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Micro controller based Heartbeat, blood pressure and body temperature monitoring and alerting system using GSM modem

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Abstract: *Primary parameters in defining the health condition of the human body are heartbeat, blood pressure and body temperature. Monitoring them all at once is a costly process. In this paper, a low cost and portable method is proposed and implemented to measure heartbeat, blood pressure and temperature from human body using the microcontroller device with LCD output. Heart rate of the subject is measured from the finger using infrared sensors. Blood pressure using wrist band and temperature by temperature sensor. The noisy output signal from the sensors is stripped out of unwanted components with the help of a hardware and then given to micro controller which is displayed on a text based LCD. Furthermore the same information is analyzed by microcontroller and an alert is triggered if those values fall out of the range of predefined threshold limits. This is useful to monitor vital parameters at low cost and trigger an alert to intimate this condition to care takers via message using a GSM modem*

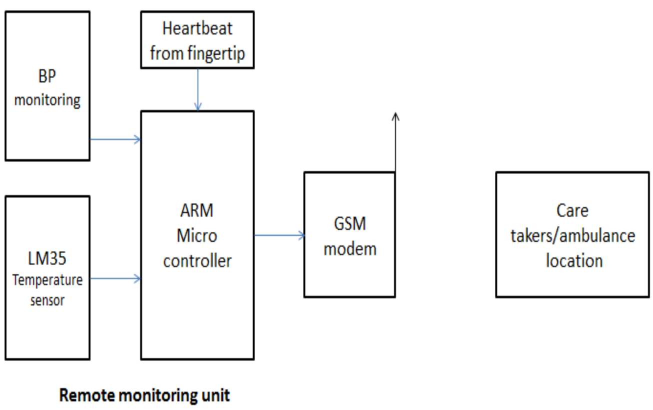
Keywords: *alerting, Heartrate; Bloodpressure monitering; temperature, cardiology, remote monitering;*

I. Introduction

Today, the medical field is facing issues with growing public concerns and government demands for reform.The outrage is directed at the high costs of quality health care and the inability of healthcare specialists to provide adequate medical services to rural populations. The availability of prompt and expert medical care can meaningfully improve health-care services at understaffed rural and remote areas. In distant regions of the country the degree of development of healthcare providing services has not reached the appropriate level to adequately address the health care needs of the populations in these areas. A mobile monitoring system utilizing Short Message Service with low-cost hardware equipment has been developed and implemented to enable transmission of the temperature, blood pressure and Heart Rate of a patient. For example in a case where a patient is to be under continious monitering of bp and heartbeat, the equipment is bulky and costly. By using this design that observation is posible at low cost and care takers are alerted in case those values crosses threshold limits.

Another situation in remote areas where patient is under primary medication and required to go for an ambulence in case of emergency, this desing could help in fully automating the situation, thus by preventing the loss of life.

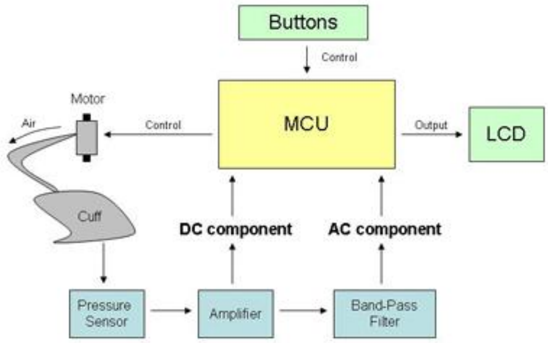
II. System hardware blocks



A. Bloodpressure monitering unit

Usually when the doctor measures the patient's blood pressure, he will pump the air into the cuff and use the stethoscope to listen to the sounds of the blood in the artery of the patient's arm. At the start, the air is pumped to be above the systolic value. At this point, the doctor will hear nothing through the stethoscope. After the pressure is released gradually, at some point, the doctor will begin to hear the sound of the heart beats. At this point, the pressure in the cuff corresponds to the systolic pressure. After the pressure decreases further, the doctor will continue hearing the sound (with different characteristics). And at some point, the sounds will begin to disappear. At this point, the pressure in the cuff corresponds to the diastolic pressure.

To perform a measurement, we use a method called oscillometric. The air will be pumped into the cuff to be around 20 mmHg above average systolic pressure (about 120 mmHg for an average). After that the air will be slowly released from the cuff causing the pressure in the cuff to decrease. As the cuff is slowly deflated, we will be measuring the tiny oscillation in the air pressure of the arm cuff. The systolic pressure will be the pressure at which the pulsation starts to occur. We will use the MCU to detect the point at which this oscillation happens and then record the pressure in the cuff. Then the pressure in the cuff will decrease further. The diastolic pressure will be taken at the point in which the oscillation starts to disappear.



