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A Wearable Device for Continuous Detection and Screening of Epilepsy during Daily Life

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Abstract- Epilepsy is a very fatal condition which is caused as a result of imbalance in the nervous system. The very common symptoms of epilepsy includes sudden fluctuations in heart beat rate and involuntary muscular movements (seizures). The aura (practical symptom) of epilepsy includes fluctuations in heartbeat, nausea, dizziness etc. The wireless electronic diagnosing system proposed here is exclusively meant for epilepsy patients. The system helps them in accurately predicting the occurrence of seizures. Sudden occurrence of seizures during driving may lead to accidents and its occurrence during sleeping hours can even lead to the patient's death, if no immediate, proper attention is provided by a bystander or a doctor. With the aid of this system, the patient can lead a normal life. Since the occurrence of seizures is unpredictable, it will be a very risky task to leave the patient alone. The electronic system proposed 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 to produce control signals for switching an alarm device, doctor or relatives mobile phone using wireless communication with help of GSM modem and GPS is used to trace out the exact location of the patient.

Keywords: - Epilepsy, Heart beat sensor, Accelerometer convolution, Microcontroller, GSM, GPS

I. INTRODUCTION

For Acquiring signals form the patient`s body are very much developed by current technologies. Many sensors are available which can detect the heart beat and muscular movements non-invasively and accurately.

Such noninvasive technique for measuring heart beat by using heart beat sensor. Muscular convolutions 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 convolutions are sensed using MEMS accelerometer which is very accurate, precise and small in size.

Heart beats are to be monitored continuously. Any sudden variation in heart which is caused by the onset of epileptic seizures is detected and confirmed with MEMS signal. When the seizures is confirmed, message is transmitted to the surroundings for initiating necessary protective measures for the patient.

The device is designed as a wireless, wearable and personal equipment. The device can sense the aura of pre ictal 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.

II. DESIGN OF THE SYSTEM

The block diagram of the epilepsy system is shown in the below fig1.The two types of biological signals are used for processing. They are heart beat senor and muscular convolution. The heart beat can be measured by using heart beat senor and muscular movement using accelerometer sensor. Processing of the signal is done by software programmed into a microcontroller. The software is designed in such a way that it detects the exact symptom of epilepsy. Communication is the setup using the transmitter and receiver module. Mobile messaging device such as GSM, an alarm device and a GPS device is integrated to the receiver for the protecting the patient.

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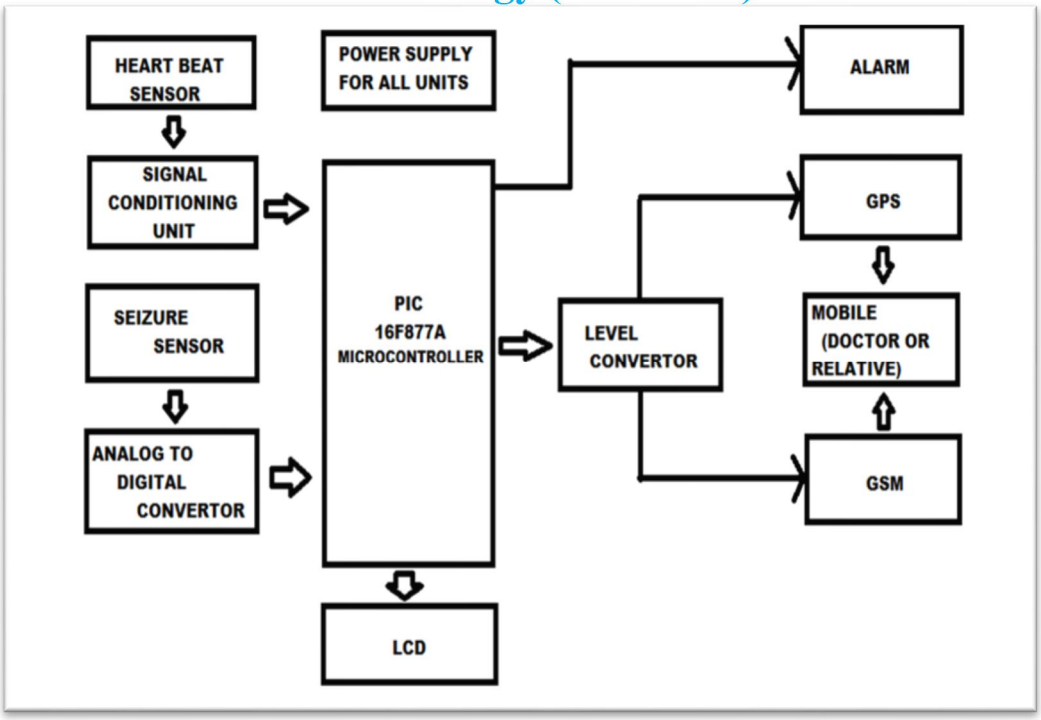


