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A GSM Based Wearable Physiological Parameters monitoring System

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Abstract **- This paper aims to develop a GSM based Wearable physiological parameters monitoring device. The system can be used to monitor physiological parameters, such as Heart rate, temperature, fall detection and SpO_2, of a patient. The system consists of an electronic device which is carried on the hand and worn on the finger tip, by the patient. Using several sensors to measure vital signs, the person is wirelessly monitored within his own home and at any place. An accelerometer has been used to detect fall detection. The device detects if a person is medically distressed and sends an alarm and SMS to a receiver unit that is connected to a mobile. This system wirelessly transmits the data from device to mobile and computer. The system gives SMS alert to the mobile in digital format and to the computer in analogues format.**

Intex Term **- Heart rate measurement, Body temperature measurement, fall detection, SpO_2 measurement, self monitoring, physiological parameters, wireless transmission, GSM.**

I. INTRODUCTION

The scientific proposed work describes the design of simple, intelligent, low cost microcontroller based Heart rate, Body temperature, fall detection and SpO_2 monitoring system integrated with GSM technology, and it sends alert information at the time of upnormal condition [1]. And, one of the reason for more development in this area is global population and increasing aging population [2], one statics provide by the US department of health that by 2050 over 20% of the world's population will be above 65 years of age. So this results in a requirement for medical care, which is more expensive for long term monitoring, and the hospitalization cost is ever increasing. So, the cost of rehabilitation after major illness or surgery and the hospitals only looking for sending people back as soon as possible to recoup at home. So this recovery period, several physiological parameters needs to be continuously measured[3-5]. So this wireless sensors are continuously monitor the patient parameters such as Heart rate, Body temperature, fall detection and SpO_2 [8]. In such a way many elderly people scared the idea of being forced to live with their adult children or in a rest home. So, they required to live independently and keep control in own self.

Such people need to be continuously monitored and provide medical help and attention when required. The proposed system is useful to continuously measure the human physiological parameters and these parameters are transmitted to the mobile phone and hospital under any emergency condition. And it is also informs relative and locates the patient using GSM technology.

II. SYSTEM OVERVIEW

The exciting one is a Zigbee based monitoring system [9]. This system consist of four sensors, the sensors are temperature sensor, fall detection sensor and heart beat sensor. Using these sensors and associated components are used to continuously monitor the patient parameters. The outputs from the sensors are processed by microcontroller . The results are sending through the Zigbee module to the mobile phone [10]. Which is stores the data. If the person is at any upnormal or emergency condition an alarm is

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generated. Once the user is connected the receiver the data is automatically updated.

The temperature sensor measure the skin temperature and the system uses DS600 temperature sensor [9]. The temperature sensor gives an analog voltage corresponding to the measured temperature. And this temperature is given to a 12 bit Analog- to- Digital convertor and is processed by the micro controller C8051F020. The relative changes are monitored within set of threshold which sets off the alarm.

A heart beat sensor is designed to give output of heart beat when a finger is placed on it when the heart beat detector is working, the beat LED flashed in unison with each heart beat. It works on the principle of near infrared spectroscopy (NIR) by blood flow through finger at each pulse. And it involves light of wavelength is 700nm to 960nm to measure blood volume. No other tissue other than hemoglobin absorbs this light. So the amount of absorbed light changes with the flow of blood which is linked the heart rate. The heart beat sensor consist of an IR LED transmitter photodetector , and filter circuit. The light is detected by the photodetector is amplified, filtered and send to the micro controller.

An impact sensor is due to detect falls. The proposed system uses ADXL335 accelerometer as an impact sensor. It provides a voltage whose amplitude is directly proportional to the acceleration.

The communication between the microcontroller and the receiver part has been carried out wirelessly. And the range of zigbee module is 2.4GHz.

GSM modems is more advantage to the Zigbee module. Because the GSM modems have increased range of operation than Zigbee modules. The GSM moderms due do send the messages to the mobile phone via doctor, ambulance driver and the relatives under any medical emergency conditions. This proposed system using PIC microcontroller and it is more advantageous than C8051F020.