The diagram above shows how our device is operated. The user will use buttons to control the operations of the whole system. The MCU is the main component that controls all the operations such as motor and valve control, A/D conversion, and calculation, until the measurement is completed. The results then are output through and LCD screen for the user to see.

B. Heartbeat sensor

The sensor consists of an IR light emitting diode transmitter and an IR photo detector acting as the receiver. The IR light passes through the tissues. Variations in the volume of blood within the finger modulate the amount of light incident on the IR detector. The sensor unit consists of an infrared light-emitting-diode (IR LED) and a photo diode, placed side by side, and the fingertip is placed over the sensor assembly, as shown below. The IR LED transmits an infrared light into the fingertip, a part of which is reflected back from the blood inside the finger arteries. The photo diode senses the portion of the light that is reflected back. The intensity of reflected light depends upon the blood volume inside the fingertip. So, every time the heart beats the amount of reflected infrared light changes, which can be detected by the photo diode. With a high gain amplifier, this little alteration in the amplitude of the reflected light can be converted into a pulse.. The IR filter of the photo transistor reduces interference from the mains 50Hz noise. These values are fed into MCU to analyze further.

C. Temperature sensor

Sensor we used in this project was LM35. We integrated this with the ARM to measure the temperature. The ARM will then read this measured value from the LM35 and translate into degrees fahrenheit and celsius, which we will be able to read from the MCU to the LCD. LM35 is placed in contact with the human body.

D. ARM micro controller

LPC2148 is used as MCU in this design. Because of the advanced 32 bit architecture, it can detect changes as low as 3 millivolts. And more faster compared to PIC's and other 80series miceo controllers. Inbuilt ADC was an added benefit of LPC2148. Hence we used this as our micro controller unit.

A Microchip microcontroller LPC2148 is used to collect and process data and then stores it in a serial buffers. This microcontroller had been used before at the laboratory and gave good results. The LPC2148 is an 32k instructions program buffers, 512 kb bytes of RAM, three timers, and a 32 -bit A/D converter microcontroller. It has RISC architecture and can use oscillators, thus it is ideal to be used as an embedded system.The ECG signal is fed to the A/ D converter withinthe LPC2148. The sampling rate of the system is 1KHz which means 1000 simples were acquired in a time period.

E. GSM modem

Gsm modem gives capability to send SMS without any mobile operating system. Sim can be read with MCU and can be used to send SMS by micro controller. Hence a GSM modem was employed, its main function here was when the parameters are over threshold limits it sends a text message to predefined contacts about the situation of the patient, thus alerting them to proceed for further actions.

III. Sensors

A. Temperature sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The output of sensor converted to digital that easy connecting with microcontroller.

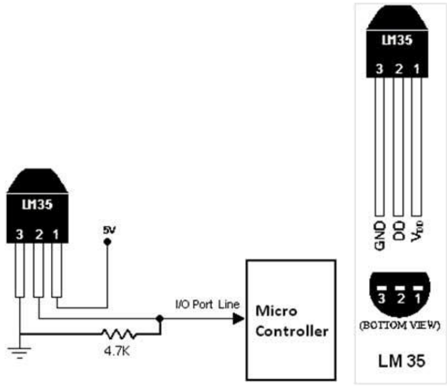


Fig: 1

Fig. 1 shows how to interface the LM35 to microcontroller. As you can see the third pin is connected to GND, the first pin is connected to VCC & the second pin is connected to the Microcontroller input. Just use single PIN female to female wire to connect with the leads of LM35 temperature sensor. So when the temperature is sensing, it give the sensor reading to controller.

B. Heartbeat sesnor

Heart rate measurement is one of the very important parameters of the human cardiovascular system. The heart rate of a healthy adult at rest is around 72 beats per minute (bpm). Athletes normally have lower heart rates than less active people. Babies have a much higher heart rate at around 120 bpm, while older children have heart rates at around 90 bpm. The heart rate rises gradually during exercises and returns slowly to the rest value after exercise. The rate when the pulse returns to normal is an indication of the fitness of the person. Lower than normal heart rates are usually an indication of a condition known as bradycardia, while higher than normal heart rates are known as tachycardia.

The change in volume caused by the pressure pulse is detected by illuminating the fingertip's skin with the light from an LED using a photodiode sensor. With each heart beat, a surge of blood is forced through the vascular system, expanding the capillaries in the finger, and changing the amount of light returning to the photo detector Very small changes in reflectivity or in transmittance caused by the varying blood content of human tissue are almost invisible. Valid pulse measurement therefore requires extensive preprocessing of the raw signal. A suitable operational amplifier is needed to amplify the heartbeat signal, due to its very low amplitude compare to the surrounding noise. A super bright LED is suggested in the circuit as it can also perform well as light sensor. A photodiode, whose resistance changes in response to the amount of light shining on it.

