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Realtime Epileptic Seizures Detection and Alert System Using NI Lab-View

M. Anil kumar[1], S. Kishore[2], N. Karthik[3], K. Chandra sekhar[4], Shaik Shafi[5] ,M.C.Chinnaiah[6]

Students[1, 2, 3, 4,] ECE, B.V.Raju institute of technology, Medak, Telangana, India.
Faculty[5, 6] ,ECE, B.V.Raju institute of technology, Medak, Telangana, India.

Abstract- For people who have been are suffering from epileptic seizures, a real time system is developed which is helpful in detecting such cases, is Smart epilepsy detection and alert system is an advanced technology by which we have developed a electronic gadget. Using that kit we can save the life of the person who is really effecting with the condition. It will do the help in both the ways means not only checks the condition but also sends an SMS to the concerned doctor for the patient's live saving sake. To implement all the above process we have used mainly four modules micro controller KEIL module, ARDUINO module, GSM module to send an SMS, and LABVIEW.

Index Terms- GSM, ARDUINO, Lab-View.

I. Introduction

The main aim of the project is to provide a electronic gadget for the epilepsy patients to protect themselves from the ***seizures*** and heart attacks. Not only will that it also intimate the respective doctors about the patient's condition. The electronic system presented here is a wearable device which predicts the occurrence of epilepsy in a few minutes advance. The device utilizes the signals from human body to detect the occurrence of epilepsy. As soon as the device detects the symptoms, it transmits a coded signal. The signal is decoded by a wireless receiver to produce control signals for switching an alarm device, mobile messaging device and an automatic vehicle control system appropriately. In future, GPS could be incorporated to trace out the exact location of the patient.

II. Literature Survey

Current technologies for acquiring signals from the patient's body are very much developed. Many sensors are available which can detect the heart beat and muscular movements non-invasively and accurately. Such non invasive technique for measuring heart beat is pulse oxymetry. Using this technique, heart beat can be accurately monitored. Muscular convulsions are collected using micro electromechanical sensors (MEMS) firmly attached to the body. The sensors used are small in size and can be firmly attached to the body. The accelerations resulting from epileptic convulsions are sensed using MEMS accelerometer which is very accurate, precise and small in size.

To provide wireless communication channel low cost network using MiWi protocol is utilized. MiWi is a standard protocol developed by Microchip Inc, USA, based on IEEE 802.15.4. Heart beats are to be monitored continuously. Any sudden variation in heart beat which is caused by the onset of epileptic seizures is detected and confirmed with the MEMS signal. When the seizure is confirmed, message is transmitted to the surroundings for initiating necessary protective measures for the patient.

The device is designed as wireless, wearable and personal equipment. The device can sense the aura of parietal stage in a few minutes advance and takes the necessary safety measures automatically. Hence a technician's assistance is not required for the patient. Therefore this device will be extremely useful for patients (especially youngsters) who wish to be active in their life. The user gets absolute freedom from wires and can be used when moving. To practically implements the epilepsy prediction system, the following aspects should be implemented. Sensing biometric signals: Two types of biological signals are required fo processing. They are heart beat and muscular convulsions. The heart beat can be measured using pulse oxy meter and muscular movements can be measured using mems sensor. Processing it and taking decisions: Processing of the signals is done by software programmed into a microcontroller. The software is designed in such a way that it detects the exact symptom of epilepsy.

III. Proposed System Design

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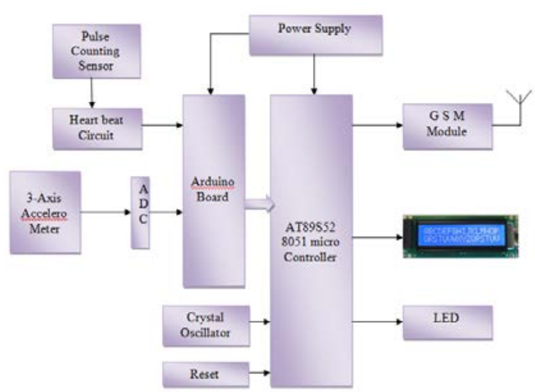

Fig.1: Block Diagram of smart epilepsy detection and alert system

The design consists of hardware and software sections. The device hardware mainly consist of three parts namely, (i) Heart beat sensor, (ii) Seizure detector, (iii) Processor and (iv) Wireless transceiver

(i) Heart beat sensor: The heart beat of the patient is to be monitored accurately. For this purpose, a pulse oxy meter is used. Pulse oxy meter measures heart beat by sensing the difference in absorbance of infrared radiation by blood during systolic and diastolic activities of heart. The volume of blood flowing through arteries varies widely during each heart beat. Hence if infrared radiation is incident on it, the absorbance of IR also varies according to the heart beat. These variations are sensed using a photo detector to determine the heart beat.

