# EPILEPTIC SEIZURE PREDICTION AND ALERT SYSTEM

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***ABSTRACT—*** *Epilepsy is a neurological disease that is a disorder caused in central nervous system of the brain which is characterized by loss of consciousness, abnormal heart rate, convulsions etc.,. Epileptic seizures are caused due to abnormal electrical discharges in brain. Approximately 50 million people around the world are diagnosed with epilepsy, and old people in the age range 65-70 years old are affected the most. The main objective of this proposed system is to develop the real-time monitoring and alert system to help epilepsy affected persons in their day to day activities in life. The proposed model predicts the epileptic seizures in epileptic patients before it occurs and detect at early stages after its occurrence and provide an alert to the doctors and caretakers regarding the occurrence and severity. Early prediction of epileptic seizures ensures enough time before it actually occurs; it is very useful because the attack can be avoided by the drug. To implement all the above process four modules are used. They are sensors module which consists of heartbeat, GSR and accelerometer sensors, ARDUINO module, GSM module to send an SMS, and GPS module to track the location of the patient.*

***Keywords****— Seizures, 3 axis accelerometer, Epilepsy, GSR.*

## I. INTRODUCTION

Epilepsy is a chronic disorder which is often characterized by unprovoked seizures. The occurrence of seizures are generally related to brain injury or sometimes inherited from their family members, but often the case is unknown. Epileptic seizures involves firing of neurons and also synchronization of neurons and this interrupts the normal working of the brain leading to the medical symptoms and semiology of the specific type of epilepsy. Many people with epilepsy have more than one type of seizures and may have different symptoms of neurological problems as well. The abnormal electrical events that occur in the brain is main cause of occurrence of seizure which may affect any part of the body. There are certain factors such as location where the event of seizure has occurred, how it spreads, how much of the brain is affected and how long it lasts have profound effect on determining the characteristics of seizure occurred.

The proposed system uses the aid of the sensors to continuously monitor the patient health conditions and check for any abnormalities in their system if any abnormalities are sensed by the sensor it is immediately intimated to the doctors and their care takers as a mobile notification along with the location of the patient. This largely helps to save the life of the epileptic patients at the early stages.

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The rest of the paper is organized as follows: The Section 2 discusses related work. Then the Section 3 explains the proposed methodology. The Section 4 includes the details of various hardware modules used. Section 5 deals with experimental results. Section 6 concludes the paper and mentions future work.

## II. LITERATURE REVIEW

Jingbo Yuan, Jisen Zheng, Shunli Ding has developed study of pattern matching algorithm [2]. They have proposed this approach for fast intrusion detection using BM algorithm. Zakareya Laser, Sai Shiva VNR Ayyalasomayajula, and Khaled Elleithy, has proposed an approach on epilepsy seizure detection using EEG signals[1]. They developed a system in which the EEG signals are processed both in time and frequency domains and applied a Chebyschev for pre-processing the signal. Jessica J. Falco-Walter, Ingrid E.Scheffer Robert, S.Fisher, have developed an research on classification of seizures and epilepsy and how these classifications may impact patients, doctors and clinicians[3].

Qi Yuan, Weidong Zhou Liren Zhang, Fan Zhang, Fangzhou Xu, Yan Leng, Dongmei Wei, Meina Chen, has developed an approach based on imbalanced classification existing in seizure detection which is addressed by weights ELM[4]. The WPT is used to decompose EEGs, and obtain time and frequency domain features. Yusuf U Khan, Omar Farooq and Priyanka Sharma extracted two statistical features i.e,. skewness and kurtosis with a wavelet based feature from the data and the classification between normal and seizure EEGs was performed using simple linear classifier[8]. Pallavi Lokhande and Tushar Mote are sending an SMS to doctor and parents as soon as the fits start as well as an SMS when the FIT ends. The main idea of the epilepsy monitoring and analysis system using android platform is to monitor and analyze the Epilepsy attack and also track the progress of patient with in a given period of time[6].