Fig 1:- Block diagram of epilepsy detection system

III. WORKING OF THE SYSTEM

The working of this system focus on epilepsy patients who wish to move freely without the assistance of others in their life. The design consists of the hardware implementation. It comprises of detailed information about the set of design specifications. The hardware design consists of the selection of system components as per the requirement, the details of the subsystem that are required for the complete implementation of the system. In the later stage design of the circuit and its testing has been carried. It involves the component selection, components description and hardware detail of the system design.
The device hardware mainly consist of

A. Biomedical Parameter

The measurement of biomedical parameters is a vital process. These parameters determine the overall condition of the patient. It plays a significant role in identification of epilepsy that has to be prevent the patient early. The parameters are as follows:-

1) *Heart beat Sensor:* Here we are using 2 IR sensors for detecting the heart beat. Plethysmograph is an infrared photoelectric sensor used to record changes in pulsatile blood flow from the finger. Pulse wave amplitude (PWM) is the most frequently used parameter obtained by finger plethysmography.

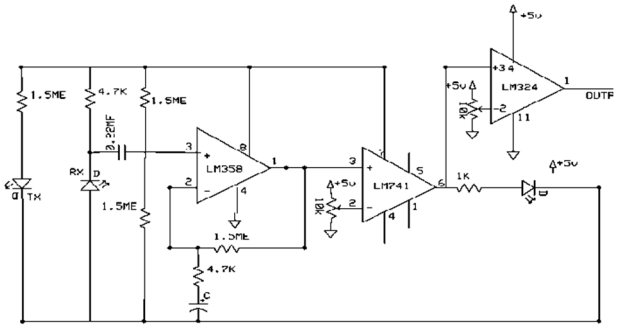


Fig 2:-Circuit diagram of heart beat sensor

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The signal conditioning circuit consist of 2 stage operational amplifier such as shown in fig 2. The LM741 is act as the comparator and the Opamp LM358 act as both comparator and amplifier. The LM324 act as the comparator to get the exact output. Potentiometer with value of 10k to set the reference voltage upto 2.3v. The gain of the 1st stage is 100 and the total gain is 10000. The pulse is taken for 10sec multiplied by 6 to get actual beats per minute (BPM).

2) *Accelerometer Sensor:* This sensor buffers a piezoelectric transducer. As the transducer is displace from the mechanical neutral axis, bending create strain within the piezoelectric element and generates voltages. It works on electromechanical principle. Vibration velocity sensors operate in accordance with the electrodynamics principles and are used for measuring the bearing absolute vibration based on piezoelectric effect. Change in resistance due to the force acting on it and convert it into 4 – 20 mA. This sensor works on 12v.It gives digital high (5V) output whenever vibration is detected.

B. Processing unit

1) *Microcontroller:* The signals from sensors are processed using PIC16F877A microcontroller. The operating speed of the microcontroller is DC- 20MHz clock input and DC- 200 ns instruction cycle. It requires a 10 bit multichannel Analog to Digital convertor circuit with 8 bit channel for processing the signals from the sensor. The ADC module has the 33 I/O pin and it divide as 5 ports (A,B,C,D,E). The A port has 6 pins and the B,C,D port has 8 pins each and E port has 3 pins. The universal synchronous Asynchronous receiver transmitter (USART) with 9 bit address detection. The synchronous serial port is a serial interface, useful for communicating with other peripheral devices. The module can operate such as serial peripheral interface (SPI) with 4 wire communication and Inter-integrated circuit (I2C) with 2 wire communication. The parallel slave port for the LCD communication. The 2 controlled register used to control the I/O port. 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.
2) *MPLAB Idle:* MPLAB is free integrated environment for the development of embedded application on PIC microcontroller and it is developed by microchip technology. MPLAB support coding, debugging and programming of microchip, 16 bit microcontrollers.
3) *Level convertor:* In this circuit the MAX 232 IC used as level logic convertor. The MAX 232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA 232 voltage level from a single 5v supply. Each receiver converts EIA 232 to 5v TTL/CMOS levels.

The 4 resisters a connected to the MAX 232 where 2 acts as the voltage shifter and 2 acts as the voltage doubler. The doubler are based on atencial command work.

