IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 09, Issue 5 (May. 2019), ||S (II) || PP 14-19

Portable Health Monitoring System with GPS, GSM and Emergency Switch

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Abstract: Now a day human health problem is one of the serious things in our day to day life. Generally in critical case patients are supposed to be monitored continuously for their Heart Rate, ECG, blood sugar and oxygen level as well as body temperature with the help of biosensors. The fixed monitoring system can be used only when the patient is on the bed and this system is only available in hospitals. Many times patients need to be constant or periodically monitored by clinician or family. The presented system is developed for such patients that are not in critical condition but needs to be under supervision. The designed system sends SMS to doctor or any family member if any critical condition occurs.
The developed remote patient monitoring system is a portable system. It is having an emergency switch to send emergency text messages and is able to send parameters like temperature, heartbeat etc of patient in real time. It also monitors the current location of patient. The implementation of the system is achieved by the advanced RISC Machine ARM LPC2148 connected to a set of medical sensors, GPS and a wireless communication module (GSM). The programming is compiled through Embedded Keil C software. All measured parameters are continuously displayed on liquid crystal display (LCD). Also current GPS location of patient and parameters are wirelessly transmitted using GSM as text messages to the registered number (Doctor).

Keywords: LCD, Heartbeat sensor, GSM module, GPS;

Date of Submission: 09-05-2019 Date of acceptance: 25-05-2019

I. INTRODUCTION

In India, in the top 10 causes of death, death due to various factors including disease and injuries: Ischemic heart disease (heart attack) was ranked no.1 in the period 2007 - 2017. During the same period, the percentage change in deaths because of heart attack was + 49.8%[1]. This increased percentage may be due to junk food intake, wrong sleeping time slots, absence of physical exercise, increased alcohol drinking and cigarette-smoking habits of Indian people[2]. The age at which death occurred because of heart attack is changing drastically. Now heart attack is observed in the school-going students also. Heart attack is not just one reason of death; there may be other diseases and injuries so deadly that can take life of patient.

During heart attack or any other critical situation, if the patient is getting timely and qualified assistance, then his life can be out of danger. It is obvious that ordinary people cannot always feel how close a heart attack is. And doctors are not able to care for a patient while the person is at home or at any other place. One solution to this is a continuous patient health monitoring system[3].

The HMS(Health monitoring system) should be portable, easy to use, small and compact; also, it should be cheaper so that anybody can afford it. Researchers had worked on them and still they are working on it to develop better systems. D. Shanthi Kumari et. al. reported health monitoring system using RF communication[4]. Sachchidanand Jha et. al. worked on Real Time Patient Health Monitoring and Alarming system using wireless Sensor[5]. Amol Pawar et. al. developed GSM based real time remote Patient Monitoring System[6]**.** V. Ramya et. al. successfully implemented Embedded Patient Monitoring System [7].

Here we report a portable HMS having sensors attached to it. It can constantly monitor important physical parameters like temperature, heartbeat etc. and display it on LCD. When the measured temperature exceeds the allowable value or if the pulse measured is abnormal, it would automatically alert the alarm. It also read patient current location using GPS receiver. The system sends patient body temperature, heart rate and current location, to the doctor's mobile number in a SMS form using GSM modem.

II. HARDWARE DESCRIPTION:

The heart of the system is LPC 2148 ARM microcontroller as shown in the figure 1. Temperature sensor LM35 is used to measure the temperature of the patient and this signal is also given to on chip ADC of ARM controller. Heart beat sensor module give digital output of heart beat when a finger is placed on it and LED flashes in unison with each heart beat. This digital output is connected to **EINT3** pin of microcontroller to measure the Beats Per Minute (BPM) rate. In addition, there is one push button switch connected to **EINT2** pin of microcontroller to have an emergency service. When a patient press this switch then system will ring alarm continuously and at the same time it will send message to doctor, caretaker and family member/s. Patient temperature and heart beat rate are displayed on LCD. GPS module connected to UART0 gives latitude and longitude. GSM sim300 connected to UART1 is used to send SMS. The buzzer gives alarm signal when patient parameters are abnormal. This system requires 5V and 3.3V power supply.