P. Grace Kanamni Prince, Rani Hemamalini and R. Immanuel Rajkumar used accelerometer MPU6050 to acquire the signals from the extremities to detect abnormal movements and sudden fall of the epilepsy seizure patients. The Wavelet transform is used for detecting the changes in movement of the extremity and a thresholding technique is used for seizure detection and fall detection [7]. Shivani Tiwari, Varsha Sharma, Mubarak Mujawar, Yogendra Kumar Mishra, Ajeet Kaushik, and Anujit Ghosal have proposed a system for detecting epileptic seizures by the use of biosensors. The system mainly uses advancements in state-of-art bio-sensing technology for epileptic diseases diagnostics and continuous monitoring or sometimes used for both the purposes. The system approximately uses 4 sensors such as EEG, ECG, EMG, ECoG which continuously monitors the body conditions of the patients thus greatly helps in epilepsy management [9].

IoT platform for monitoring and supervising system was developed by Paula M. Vergara, Enrique De La Cal, Jose R. Villar, Victor M. Gonzalez, and Javier Sedano [11] which mainly focuses on two main types of epilepsy the focal myoclonic and the epileptic absence seizures. The system uses tuned and trained models of previous existing system into the MCC kernel which allows continuous monitoring and providing real time responses through Wi-Fi Networks. Another which was developed by Ahmed I. Sharaf, Mohamad Abu El-Soud, and Ibrahim M. El-Henwy was based on Q-Wavelet and firefly feature selection algorithm [10] the tunability of the Q-factor provides a proficient method to adopt wavelet transformation and the firefly algorithm which is a stochastic search technique.

# III. PROPOSED SYSTEM

The implementation of this project consists of both hardware and software. The hardware section consists of a 3 axis accelerometer, heart beat sensors and GSR sensors. The epilepsy is predicted before its occurrence with a help of heart beat sensor and galvanic skin resistance (GSR) sensor. The detection of occurrence of epilepsy is done with the help of 3 axis accelerometer sensor. The patient is usually spotted with high heart beat rate during or prior the occurrence of epilepsy and experience a high sweat rate which is predicted using GSR sensor. The early detection of epilepsy is taken place through the serial communication of the sensors which continuously checks for the abnormalities in the sensor readings, if there is any abnormalities spotted in the sensor readings it is immediately intimated as mobile notification. It is intimated to the respective doctors and care takers along with the location of the patient using GPS tracking system.

The proposed system also has a software section which is mainly for complete analysis of the patient through tracking the number of occurrences of epilepsy in a patient within a particular period of time and the exact details of the severity of the occurred epilepsy. The software section consists of database of sensor values (GSR, accelerometer and heartbeat) of the patient which is used for analysis of patient's body conditions by providing fine details of the severity of the occurred epilepsy. This is done by finding the percentage change in the sensor data obtained from the patients to the threshold values that are set based on the values during the occurrence of epilepsy from which appropriate medication can be provided. The block diagram of the proposed system is shown in fig 1 and flow chart is given in fig 2.

