GSM BASED TELEMETRY SYSTEM TO MEASURE VARIOUS PHYSIOLOGICAL PARAMETERS

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Abstract- GSM based telemetry system consists of monitoring and measurement of the various physiological parameters of the patients from remote areas or it can be within the same location in optimum time. It comprises of biological parameters such as Body temperature, heart rate and SpO2. Apart from these parameters it can detect the random body movements in ambulatory patients with the help of motion sensor (Accelerometer). These physiological signs are acquired, compared, processed and finally displayed on an LCD. The conversion of signals from analog to digital form is done by microcontroller AT mega 328 which is interfaced with Arduino Uno. A threshold value has to be set up for these parameters and if these particular values are surpassed, a message in the form of SMS will be sent to the specified mobile number via GSM Modem (SIM 800), so that the necessary steps can be taken.

Keywords: Heart Rate, SpO2, Temperature, Accelerometer, GSM Modem (SIM 800).

1. INTRODUCTION

In Today's era, Telemedicine is the utilization of profoundly created biomedical instruments and telecommunication technologies for better patient care and diagnostic purposes. With each passing day, the demand for the patient transport to the hospitals is growing more and more, so in order to gain high success rate in critical care, the continuous monitoring of the vital or physiological signs is paramount. These signs include Heart rate (HR), Oxygen saturation (SpO2), Body temperature etc. Due to progression or development in biomedical field, computer sciences and telecommunication technologies, it is viable to design such a system which can sense, monitor, display and transmit these bio signals from the patient from remote location to any health care professional via GSM services. It has turned out to be advantageous for the medical professionals.

As bed ridden and ambulatory patients require continuous and accurate decisions in order to provide life saving therapy, it is necessary to keep them under constant monitoring. Study reveals that in around every one minute a human life is lost across the globe and a higher rate among them occur in India. Heart attacks affect many lives everyday it is because the patients who suffer from cardiac diseases did not get help at the required time, whether it is the lack of SpO2, high heart rate or other cardiac problems. The developed system is about the monitoring of the patients, which is reliable and cost effective as the devices available in the market can't be afforded by everyone.

The persistent observation of the heart rate can be useful to detect any cardiac related problems. Temperature, SpO2 are the other vital parameters can be used for the constant monitoring of patient's health condition. The signals which are acquired by the sensors are in the form of analog signals, which are later on processed and converted into the digital values, this is achieved with the help of Microcontroller ATmega 328 and coding or programming in Arduino IDE. The coding consists of various formulae used to count the heart rate and SpO2, once the values are converted to digital values; they are displayed on a 16*2 LCD. [1][4] [15]

2. SYSTEM ARCHITECTURE

The system developed can scrutinise the various physiological parameters, which comprises of heart rate sensor, temperature sensor (LM35), Microcontroller AT mega 328, Accelerometer ADXL335, GSM module (SIM800A), Arduino Uno and LCD display. The heart rate sensor is used to measure the heart rate and the SpO2 of the patient; for this manual basic heart rate sensor which works on the principle of Photo resistivity is used. LM35, a temperature sensor is used to measure patient's body temperature. A 12-0-12-volt step down transformer is used as a power supply for the functioning of the overall system. Voltage regulators are installed in order to supply specific voltage to the sensors to avoid the abnormal functioning as the proper voltage supply is paramount for these modules. As already stated that if the acquired bio signals are beneath or over the threshold value the condition then is referred as 'abnormal'. An attentive or emergency message is sent via GSM module (SIM 800) on the care taker's relative. [14] [15]

The overall functioning of the developed system can be observed through the block diagram given in Figure 1.