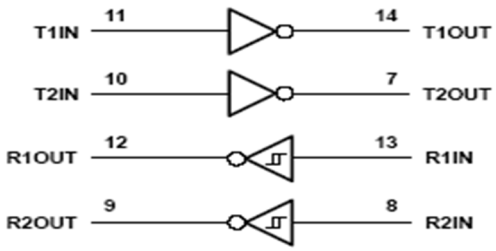


Fig 3:- logic level

In this circuit the microcontroller transmitter pin is connected in the MAX232 T2IN pin which converts input 5v TTL/CMOS level to RS232 level. Then T2OUT pin is connected to receiver pin of 9 pin D type serial connector. In the transmitting data is given to R2IN of MAX232 through transmitting pin of 9 pin D type connector which converts the RS232 level to 5v TTL/CMOS level. The R2OUT pin is connected to receiver pin of the microcontroller. Likewise the data is transmitted and received between the microcontroller and other devices or PC vice versa.

C. Alerting unit.

1) *LCD Display:* LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reason being: LCDs are economical; easily programmable;

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having no limitations of displaying special & even custom characters, animations and so on.

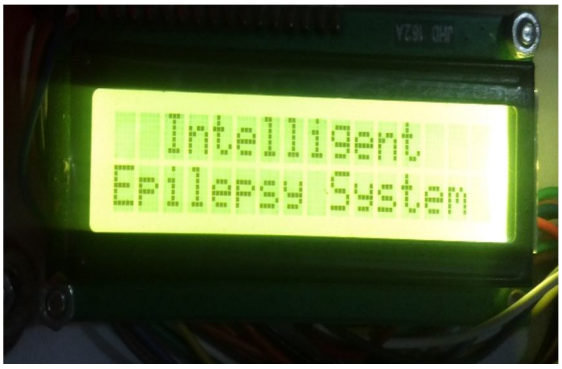


Fig 4:- LCD display

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD, each character is displayed in 5x7 pixel matrix. This LCD has 2 registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to the LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

2) *GSM Modem:* A GSM (Global System for Mobile communication) modem exposes on interface that allows applications such as SMS to send and receive messages over the modem interface.

To perform these tasks, a GSM modem must support an "extended AT command set" for sending/receiving SMS messages, as defined in the ETSI GSM 07.05 and 3GPP TS 27.005 specifications. The number of SMS messages that can be processed by GSM modem per minute is very low, only about six to ten SMS message per minute. In our project, we are set the physician and the relative number in the GSM modem to receive the message. While the occurrence of seizures in the patient.

3) *GPS:* A GPS (Global Positioning System) receiver calculates its position by precisely timing the signals sent by GPS satellites high above the earth. Each satellite continually transmits messages that include
   a) *The time the message was transmitted*
   b) *Precise orbital information*
   c) *The general system health and rough orbits of all GPS satellites*

The receiver utilizes the messages it receives to determine the transit time of each message and compute the distance to each satellite. These distances along with the satellite locations are used with the possible aid of trilateration, depending on which algorithm is used, to compute the position of the receiver. This position is then displayed, perhaps with a moving map display or latitude and longitude; elevation information may be included.

IV. RESULT

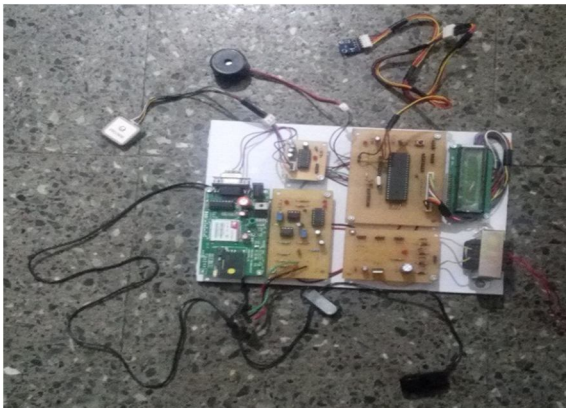


Fig 5:- Epilepsy system

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Fig 5 shows the hardware design of the Epilepsy prediction system. It consist of step-down transformer with power supply unit. The heart beat sensor and accelerometer are connected with the microcontroller. The coded signal from the microcontroller displays the patient condition in the LCD display. The level convertor will convert the signal to TTL/CMOS logic.

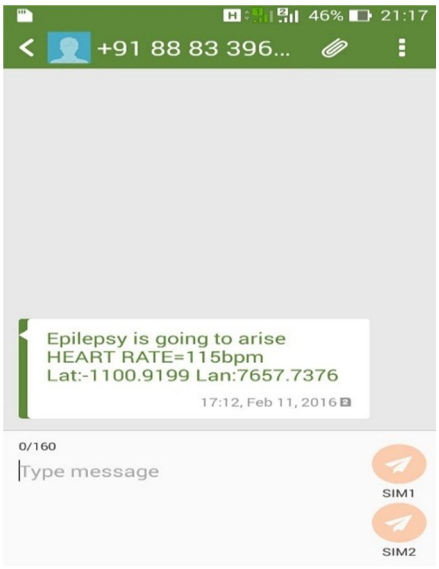


Fig 6:- SMS Received

The GSM Modem send the information of the patient condition through the SMS for physician or relative. Fig 6 shows the output of the hardware system from the GSM modem to the mobile.