2.1 Block diagram of proposed system:

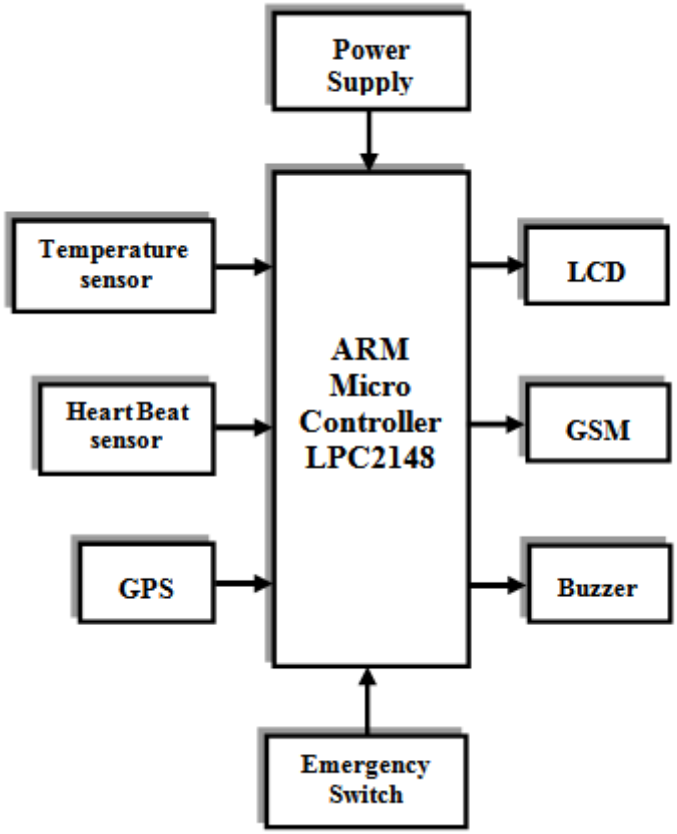

Fig. 1. Block diagram of HMS

2.1.1 Power supply circuit:

The hardware is driven by 7.4V, 1030mAh and 18Wh Lithium-ion rechargeable battery.

a) **5 V:** for temperature sensor circuit, heartbeat, GPS and GSM module.
b) **3.3 V:** for ARM 7 processor

2.1.2 Liquid Crystal Display (LCD):

A 16x2 LCD display has 16 characters per line and there are 4 such lines. In this LCD each character is displayed in 5x7 pixel matrix. LCD has two registers namely, Command and Data. It works on extended ASCII code i.e. when ASCII code is send it displays that on the screen. On the LCD total no of pins are 16 out of which 14 pins are used by the LCD and 2 are used for backlight. LCD is an edge trigger device i.e. from high to low.

2.1.3 ARM 7-LPC2148

ARM is 32-bit an advanced reduced instruction set computer (RISC) machine. It offers high performance and very low power consumption. The instruction set and related decode mechanism are simpler than CISC Pipeline techniques. All main semiconductor companies such as Samsung, Atmel, TI etc manufacture their products using ARM architecture. It is available in a small LQFP64 package. It supports ISP (in system

programming) or IAP (in application programming) using on-chip boot loader software. It has a 512-kB Flash memory system and this memory may be useful for both the data storage as well as code. It offers static RAM with 32-kB. It is accessible for 8-bits, 16-bits, & 32-bits. It has one or two 10-bit ADCs with low conversion time as 2.44 μs/ channel. Two UARTs and Two 32 bit timer/ External event counter and watchdog. On chip oscillator, require exterior crystal that ranges from 1-25 MHz. It supports idle & power down mode. The LPC2148 microcontroller has 2, 32 pin input/output ports and these are termed as P0 & P1. Every port pins are identified with PX.Y. Here, 'X' represents port number like 0 or 1, whereas 'Y' represents pin number 0-31. All the pins have alternate tasks. On RST (RESET), every pin is arranged as GPIO. The target board of LPC 2148 is as shown in figure 2.

Fig. 2 ARM LPC 2148 target board

2.1.4 Temperature Sensor LM35:

The temperature sensor LM35 is placed in contact with body of patient to sense body temperature. Its pin out as well circuit symbol is shown in figure 3a and 3b respectively. It is a three terminal device. Pin number one is for 5 volt positive supply and Pin three is for ground. Pin number two is analog output voltage provided as 10 mV/^{0}C. The LM35 is precise integrated circuit temperature sensor, whose output voltage is linearly proportional to the Celsius (centigrade) temperature [8]. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling [9]. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.

It does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150^{o}C range. As it draws only 60 μA from its supply, it possesses low self heating ability, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range. There is no need of extra circuitry to operate it. The Relation between the temperature and analog output voltage is: 1°C = 10m volt, hence for every 1 degree increase in temperature there will be an increment of 10m volt in output voltage of LM35 sensor. This output of sensor is given to analog channel of ARM LPC2148. Now after reading ADC value, using voltage and temperature relationship, voltage is converted into temperature. This conversion has been done through programming.