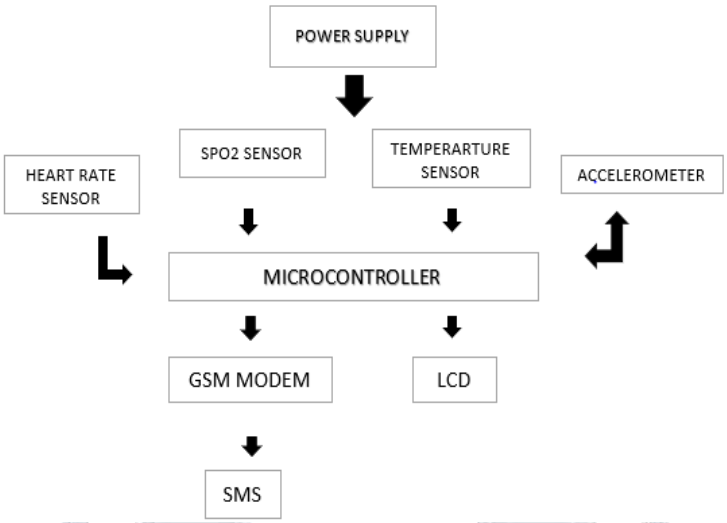

Figure1: Architecture of the system

A. Heart Rate Sensor

In this system the basic heart rate sensor is used to measure the heart rate as well as SpO2 in the blood. The sensor consists of a LED and LDR where one acts as a transmitter and the another one as a receiver. It works on the principle of photo resistivity. When a tissue is illuminated with the light source, i.e. light emitted by the LED, it either reflects (a finger tissue) or transmits the light, and during this process some of the light is absorbed by the blood which is transmitted or reflected and is then received by the light detector (LDR). The output is in the form of electrical signal and is proportional to heart beat rate. After acquiring the signals, it is compared and amplified by LM324 IC before feeding it to microcontroller. The voltage supplied to the sensor is 5V which is regulated by the voltage regulator to ensure the proper values. The digital pulses are given to a microcontroller for calculating the heart beat rate, given by the formula- [5] [1] [14]

BPM (Beats per minute) = 60*f

Where f is the pulse frequency

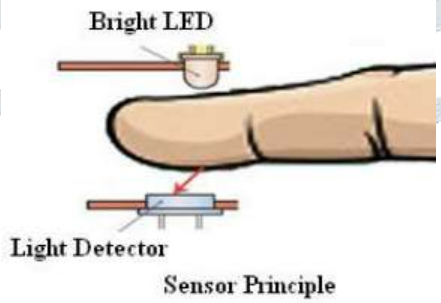

Figure 2: Working of heart rate sensor

B. Temperature sensor

For making the system LM35 temperature sensor is used which can measure accurate centigrade temperature. It can sense the temperature in a range of -55 C to +150 C.The output voltage of this sensor is directly relative to the Celsius temperature. It requires a voltage of 4 to 30 volts which is supplied by the 12-0-12 transformer. It senses the temperature and sends the acquired value to the ATmega 328 which processes it and then displays it on LCD. [5] [6] [12]

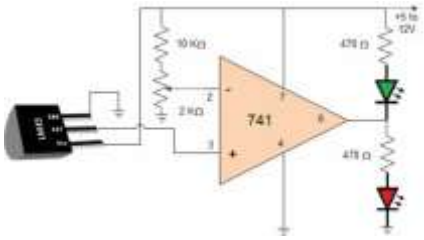

Figure 3: Circuit diagram of LM35

C. GSM Modem (SIM 800)

The modem used is a quad band GSM/GPRS module which works on 850 MHz, DCS 1800 MHz and PCS 1900 MHz's. It supports GPRS multi-slot class 12/class 10 (optional) and also supports the GPRS coding schemes. It interfaces in Arduino via two serial pins Rx and Tx. It receives output from MAX232 which is used for serial communication for sending and receiving messages from the patient's body to a doctor.

The different types of commands:

AT+CMGF =set SMS text mode.

AT+CMGS =send SMS command in text mode.

AT+CMGL =list received messages in text mode.

AT+CMGD =delete a received message.

The following image display the command's processed by GSM SIM (800)

```
void SendMessage()
{
  Serial.println("AT+CMGF=1");
  delay(1000);
  Serial.println("AT+CMGS=\"+919971290917\"\r");
  delay(1000);
  Serial.println("Alert!!");
  delay(100);
  Serial.println("Heartbeat:");
  Serial.println(rate);
  Serial.println("Temperature:");
  Serial.println(t);
  Serial.println("SpO2:");
  Serial.println(rate2);
```

Figure 4: Processing command of GSM modem in IDE

D. Accelerometer (ADXL335)

The ADXL335 is a 3-axis motion sensor which is used to detect the change in direction. It measures the movement in three axis viz X, Y, Z. It consists of a polysilicon surface-micromachined sensor and signal conditioning circuitry to implement open loop acceleration architecture. In this system, the sensor is used to detect the bodily moments of ambulatory patients thus alerting the doctor when the message is received. The movements can be measured in 3 directions X, Y, Z. It can be mounted on the limbs of the patients and is interfaced with the Arduino Uno. [2][7] [11]