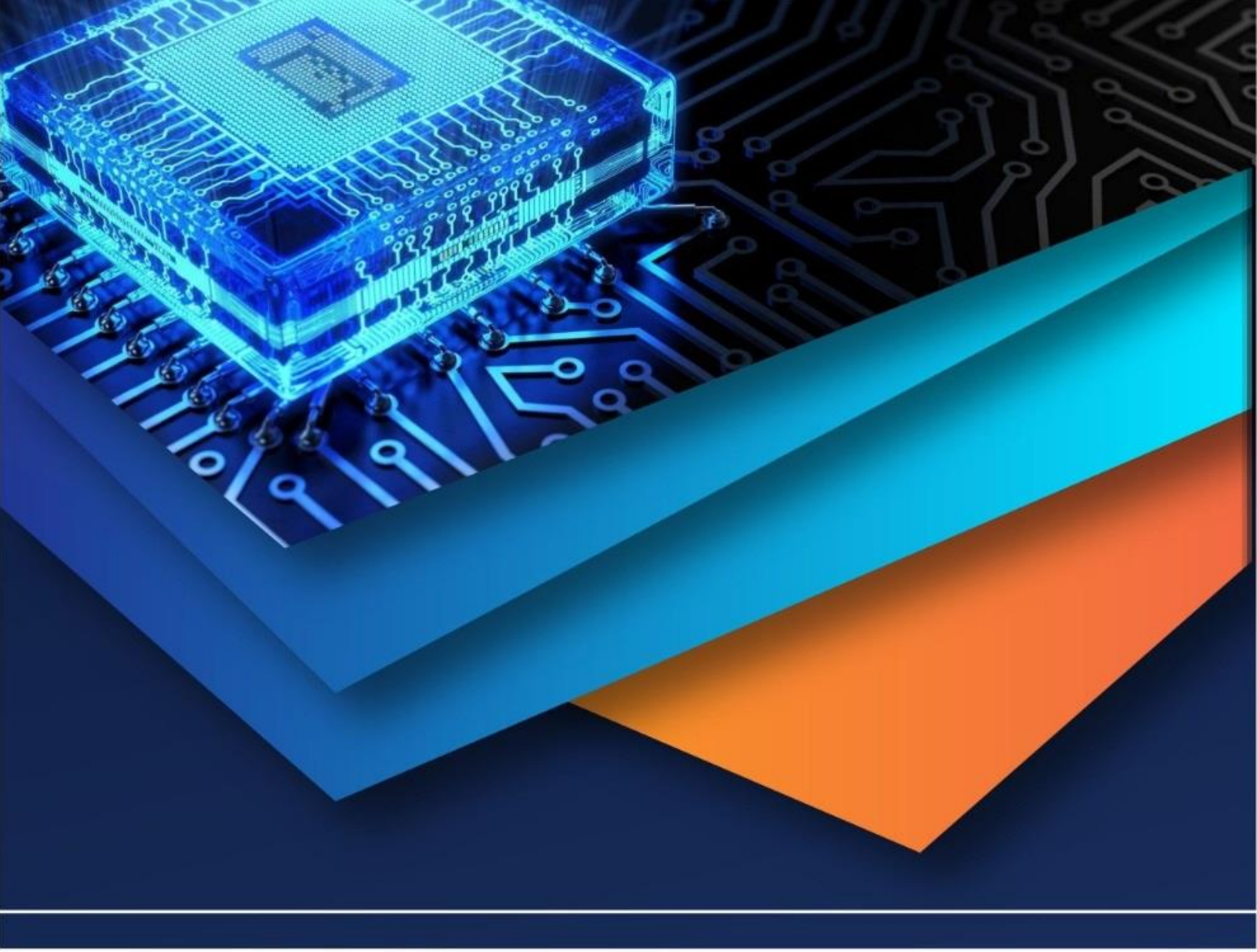
V. CONCULSION

Nowadays, Modern technologies have developed automation. A rugged, cost effective wearable is developed which helps millions of victims of epilepsy. With the device in possession an epilepsy victim can move around freely like normal people. Prevention is better than protection and our project on epilepsy prediction is one of the efficient preventing systems.

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