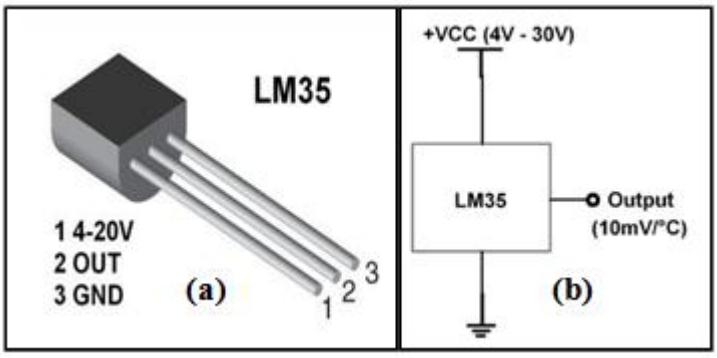

Fig. 3(a,b) LM-35 pin out and circuit symbol

2.1.5 SIM300 GSM module:

GSM SIM300 module is with a simple serial interface. It allows sending, receiving SMS and making, receiving voice calls. It is suitable for long range connectivity. The SIM300 interconnects with microcontroller via UART port. It supports command AT Commands. It provides the industry standard serial RS232 interface for easy connection to computers and other devices. It also provide serial TTL interface for easy and direct

interface to microcontrollers. GSM Module has Power, RING and Network LEDs for easy debugging. It has On board 3V Lithium Battery holder with appropriate circuitry for providing backup for the modules internal RTC. It comes with an onboard wire antenna for better reception. SIM 300 Board provides an option for adding an external antenna through an SMA connector. It allows an adjustable serial baud rate from 1200 to 115200 bps (9600 default). It Operates on Voltage: 7 – 15V AC or DC. SIM 300 can be used for GSM based Voice communications, Data/Fax, SMS, GPRS and TCP/IP stack. SIM300 GSM module is shown in figure 4.

Fig. 4 GSM module SIM 300

2.1.6 GPS Module:

U-blox NEO-6M GPS module is a complete GPS module shown in figure 5. This unit uses the latest technology from Ublox to give the best possible positioning information. It includes a larger built-in 25 x 25mm active GPS antenna. It communicates with microcontroller using a UART TTL pins. A battery is also included so that you can obtain a GPS lock faster. This is an updated GPS module. This GPS module gives the best possible position information.

It has high precision binary output. It has also high sensitivity for indoor applications. The GPS Module has a battery for power backup and EEPROM for storing configuration settings. The antenna is connected to the module through aufl cable which allows for flexibility in mounting the GPS such that the antenna will always see the sky for best performance. The Ublox GPS module has serial TTL output, it has four pins: TX, RX, VCC, and GND. U-center software is used for configuring the GPS and changing the settings.

Fig. 5. GPS module NEO-6M

2.1.7 Heart beat sensor:

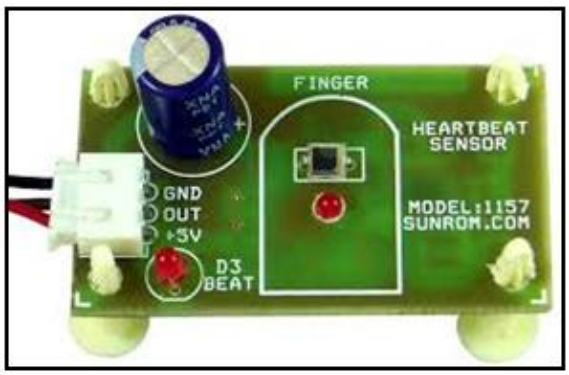

Fig. 6 Heart beat sensor module

Heart beat sensor is compact in size and operates on 5V DC. The heart beat sensor module is 1157 from sunrom as shown in figure 6. It gives digital output of heart beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heartbeat. This digital output is connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

III. SOFTWARE DESCRIPTION

The software for this system is developed in µVision IDE from KEIL. The code is dumped into ARM LPC 2148 using flash magic software tool.

The µVision IDE project management facilitates source code editing, program debugging, and complete simulation. The µVision development platform is easy to use and helping you quickly creates embedded programs that work. The Keil C development platform for the ARM processor family support every level of developer from the student just learning about embedded software development to the professional applications engineer. The industry-standard Keil C Compilers, Macro Assemblers, Debuggers, Real-time Kernels, and Single-board Computers support all ARM processor compatible derivatives and help you get your projects completed on schedule. With the Keil tools, we can generate embedded applications for virtually every ARM derivative. Keil C µ Vision 4 help provides the various simulation output. System operation is described by the flow chart as shown in figure 7.