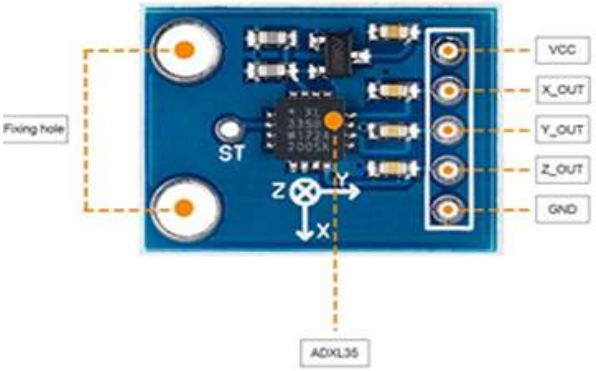

Figure 5: ADXL335 sensor

3. SYSTEM DESCRIPTION

The signals that are acquired from the sensors are in the form of analog signals and are feed to microcontroller. In case of heart rate sensor which is a LED-LDR based sensor, when the signals here are taken they are first fed to IC LM 324 which does the job of comparator and amplifier, like it reduces the noise and compare the values as according to the input given by the sensor. Later on, these values are fed to microcontroller ATmega 328 which does the remaining job i.e. converting them from analog to digital values before they are displayed on the LCD.

A particular set of values has been coded in the IDE which is the coding platform of Arduino. In this case, different high and low values for each of the parameters is set in order to execute the function of GSM which is to send the message if the threshold value is manipulated. [8] [9]

The coding in the IDE form is the most important part in this system; as the system will work according to the coding done by the user. The system is shown in Figure 6.

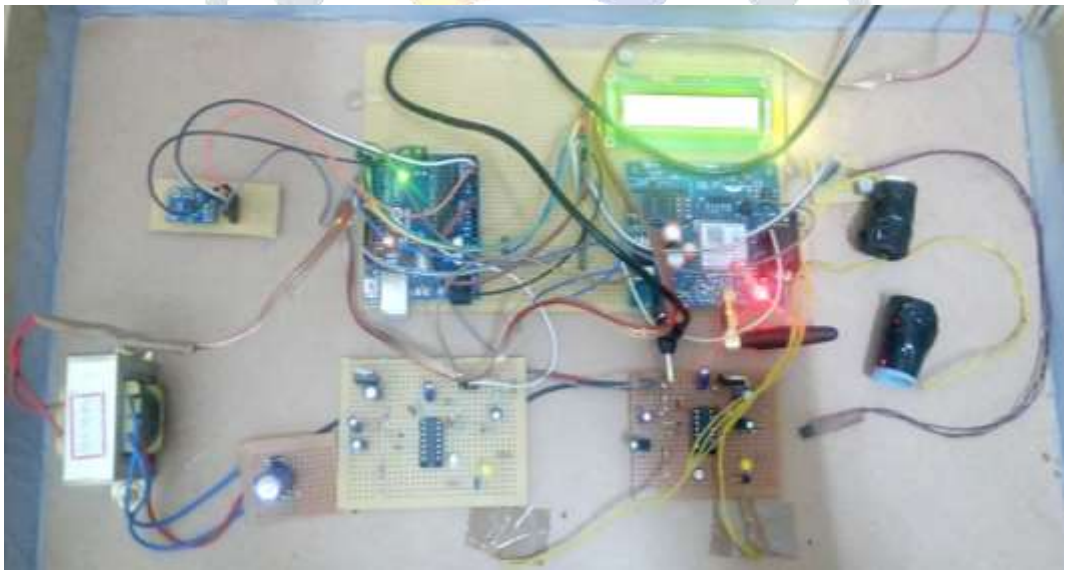

Figure 6: Developed GSM based telemetry system.

4. RESULTS AND DISCUSSION

After the processing is done, the signals are finally displayed on LCD. All the sensors holds a particular threshold value, but the LCD displays all the values for the purpose of constant monitoring of these physiological parameters, so that the persons around the patient can monitor the signs 24*7. Apart from that, the system will automatically send a message if the threshold values are exceeded. This system is cost effective and reliable and can be developed further. This kind of system can be of utmost importance to people living in remote areas and who can't afford to go for the expensive ones. The final output acquired on the LCD and the SMS received on the specific mobile number is shown in the Figure 7 and Figure 8.