Fig: Fingertip heartbeat sensor

C. Bloodpressure sensor

A blood pressure cuff is a device used to measure the force of the blood in the veins and arteries. At rest, the force of blood flow is constant and, in healthy individuals, ranges between 110/70 and 120/80. The larger number is the systolic number--the force of blood as the heart contracts. The lower number is the diastolic number--the force of blood as the heart relaxes. If the force of the blood is greater than 120/80, this may indicate hypertension. A blood pressure cuff is specially calibrated to register the force of the blood and help medical personnel determine the patient's health status. The patient can also monitor his own blood pressure with the use of a home monitor. Blood pressure cuffs come in both manual and automatic versions; they function similarly. Manual blood pressure cuffs are flexible air bladders connected to a bulb pump assembly. The air bladder may have a cloth or vinyl covering and has a sensor connected to a numbered gauge, which displays the blood pressure reading. The outer covering has markings, which indicate exactly how to place the cuff--the sensor needs to sit directly over artery just above the crook of the elbow. Once the cuff is in place, the tester squeezes the bulb to inflate the cuff. The cuff cuts off blood flow to the arm, stopping the pressure so that the sensor can accurately record when the pressure returns. A valve on the end of the pump bulb releases the air from the cuff. The tester slowly releases the air and the cuff loosens, allowing blood flow. The sensor registers the blood flow as circulation returns and the gauge should jump or pulse in time with the blood pulsing in the artery. As the cuff loosens, the pulsing becomes progressively more faint until it stops completely. The number on the gauge where the pulsing starts is the systolic number, and the number where the pulsing stops is the diastolic number. The tester may also listen to the blood flow with a stethoscope to verify the readings on the gauge. Here we use U80BH for sensing BP.

Fig: BP wrist cuff

These 3 are vital sensore for the project, these are monitered by MCU and in case of readings crossing threshld limits, the predefined action is taken by the controller unit.

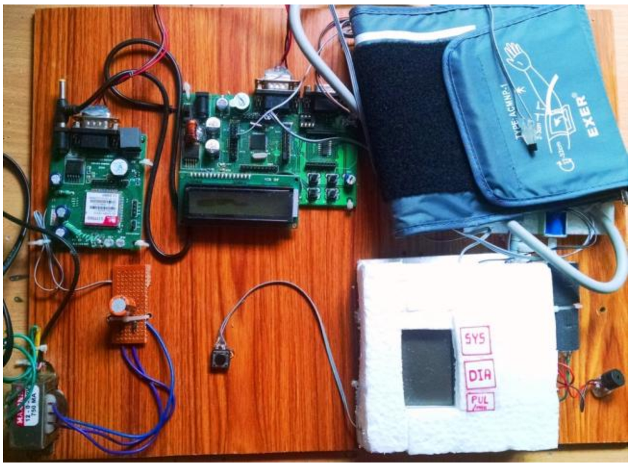
IV. Working

The designed unit consists of all the sensors namely Bloodpressure, heartbeat and temperature. This setup is arranged to the patient whose health condition is to be monitered. The ambient temperature sensor LM35 is arranged in contact with the patient body to improve accuacy in reading and bp cuff is arranged to the arm of the patient and heartbeat clip to his finger tip.

This is a continious process of observing patients health. The readings are checked for every interval of 10 seconds and in case if the values were exceeding the threshold limits, the micro controller keeps ok for one to two crossings, if the values keeps on exceeding continiously or if it is above the limit for given period of time, the micro controller alerts the care takers by triggering the buzzer and sending the same information to care takers via SMS.

If all the parameters exceeds the limits. The same is intimated or even if individual parameters are in danger condition, that is intimated via sms as the sms string consists of current condition values.

This design can also be used to record all values over the period of time that helps to study the medical condition of the patient and in case of small hospitals, that sms can alert ambulence services in case of danger.



V. Conclusion

A low cost mobile patient monitoring system that utilizes Short Messaging Service (SMS) was designed, developed, and tested. An Infrared temperature sensor was integrated with a BP sensor and Heart Rate monitor on a cellular (mobile) phone platform, which can be considered as a real time transmission mode. he real-time decision is taken to inform the patient on his heart rhythmic conditions. It should be noted that this system can be ported either by patient or sport-person. The programmable methodology employed in the design also allows others biomedical signals, such as breathing rate and patient movements to be transmitted.

In summary, a new medical wearable device has been developed as part of a study targeted to heart rate, BP and body temperature intimated via SMS Final goals of this paper is reducing the hospitalisation and assistance costs. In addition, patients and families quality of life are increased. And preventon of manual errors in observing critical cases were reduced. Furthermore, we believe that elderly people ans people in remote locations where highly sophisticated mechinaries were absent as well, may benefit from this system

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