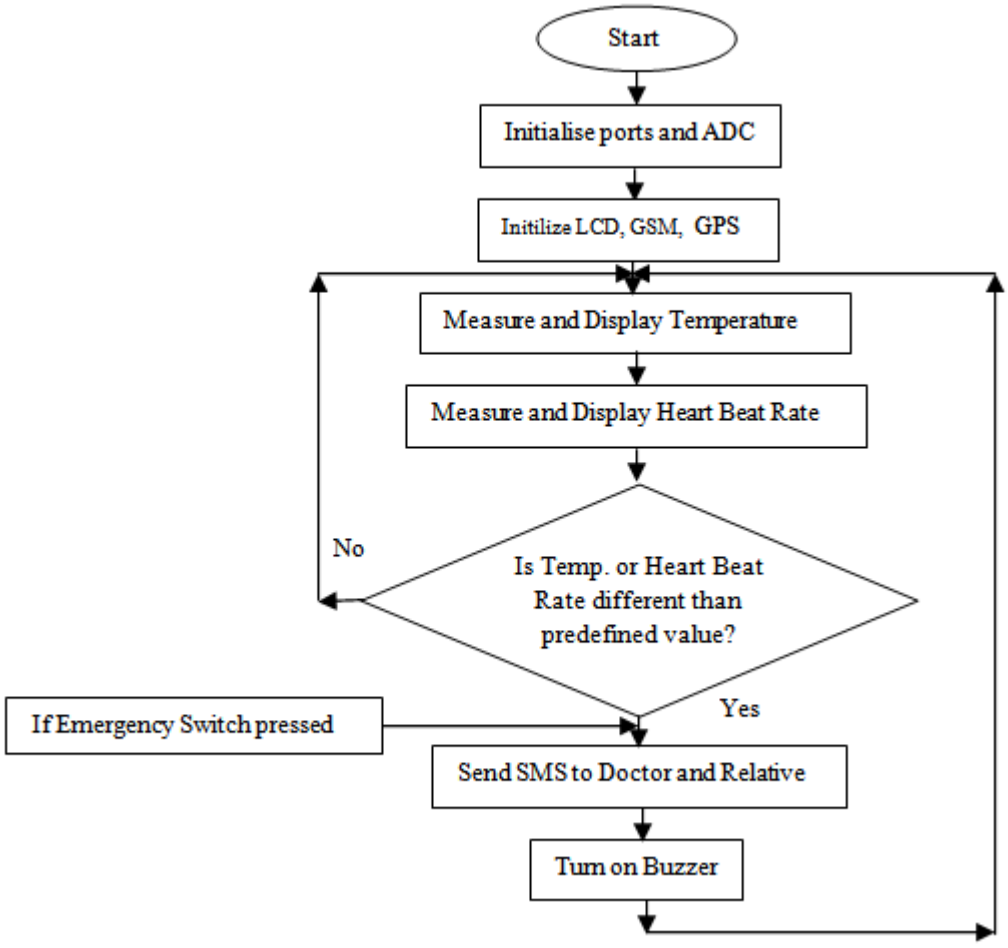

Fig. 7 Flow chart of complete system

Advantages of proposed system:

- Provides high level safety to human life.
- Easy retrieval of data for the cause of incidents.
- Low cost and less complex system for installing and application.

IV. RESULTS

LCD output:

SMS Text:

V. CONCLUSION:

Paper provides the real-time, low complexity, low-power, low-cost, portable health monitoring system by using ARM, GSM and GPS technology. From the above designed project it can be concluded that system is able to measure and transmit the patient's health data to doctor by using GSM communication. It can send message to mobile phone of the doctor when patient presses emergency switch or when any abnormal event happens, like abnormal heart beat rate and temperature. The SMS contains Patients Heart Bit Rate, body temperature and its current location. It alarms when patients health is abnormal.

VI. FUTURE ENHANCEMENT:

In future, we will develop a webserver which will maintain data base of the patient's health parameters. The system will continuously monitor and upload health parameters to the web server. The doctor can access information at anywhere with the help of web server.

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Tanaji B. Sonawane. "Portable Health Monitoring System with GPS, GSM and Emergency Switch." IOSR Journal of Engineering (IOSRJEN), vol. 09, no. 05, 2019, pp. 14-19.