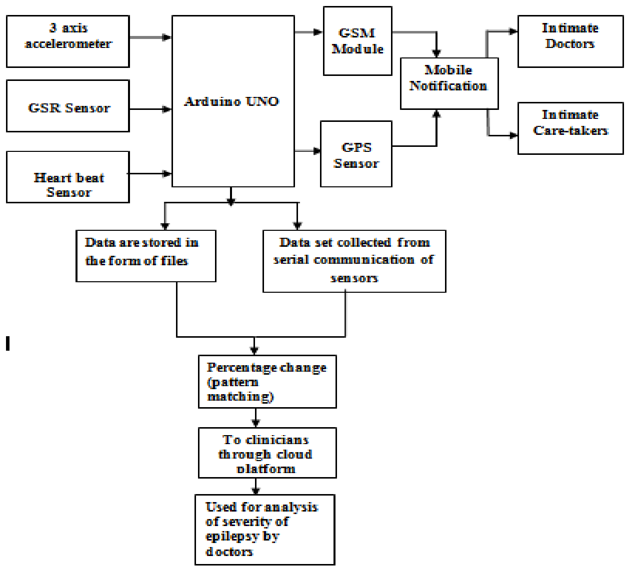


**Figure 1:** Block diagram

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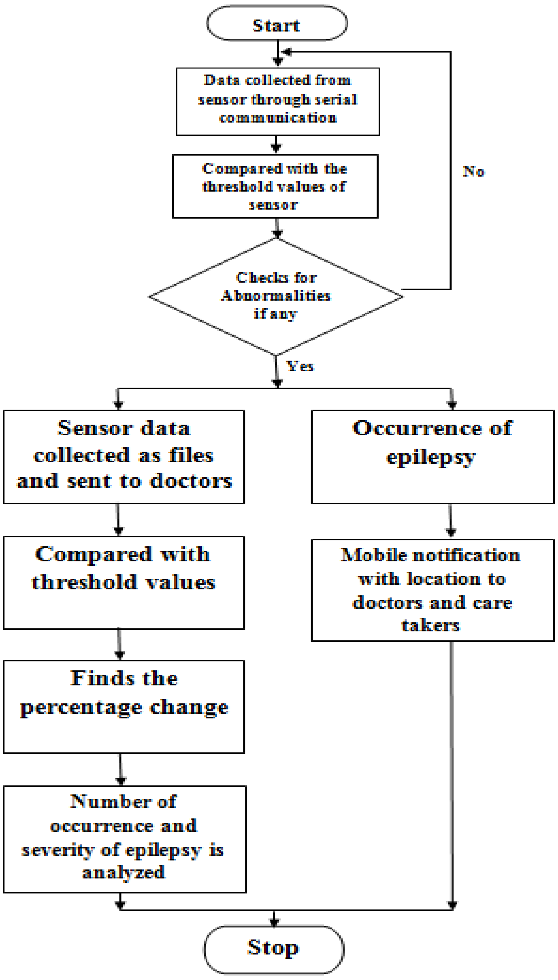


**Figure 2**: Flow chart

The above flow chart, the data from the sensors of the respective patients are used for prediction of occurrence of epilepsy and the data are collected in files for analysis. The data collected from sensor through serial communication and the data is compared with the threshold values of sensor. From the collected data in files is checked for abnormalities. If the abnormalities is found, further the data splitting process is taken place, where the sensor data collected as files are sent to doctors and experiences occurrence of epilepsy. On the other hand, if there is no abnormality found then the process again repeats from the start. Data splitting is done in the areas of abnormalities from the data and the threshold values from the data obtained. Now the data set is checked through the software to look for the percentage change from the threshold values set. Here the Pattern Matching addresses the problem by finding all occurrences of a pattern in a text form. Original data structures are introduced and existing data structures are enhanced to provide more efficient solutions for the problems in pattern matching. The percentage change is the algorithm used in pattern matching. The pattern matching algorithm review is in one and two dimensions. There are 3 data send through serial communication i.e., x, y and z. Both the threshold values and the percentage change occurred from the threshold values are plotted as graph. From the graph obtained the clinicians can clearly understand the number of occurrences of epilepsy and also the

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severity of the occurred epilepsy. Number of occurrence and severity is analyzed. When the epilepsy is occurred, it sends a mobile notification with location to doctors and care takers.

## IV. HARDWARE DESCRIPTION

### *A.3-Axis Accelerometer:*

An accelerometer is a device that measures acceleration. By measuring the amount of acceleration due to gravity on Earth, an accelerometer can figure out the angle it is tilted with respect to the surface. The 3-axis accelerometer sensor will operate between 2.2 - 6 volts. The 3-Axis Accelerometer sensor module comes with a 5-pin headers, a two pin header, and a shunt for G selection. By sensing the amount of dynamic acceleration can find out how fast and in what direction the device is moving. The hardware is shown in the fig.3.


**Figure 3:** 3-**Axis Accelerometer**

### *B. Arduino UNO*

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button. It can be powered by the USB cable or by an external 9-volt battery, through it accepts voltages between 7 and 20 volts. The Arduino Uno is an open-source microcontroller board which is shown in fig4.