Figure 7: Results displayed on LCD

Figure 8: SMS received on Mobile Number

5. FUTURE WORK

For the future, this system can be upgraded and other parameters like ECG, respiratory rate etc can be added to it hence giving access to all the vital parameters of the patient. Moreover, the output values taken can be viewed by the respective doctor on a private server through LabVIEW which will include the patients name, age, gender etc, and giving full information for the easy access and to avoid any other confusion. These signals can also be transmitted in real time which will have a great impact from the diagnostic point of view.

6. REFERENCES

1) R.Sukanesh,S.PalanivelRajan,S.VijayprasahPrabhu, P.Subathra "GSM-based ECG Tele-alert System" International Journal of Computer Science and Application Issue 2010M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

2) T. Tamura, T. Togawa, M. Ogawa, M. Yoda, "Fully automated health monitoring system in the home", Med. Eng. Phys., vol. 20, no. 8, pp. 573-579, 1998

3) A. A. Al-Imari, Kasim A. Rashid, M. AL-Dagstany, "Telemetry Based System for Measurement and Monitoring of Biomedical Signals", AMSE Journal of Signal processing and Pattern Recognition, Vol. 50, Issue 4, 2007.

4) P.S. Pandian, K. Mohanavelu, K.P. Safeer, T.M. Kotresh, D.T. Shakunthala, P. Gopal, V.C. Padaki, "Smart Vest: Wearable multi-parameter remote physiological monitoring system" , Medical Eng. & Physics 30,pp. 466-477, 2008.

5) N. V. Panicker, A. Sukesh Kumar "Recent Trends in Wireless Technologies for Healthcare Applications", in Proc. of Int. Conf. on Emerging Trends in Engineering and Technology (ICETET),Munnar, Kerala, India October 4-5, 2013.

6) N Natarajan, S Aparna and J Sam Jeba Kumar, "Patient Monitoring System Based on e-health Sensors and Web Services," ECAI 2016 - International Conference – 8th Edition, July 2016.

7) I. Korhonen,J. Parkka, M. Van Gils, "Health monitoring in the home of the future" IEEE Engineering in Medicine and Biology Magazine, Volume: 22, Issue: 3, May-June 2003.

8) K. Malhi, "Wireless sensors network based physiological parameters monitoring system," M.S. THESIS, MASSEY UNIVERSITY,Palmerton, New Zealand, 2010.

9) A. Lymberis, "Smart wearable systems for personalized health management: Current R&D and future challenges," in Proc. IEEE25th Ann. Int. Conf.: EMBS, Sep. 2003, vol. 4, pp. 3716-3719.

10) D.J.R.Kiran Kumar, NaliniKotnana Design and Implementation of Portable Health Monitoring system using PSoC Mixed Signal Array chip (IJRTE) 2277-3

11) N. Watthanawisuth, T. Lomas, A. Wisitsoraat, A.Tuantranont, "Wireless Wearable Pulse Oximeter for Health Monitoring using Zigbee Wireless Sensor Network'', Nanoelectronics and MEMS Laboratory, National Electronics and

Computer Technology Conference on Computer, Mechanical, Control and Electronic Engineering (CMCE)., pp.172-175,2010.Center (NECTEC)., Pathumthani, Thaiiand 12120.

12) Wang Feng Qin, Li.Yang "Zigbee Technology for Designing and Implementing aEemote Medical Monitoring System'', International Conference on Computer, Mechanical, Control and Electronic Engineering (CMCE). pp.172-175,2010.

13) Y. Hao and J. Foster, "Wireless sensor networks for health monitoring applications," Physiological Meas., vol. 29, no. 11, pp.R27-R56,2008.

14) M. Scholtz, "Addressing the global demands for improved healthcare," in Proc. Telemedicine 21st Century, Opportunities Citizens, Society, Industry, 1999, pp. 11 -18.

15) A. Dittmar, F. Axisa, G. Delhomme, and C. Gehin, "New concepts and technologies in home care and ambulatory monitoring,"Studies in Health Technol. Inform., pp. 9-35, 2004