The pulse oxy meter designed here works using reflective principle. The IR source emits IR radiation which is reflected in accordance with the flow of blood. The reflected rays are detected using a photo detector. A sensor is placed on a thin part of the patient's anatomy, usually a fingertip or earlobe, and light of infrared wavelength is made incident on the body. Changing absorbance of the infrared is measured, allowing determination of the absorbance's due to the pulsing arterial blood alone, excluding venous blood, skin, bone, muscle, fat, and (in most cases) fingernail polish. The circuit of pulse oxy meter consists of a trans-resistance amplifier, voltage follower, difference amplifier, and filter. All these stages are cascaded together to from the complete circuit of pulse oxy meter. The circuit works in 5 V supply. In order to get perfect amplification sans noise, ultra low offset operational amplifier

OP07 and FET input operational amplifier LF 356N is selected.

A trans resistance amplifier is used in the first stage to convert the photodiode current to voltage. The major design parameter of this sensor is its output voltage and the output frequency. The output frequency is band limited to 15 Hz using filters. Low pass first order butterworth filter is used. Low pass filter is designed at 15 Hz upper cut off frequency with a gain of 1.5. A high pass first order butter worth filter with lower cut off frequency of 0.5 Hz is cascaded with the low pass to remove the dc voltage. An amplifier is set at the output of the meter in order to raise the output signal level to +5V (approx). Amplifier with amplification factor of 50 is designed. Typical output of the sensor is shown on the graph below. Normal heart beat is 72 beats per minute. That is the frequency of the signal is 1.2 Hz for a healthy person. The output amplitude varies from 70mV to 120mV

(ii) Seizure detector: Seizures are involuntary muscular movements which occur during epilepsy. Muscular movements are sensed using MEMS (micro electro mechanical sensor) accelerometer. A 3D accelerometer is used to sense the muscular movements. The ADXL330 is a low cost, low power, complete 3-axis accelerometer with signal conditioned voltage outputs, which is all on a single monolithic IC. The ADXL330 is a complete acceleration measurement system on a single monolithic IC. The ADXL330 has a measurement range of ±5 *g*. The sensor is a polysilicon surface-micro machined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor that consists of independent fixed plates and plates attached to the moving mass. The fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the beam and unbalances the differential capacitor, resulting in an output square wave whose amplitude is proportional to acceleration. Phase-sensitive demodulation techniques are then used to rectify the signal and determine the direction of the acceleration.

(iii)Processor: The signals from sensors are processed using PIC18F4620 microcontroller. The microcontroller requires a 10 bit ADC and a comparator circuit for processing the signals from the sensor. PIC 18F 4620 includes built in ADC and comparator. The processor is clocked at 4MHz. The frequency of normal heart beat rate is 1.2 HZ. Approximately. Or the time period of the heart beat signal is 0.83 secs. The algorithm detects the sudden decrease in pulse width which is one of the aura of epilepsy. As soon as the variations in the heart beat are detected, the algorithm checks for the typical seizure waveform from the mems sensor. When these two signals coincide, the software takes the decision as an epileptic seizure and generates control signals.