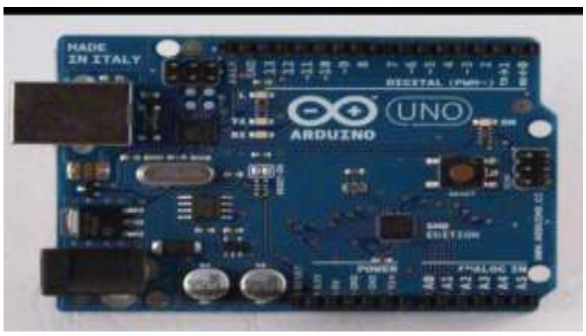


**Figure 4**: ARDUINO UNO

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***C.GSR Sensor:***

A GSR Sensor lets one have the measure of sweat gland activity, which is related to emotional arousal. To measure GSR electrical properties of skin are used. Specifically, how the skin resistance varies with the sweat gland activity, the more perspiration, and thus, less skin resistance. GSR stands for stands for galvanic skin response, is a method of measuring of measuring the electrical conductance of the skin. Strong emotion can cause stimulus to sympathetic nervous system as a result more sweat is being secreted by the sweat glands. Both the positive and negative stimuli can result in an increase in arousal and in an increase in skin conductance respectively. This is shown in fig 5.

**Figure 5:** GSR Sensor

***E. GSM Module:***

A GSM modem is a device which is either a mobile phone or a modem device that can be used to make a computer or any other processor communicate over a network. A GSM modem requires a SIM card to be operated and operates over a network range subscribed by the network operator. GSM (Global System for Mobile)/ GPRS (General Packet Radio Service) TTL-Modem is SIM900 Quad-band GSM/ GPRS device, works on frequencies 850 MHz, 900 MHz, 1800 MHz and 1900 MHz. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with 3V and 5V DC TTL interfacing circuitry, which allows User to directly interface with 5V Microcontrollers(PIC, AVR, Arduino , 8051, etc,.) as well as 3V Microcontrollers (ARM, ARM Cortex , XX, etc,.). The baud rate can be configurable from 9600- 115200 bps through AT (Attenuation) commands. This GSM/GPRS TTL Modem has internal TCP/IP stack to enable User to connect with internet through GPRS feature. It is suitable for SMS as well as DATA transfer application in mobile phone to mobile phone interface. The modem can be interfaced with a Microcontroller using USART (Universal Synchronous Asynchronous Receiver and Transmitter) feature (serial communication). The hardware is shown in fig 6.

**Figure 6:** GSM Module

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***F.GPS Module:***

The Global positioning System (GPS) is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations. GPS uses these as man-made stars as reference points to calculate positions accurate to matter of meters. Global Positioning System (GPS) is a satellite-based system that uses satellites and ground stations to measure and compute its position on Earth. These GPS satellites are used to transmit information signal over radio frequency about the range of 1.1 to 1.5 GHz to the receiver. With the help of the received information, a ground station or GPS module can compute its position and its time. GPS receiver module gives output in standard (National Marine Electronics Association) NMEA format. It provides output serially on transmitter (TX) pin with default 9600 Baud rate.

**VCC:** Power supply ranging from 3.3 - 6Volts

**GND:** Denotes ground

**TX:** Transmits data serially which gives information about location, time etc

**RX:** Receives Data serially and it is required when to configure GPS module.

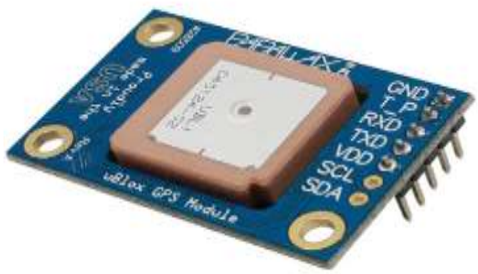


**Figure 7:** GPS Module

***G. Heart beat sensor :***

Heart beat can be measured in different ways. Two of the most common techniques are the electrical and the optical methods. In principle, the optical method measures the heart beat rate by sensing changes in blood flow through the index finger. A plot for this change recorded against time is named as photoplehtysmographic (PPG) waveform. The systolic phase is used to characterize rapid increase in pressure to a peak then carried out by a rapid decline. The opening of the aortic valve and corresponds to the left ventricular ejection in the beginning. There is a dicrotic notch and it represents the closure of the aortic value and also the diastolic phase, which represents the run-off of blood into the peripheral circulation. The non-invasive type of optical heart rate sensor consists of an electronic circuit that monitors heartbeat by clipping onto a finger tip. It does this by shining light into(or through) the finger and measuring how much light is reflected (or absorbed). This goes up and down as blood is pumped through the finger. Since the heart beat of an epileptic patient will be abnormal before few seconds of occurrence of seizure, the sensor is used for predicting the epilepsy.