III. PROPSED SYSTEM

Figure 1 shows the block diagram of the proposed system. The patient observing and monitoring system includes the sensors and the micro controller which are used to continuously monitor the patient condition. The system consist of subsystems like mobile phone in ambulance, hospital, patient and relatives to which alert SMS is send if any medical distress happens to the patient. The sensor outputs are processed by the patient monitoring system and the results are send wirelessly to the corresponding subsystems using GSM systems.

The system mainly consists of Heart beat sensor, SpO_2 sensor, temperature sensor, PIC microcontroller and GSM module. The block diagram of proposed system shown on the below and the details of the proposed system are depicted as follows.

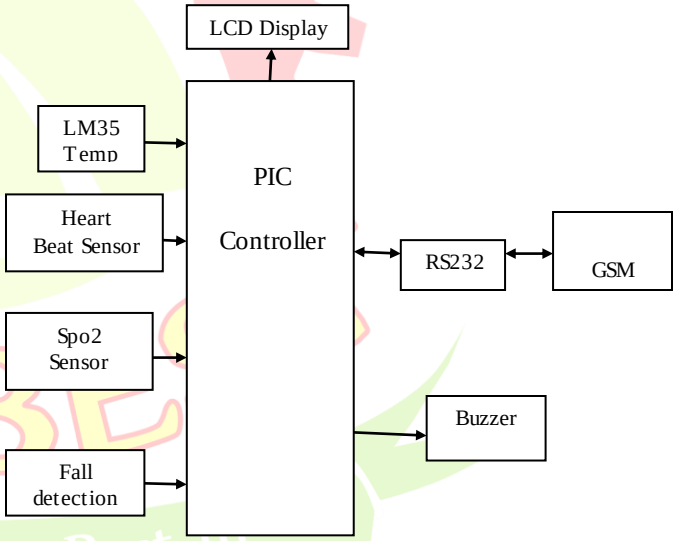

Fig.1. Block diagram of the proposed system

IV. SENSOR DETAILS

The proposed system consists of three type of sensors there are temperature sensor, Heart beat sensor and SpO_2 sensor. Temperature sensor is used to measure and detect the body temperature while the heart beat sensor is used to measure the pulse rate and the SpO_2 sensor is used to measure the blood saturation level [7]. The outputs of the sensors are given to the micro controller.

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The temperature sensor is used to measure the body temperature. The changes of temperature is sensed by sensor. Since change is reproducible, the temperature sensors are very accurate.

In the proposed system, the proposed system used LM35 temperature sensor for body temperature measurement. LM35 series are precision integrated-circuit temperature sensor that can be used to measure the temperature with an electric output proportional to the temperature in degree Celsius (centigrade). It is connected to the PIC microcontroller. The changes in the body temperature when a person is hungry, sleepy or cold. And the patient is suffering from any of the following conditions: trauma, heart attack, burns, stroke, brain damage, blood pressure and heat exhaustion. The advantages of using LM35 is non invasively measure the temperature and it more accurate than using thermistor. The sensor circuitry is not subjected to any oxidation and this sensor circuitry is sealed. The LM35 generates a higher output voltage than thermocouple and the sensor simply connect to the vcc to 5V, GND and the out to one of the ADC. The output is linearly varies with temperature. The LM35 does not requires any external calibrating or timming an accuracy of ±1/4◦c at room temperature and ±0.8◦c over a range of -55 to 150◦c.

A person's heart beat is the sound of the valves in his/ her,s heart contracting or expanding as they forced pressure wave moves out along the artries at a few meters per seconds. This pressure wave can be felt at the wrist, but it also causes increase in the blood volume in this tissue. The heart beats are detected by neats per minute. Its unit is BPM. Heat beat can be measured based on absorption of light

through the tissue. The light is scattered or absorbed during its path through the blood as the heart beat changes. The surface of the skin, at heart beat sensor can detect the transmission of waves from various depth and from highly absorptions or weakly absorptions tissue.

