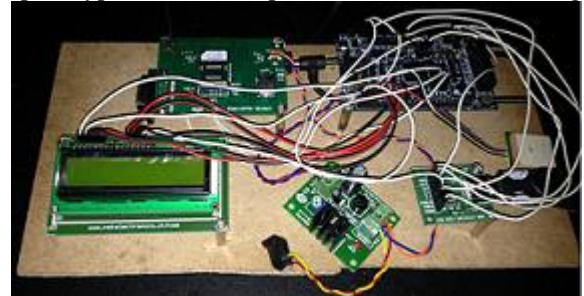


Fig. 4: Hardware Developed

Output of the sensor i.e. the RAW EEG data obtained from the normal subject is shown in Fig.5.

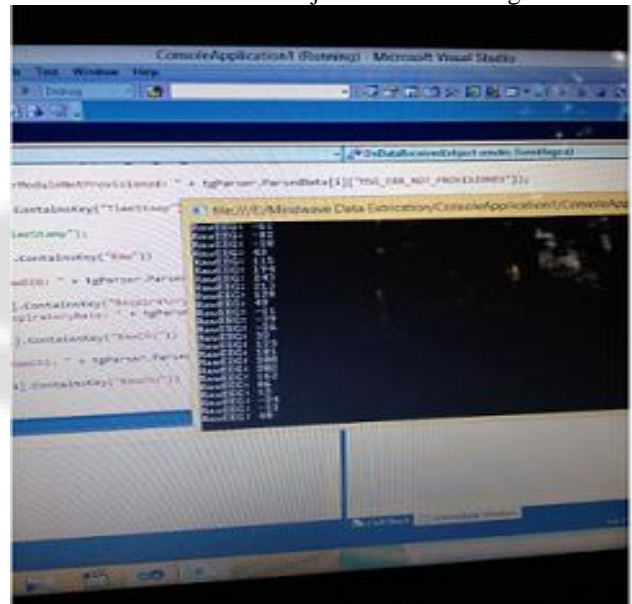


Fig. 5: EEG data from sensor

Fig.6 shows message obtained from the system after determining the person as abnormal.



Fig. 6: Message obtained and GPS values

V. CONCLUSION AND FUTURE WORK

The prototype of the EEG signal acquisition, analysis and alert system is developed and verified for the epilepsy data. Message is received and the location of the patient can be found after determining abnormality.

Entire system developed can be made as wearable device by mounting on a single chip and the EEG data from the sensor can be transmitted to the device using Bluetooth in real time.

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