(iv) GSM Module:

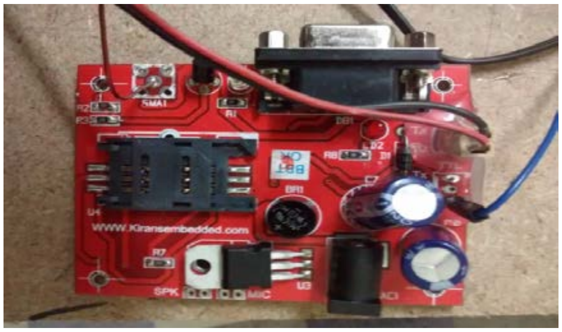

Fig.2: GSM Module

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 3V3 and 5V DC TTL interfacing circuitry, which allows User to directly interface with 5V Microcontrollers (PIC, AVR, Arduino, 8051, etc.) as well as 3V3 Microcontrollers (ARM, ARM Cortex XX, etc.). The baud rate can be configurable from 9600- 115200 bps through AT (Attention) 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).

IV. Design Implementation

The processing unit utilizes the logic implemented in the software for accurate detection of seizures. The software checks the input signal from the pulse oxy meter from the patient's body continuously and measures the pulse width of the signal. This width is converted into heartbeat rate by the software. If there is any abnormalities in heart beat, it can be detected as a change in the pulse width .As soon as the logic detects a change it triggers the vibrator and the system waits for the response. The patient has to press a button on his wearable unit. If the patient is unable to do so due to occurrence of seizure, then response signal from MEMS sensor which senses the muscular convulsions is captured and analyzed. If there are signals of muscular convulsions the software concludes that the patient has seizure and warning message is transmitted using the wireless transmitter. The seizure detection algorithm from the MEMS signals is to check only the sudden abnormality occurring in the human body. This algorithm helps to avoid situations where heart beat rises due to excessive physical work or due to tension etc. The algorithm uses the averaging technique to determine abnormalities accurately. P=(P+N)/2 where p=previous heart beat rate N=next heart beat rate. For a person suffering from epilepsy, in the pre ictal stage the heart beat varies abruptly and hence the value of P also changes. This change in the value of P is detected and the program is made to wait for the signal from the second sensor which senses the muscular convulsions. If muscular convulsions are detected from the second sensor, it triggers the transmitter on which transmits a coded signal which is received by the receiver. The software section contains the following major functional modules:

1. Heart beat rate calculations
2. Seizure detection from MEMS signal
3. Communication control
4. Overall supervision

The system requires a heart beat sensor, muscular convulsion Sensor, a transmitter, receiver, mobile messaging device, alarm device and automatic vehicle control system. All the above said parts are integrated together to a processor to form the device. The epilepsy prediction system can be practically implemented by incorporating the following components

a) Heart beat sensor: A pulse oxy meter is used as a heart beat sensor.

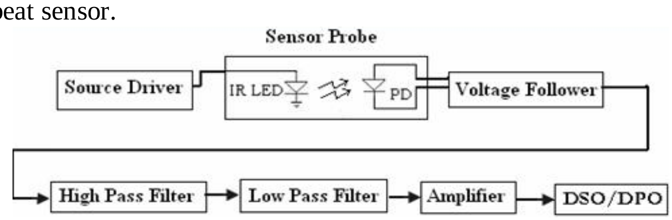

Fig. 3: Block schematic of pulse-oxy meter

The implementation of pulse oxy meter is by cascading several stages as shown in the figure 4. A high pass filter is designed with lower cutoff frequency of 15 Hz. .the high pass filter is cascaded with a low pass filter designed to an upper cut off frequency of 0.5 Hz. The amplifier at the final stage raises the voltage from mV level to the required voltage range. An amplification factor of 50 is given to it.

b) Convulsions sensor: An accelerometer is used as a convulsion sensor.Muscular convulsions are detected using single axis mems ICMMA1260EG. The sensitivity of the sensor is set to 1.55g. The circuit is implemented as shown in the circuit diagram. The output of the sensor is filtered out sing a low pass RC filter externally. The value of R is selected as 1KΩ and C as 0.1μf.

c) Processing unit: The processing unit contains PIC 18F4620 microcontroller which is clocked at 40 MHz.. PIC18F4620 have 64 Kbytes of Flash memory. The microcontroller has inbuilt 10 bit ADC which is used to digitize the output from MEMS module. It also includes a comparator which is used to process the heart beat waveforms from the pulse oxy meter. The incoming signal is processed using logics implemented in the software which runs the device. The processing unit continuously checks for symptoms in the incoming signal. As soon as it detects any abnormality, it triggers a warning vibrator and the wireless transmitter.

d) GSM module

Using the GSM module in the kit to send an SMS to the guardian and the doctor who will take care of the patient in the hospitals. GSM module code we have dumped in the 8051 micro controller using the KEIL software.

e) Enclosure design

The device is a wearable one (on the wrist). Hence the enclosure is designed suiting to that purpose. The enclosure can be designed in the form of a watch.