The heart beat sensor made up of an Infrared LED and LDR, which is placed parallel to each other. The finger is placed between the LED and LDR. The heart beat pulses causes the variation in light waves through the flow of blood. LED emits Infrared rays and it travels through the finger are detected by the LDR. The principle of LDR is when the light is falls on it, its resistance changes. As the light intensity increases, so the resistance decreases. Thus the voltage drop across the resistor is decreases. Heart beat sensor is designed to give digital output of heart beat when a finger is placed on it. The detector output is in the form of electric signals and it is proportional to the heart beat. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can connected to the PIC microcontroller directly to measure the Beats per Minute (BPM) rate and is processed.

The SpO_2 sensor is used to measure oxygen saturation level through the blood. The body maintains a stable level of oxygen saturation for the part by chemical process of aerobic metabolism associated with breathing. Using the respiratory system, red blood cells, specifically the hemoglobin gather oxygen in the lungs and distribute it to the rest of the body. When oxygen reacts with protein gets attached to it and generates Oxyhemoglobin (HbO_2). When blood gets in contact with a cell, the red cells hemoglobin release oxygen and becomes Deoxyhemoglobin. At this point blood without oxygen returns to the hearts right atrium to repeat the process. The needs of the body's blood oxygen may fluctuate such as during exercise when more oxygen is required or when living at higher attitudes. A blood cell is said to be saturated when carrying a normal amount of oxygen.

The SpO_2 sensor is non – invasive method for measuring a person's O_2 saturation. In this method used to transmissive application mode. A sensor device is placed on a thin part of the patient body such as finger tip. The device passes wavelength of light through the body part of photodetector. The SpO_2 sensor consist of IR LED and photodetector. It measures the changing at each of the wavelengths, allowing it to determine the absorbance due to

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pulsing atrial blood alone, excluding venous blood, skin, bone, muscle and fat. Absorption of light at these wavelengths differs significantly between blood loaded with oxygen and blood lacking oxygen. Oxygenated hemoglobin absorbs more infrared light and deoxygenated blood allow more infra red light. The ratio of absorbed light measurement and allowed light measurement is than calculate by the processor and this ratio is then converted to SpO_2.

V. MICRO CONTROLLER

The micro controller used in this project is PIC16F877A. it is a 40 pin PIC with 5 I/O ports. It has got an inbuilt five channel 10 bit ADC module. It has 368 x 8 bytes RAM and 256 x8 bytes EEPROM.

The advantages of using PIC microcontroller are it has RISC CPU design. It has only 35 single word instruction to learn. Its code is extremely production, allowing the PIC to run with typically less program memory than its larger competitors. PIC micro controller are more advanced than other micro controllers. It is low cost, low power consumption, high clock speed.

VI. GSM MODULE

GSM is Global System for Mobile Communication. GSM moderm has slot for inserting SIM. GSM moderm contains sub systems such as mobile stations, base station and network system. The SIM contains IMSI number and the mobile station has IMEI number. Base station subsystem contains Base transceiver station which has antennas for communication. Network subsystem has Authentication center (AuC), Equipment Identity

Register (EIR), er and to Visitor Location Register (VLR) and Home Location Register (HLR). HLR is used to stores the information about the subscriber and the current location of the subscriber. VLR gives services to the subscribers of HLR who are visitor users. EIR is also used for security purpose and to identify the mobile station. MAX232 which is inbuilt to the moderm is useful for serial data transmission.

VII. MONITORING SYSTEM

In the proposed system is using 16 x2 LCD. It is used to display the measured value. The system madeup of a power on LED and status LED. Status detectors are used to indicate the status of patient subject. It is a 16 pin LCD, which is transmit the data from the microcontroller to LCD. The LCD blinks the green LED. An audible alarm to alert the people around is also provided in the system this sets if any medical distress happens to the patients.