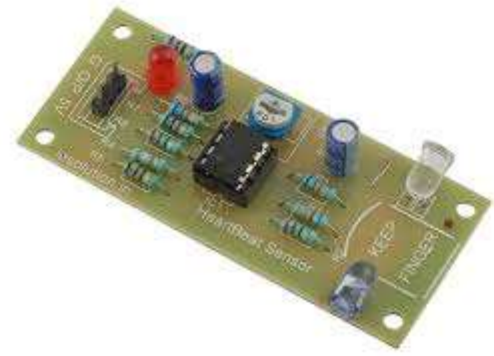

**Figure 8 :** Heart beat Sensor

## V. RESULT AND DISCUSSION

The reading of the sensors are varied for normal and abnormal patients. Table 1 shows the values of sensors during normal condition and during the occurrence of epilepsy. The heart beat sensor having 72 bpm (beats per minute) denotes the person having normal rate of contraction and expansion of the heart. And the epilepsy is sensed when the sensor reading is greater than 100 bpm.

**Table 1:** Value of sensor during normal and abnormal conditions

| **Sensors** | **Normal reading** | **Reading at the time of epilepsy** |
|---|---|---|
| **Heart beat** | 72 bpm | >100 bpm |
| **GSR** | 27 k ohms | >5 k ohms |
| **3 axis accelerometer** | The graph is not produced for normal (stable) readings. | The simulation graph is obtained during the occurrence of epilepsy. |

For GSR sensor the normal rate is 27 k ohms where as for the time of epilepsy it is greater than 5 k ohms at recurrence. The 3-axis accelerometer determines the moment of impact, the x, y and z axis denotes the forward, vertical and sideways fall respectively. As GSR value is greater than 25 k ohms (kilo ohm or 10^3 ohm) this will indicate low arousal that means brain is in calm state and if greater than 5 k ohms then this will indicate high

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level. In the 3-axis accelerometer, all the raw data is collected and with the help of percentage change the graph is produced in the occurrence of epilepsy. In the idle state or normal (stable) condition the graph is not produced.

The data from the sensor is received by Arduino through serial communication. The sensor data in Arduino are saved in the form of files. The following results (fig .9) show the sensor data, where the five different number, x-axis, y-axis and GSR. All the data is collected and with the help of percentage change when there is an occurrence of epilepsy the graph is produced.

```
20130501000001,2330,5332,-4750,28
20130501000001,2060,5208,-5816,24
20130501000001,2406,9480,-7924,24
20130501000001,2834,5790,-6610,23
20130501000001,772,1780,-7690,27
20130501000001,-2156,-874,-6810,2
20130501000001,4004,7556,2060,6
20130501000001,-4032,-1180,-7268,-15
20130501000001,970,3946,-3136,-6
20130501000001,8518,14914,-2148,16
20130501000001,-1028,-1212,-11058,30
20130501000001,-2584,0,-7550,29
20130501000001,5292,12978,1214,43
20130501000001,2628,7582,-5652,26
20130501000001,-2608,112,-7572,25
20130501000001,-2594,236,-7544,22
20130501000001,-2678,48,-7448,26
20130501000001,-2584,0,-7550,29
20130501000001,-2666,104,-7578,35
20130501000001,-1732,-1738,-7582,-4
20130501000001,-2124,2422,-7342,-121
20130501000001,-1350,1378,-6734,24
20130501000001,1044,7720,-3448,24
20130501000001,-1704,4,-7680,32
```

**Figure 9:** Serial communication occurring in sensor (normal and abnormal state)

The above serial communication data obtained from sensor changes with the changes in the patient from normal (stable) state to abnormal (unstable) state. The fig 9 (a) shows the serial data of patient, the first five readings shows the normal condition of the patient which is followed by the abrupt readings which indicates the occurrence of epilepsy. The fig 9(b) denotes the occurrence of epilepsy with the variation in serial data. The change of state of abnormality to normal condition is shown. From the data set collected it is clear that the occurrence of epilepsy can be seen by the abrupt change in the sensor values.