V. TESTING

Fig.4: Pulse Oxy meter and its principle of operation

(i) Testing of Pulse oxy meter: The pulse oxy meter was tested by wounding the probe of the device on the index finger of a person and the output were viewed on a DSO. The output is shown in the graph given below. The pulse oxy meter successfully detected the heart beat waveform from the patient's index finger. The out put frequency was 1.2 Hz . And the voltage level was in the range of 100 to 120 mV.

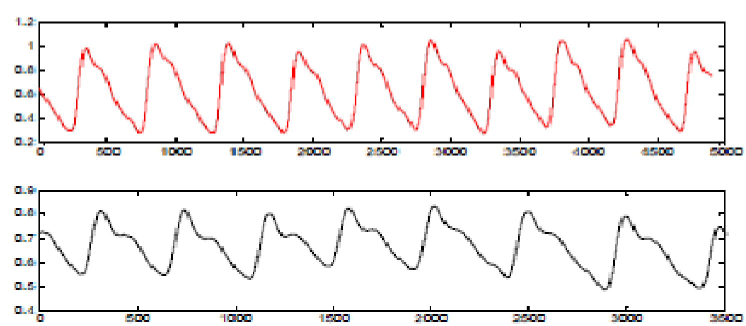

Fig.5: Output graphical wave form from pulse oxy meter

(ii) Testing of MEMS sensor:

The MEMS sensor is connected to the body of the patient using straps. Typical epileptic seizure waveform is shown in the figure below. The sensor output is expected to be of the shape as shown below. This stage is not yet fully tested and testing is under way.

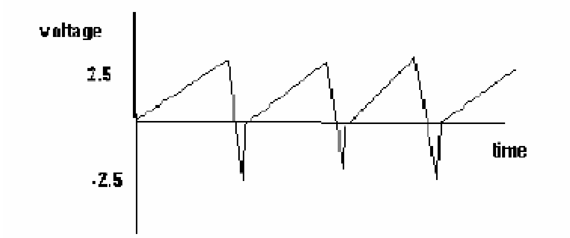

Fig. 6: Typical signal from the MEMS sensor during seizure

(iii)Testing of software:

The inputs from the sensors were provided to the PIC controller in which the software was programmed. Wave forms describing different conditions of the patient were given as input and tested successfully.

(iv)Testing of communication module

The transceiver is directly connected to the microcontroller in which the software was programmed. As soon as the software detected the epileptic symptom, the transmitter was triggered. Using Zena network analyzer, the network was detected at a frequency of 2.4G Hz. A peer to peer single node network was formed which transmitted the message to the receiver node. The system designed here processes the heart beat continuously and abnormalities are detected accurately. The device transmits the signal only when seizures of epilepsy are detected. The performance of the device is not restricted by movement of the patient. By using this device the patient can move freely without worries

VI. LABVIEW

We have used NI labview to interconnect the sensors and as the input output lines through the Arduino board.Lab view is a software we are using this through the laptop to show the results like the condition of the patient at the time of getting effected with the suizers and heart attacks. And to run the process when the person encountered the situation then we can observe the condition through the MEMS and ECG screens provided on the screen of the laptop in the labview module.