VIII. HARDWARE IMPLEMENTATION

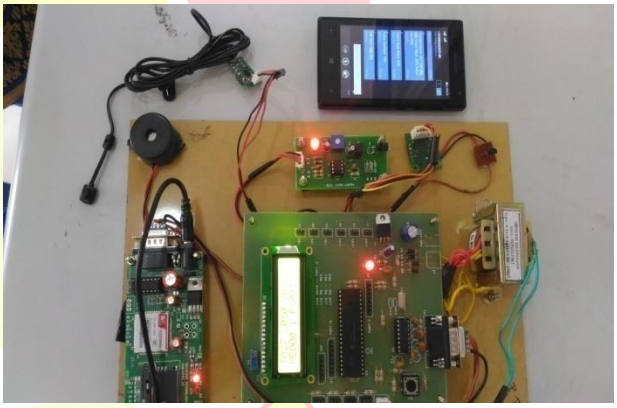

Fig.2. Proposed system

The figure above shows the prototype of the proposed system. LM35 temperature sensor, SpO_2 sensor and heart beat sensor senses the temperature, blood oxygen saturation level and heart rate of a patient. The PIC microcontroller was programmed in Embedded C. in, the code a threshold value for temperature, heart rate, saturation level and fall range is set. The temperature and fall detection is continuously monitored and the heart rate and SpO_2 is checked in every 30 seconds. For heart beat sensor, pulses for 30 seconds are measured and it is multiplied by 2 to obtain beats per minute. Normally the pulse rate is 72 bpm and this system programmed by normal heart beat is 72 to 80bpm. If any imbalance occurs to either temperature, heart beat, fall detection and SpO_2, an alarm is generated and message is sent using GSM moderm. in this system GSM is used to send message to patient mobile

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phone and sub system such as hospital, ambulance driver and the relatives to make alert that a patient is medically distressed condition and an immediate medical assistance is needed. And this measured values are displayed on the 16 x2 LCD display. And this LCD requires 5V dc supply except for GSM moderm.

1X. RESULTS AND DISCUSSION

New technologies and innovation in science offers speed materials at low cost, accuracy to give results in the development of high performance sensing system. This system is used to continuously monitor the patient condition, which is especially used to above 65 years of people. With this system patients are continuously monitored using a network of wireless sensors. The system is also used to physically challenged people. Whose temperature, heart rate. SpO_2 level and fall detection. If any upnormal condition occurs message is send to the doctor and sub systems.

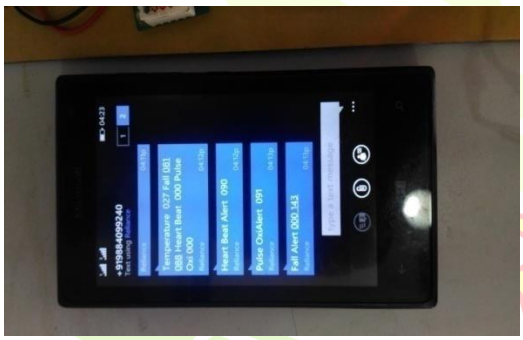

Fig.3. Alert SMS in mobile phone

The above figure 3 shows the alert SMS through the smobile phone snap shot of the proposed system. The mobile phone receive SMS at 30 sec. and it display the Heart beat, temperature, fall detection and SpO_2 range on the screen. The outputs from the sensors were received and are processed by the micro controller. The LCD display measured values Fig shows body temperature, heart rate, fall detection and SpO_2 of the human subject. The microcontroller to check the upnormality in the measured values. If any problems occurs, an immediate message sent to mobile phone and other sub systems.

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Fig.4. Output in LCD display

X. CONCLUSION AND FUTURE SCOPE

The future scope is to measure the blood pressure by using blood pressure sensor [8]. Thus the medical distress caused by increase in blood pressure. Zigbee modules of high range are available in the market [9]. The proposed system is used to measure the physiological parameters such as Heart rate, temperature, fall detection and oxygen saturation (SpO_2) to the blood of a human subject. This system consists of sensors, micro controller, GSM system. Using multiple sensors tos measure different vital signs, the person is wirelessly monitored. And it detects patient conditions, if a person is medically distressed and sends SMS to the mobile phone for relatives, hospital. The alarm system is provided sound at up normal condition of patient. The proposed system consist of wearable and finger circuitry. Continuous monitoring of people can be done effectively by using GSM moderms.

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