The data is compared with threshold values. If the received value exceeds the threshold value, then it is assumed that there is chances of occurrence of epilepsy or the patient is suffering from epilepsy. So immediate intimation is sent to the care takers and doctors through GSM. The result of embedded C program gives the link of the location along with the Latitude and Longitude as notification to the care takers. The Encoded data is read from GPS while data is available on serial port, it is used to parse the string received by the GPS and store it in a buffer to extract the information. The message notification is shown in fig.10 to find the location of the patient which is given with longitude and latitude.


**Figure 10:** Notification with location of patient

On clicking the above link, the location of the patient for the Doctors and care takers is shown as in fig11. This is used to know the position of the epileptic patient and reach them out and help them with appropriate medication. The location is shown as map in fig 11. The red pin denotes the exact area of the patient.

Severity of the occurred epilepsy is found by comparison of the sensor data with the stored data set of the sensor reading that is generally noted during a seizure with help of pattern matching algorithms. The main purpose of the this comparison is by setting the severity level minimum from the sensor data set obtained from the patient, total number of occurred epilepsy and the severity of them can be clearly understood through analyzing the percentage change of the sensor values from the threshold values. In fig 12, the blue plot represents the threshold value set and the red line indicates the sensors values collected from the patient.


**Figure11: Location of the patient**

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The occurrence of epilepsy is equal to the number of times the graph occurs. The similar graphs can be taken individually from any affected person by acquiring their individual sensor data by applying the same method. The threshold level of severity can be adjusted i.e,. increased or decreased according to the clinicians aspect. For example, the severity level is set as 30 which is set to find even the basic seizure occurring. Similarly the severity level can be further increased i.e,. 90 to analyze the major seizure occurring. The blue plot represents the threshold value and when it is compared with the sensor values with the help of percentage change the similar variations are detected and graph is obtained. In the fig 12, the graph represents the pattern recognition through percentage change for analysis purpose is shown where the x-axis is the number of counts and y-axis is the percentage change in sensor data.

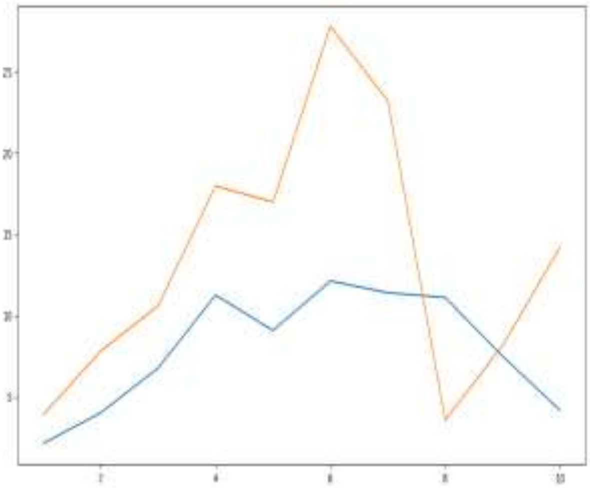

**Figure 12:** Pattern recognition through percentage change for analysis purposes.

## VI. CONCLUSION

In the modern era of science and technology, epileptic seizure prediction and alert system is very useful for the life of Epileptic patients. The pattern matching algorithm which uses predetermined dataset for prediction process is less tedious. The percentage changes that occurs in the dataset collected is the main source of analysis which will greatly guide the clinicians to provide appropriate medications and occurrence of epilepsy is also send through the mobile notification before and after the occurrence within few seconds which help to save the life of the patient. It also has a feature of updating system along with the location of the patient. This can be embedded into a wearable device which makes the life of epileptic patients less intricate. Thus an efficient detection and alert system for occurrence of epilepsy and an efficient methodology for analyzing the health conditions of epileptic patients have been designed.

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