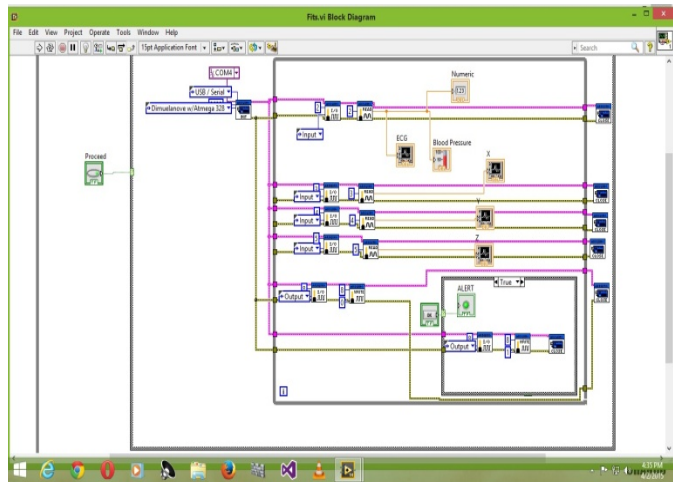

Fig.7: Lab VIEW circuit diagram

VII. RESULTS

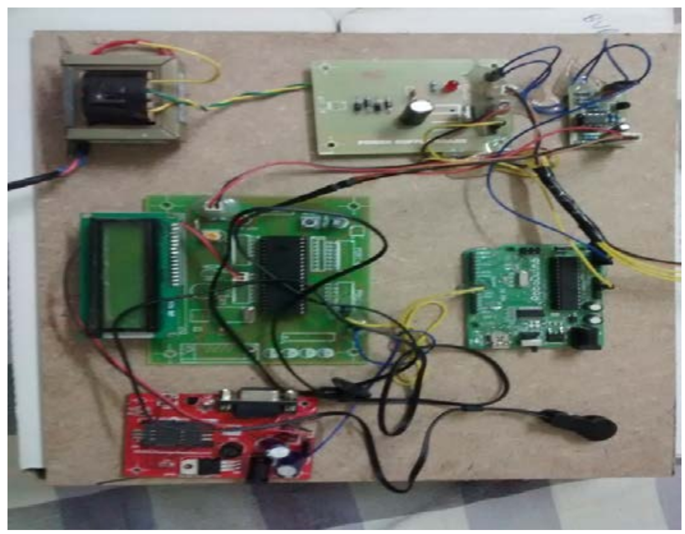

Fig.8: Epilepsy kit with the arduino and gsm module

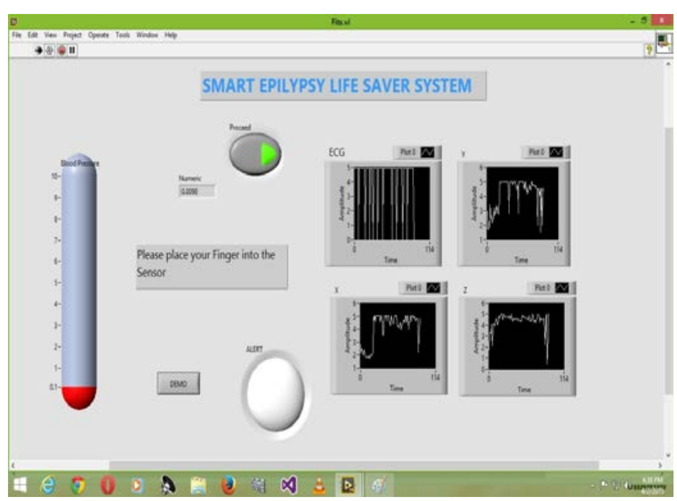

Fig.9: Lab view results

VIII. Conclusion

A light weight, rugged, cost-effective wearable device is developed which helps millions of victims of epilepsy around the globe. With the device in possession an epilepsy victim can move around freely like normal people sans worries. The system is easily expandable to incorporate GPS systemand to capture and transmit various patient parameters likeECG, body temperature etc.We can further extend the project when the patient in driving in the traffic placess then we can include the GPS system to trace the exact location of the patient and take the necessery action

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Authors

First Author – M. Anil kumar, Student, ECE, B.V.Raju institute of technology, Medak, Telangana, India.
Second Author – S. Kishore, Student, ECE, B.V.Raju institute of technology, Medak, Telangana, India.
Third Author – N. Karthik, Student, ECE, B.V.Raju institute of technology, Medak, Telangana, India.
Fourth Author – K. Chandra sekhar, Student, ECE, B.V.Raju institute of technology, Medak, Telangana, India.
Fifth Author – Shaik Shafi, Faculty, ECE, B.V.Raju institute of technology, Medak, Telangana, India.
Sixth Author – M.C.Chinnaiah, Faculty, ECE, B.V.Raju institute of technology, Medak, Telangana, India.