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Design and Development of Wearable Medical Power Suit

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ABSTRACT: In India many patients are passing away because of heart attacks and, not getting proper treatment timely. The rapid growth in technology has remarkably enhanced the scope of remote health monitoring systems. In order to save their life, the continuously monitoring is required. This paper proposed a novel idea for continuously monitoring the patient's physiological health conditions by microcontroller based system with GSM. Here the physiological conditions of the patient's being monitored by sensors and the output of these sensors is transmitted via GSM and this will be sent to the remote wireless monitor for acquiring the observed patient's physiological signal. The main focus of this paper is that the wearable sensors are used to measure Heart beat rate, Temperature, Blood pressure and Sweat from human body using GSM. The existing monitoring system is suitable only when the patient is on bed and monitoring of the patients usually occur at hospitals or healthcare centres. In this proposed system, the patient's health conditions are being monitor in their home itself. Even though the person is not in a critical condition, it is need to have constant or periodical monitoring by the clinician and by any family member. In any critical condition, the SMS will be sent to the doctor and to any family member. Through GSM status of the person can be monitored. So it can easily save many lives by providing swift treatment to them.

KEYWORDS: Heartbeat sensor, Pressure sensor, Temperature sensor, Sweat sensor, GSM

I. INTRODUCTION

Nowadays patient monitor system in hospitals allow continuous monitoring of patient vital signs, it's normally require the sensors to be hardwired to nearby, bedside monitors or PCs and essentially confine the patient to his hospital bed. Even after connecting this system to a particular patient, a paramedical assistant need to continuously monitor and note down all the vital parameters of a given patient by keeping track of all records manually. In the proposed system the patient health is continuously monitored by the sensors and the acquired data is transmitted to a centralized microcontroller using Wireless Sensor Networks. A GSM is connected to microcontroller that consumes very low power and is extremely small in size. These are specially designed for low power consumption, with smaller circuit components intended for miniature packet, long distance range applications and typically consist of a low power controller with smallest resources and interface capabilities. The device detects when a person is medically distressed and intimates alarm to the clinician and also the emergency button is provided for operating manually by the patients. This paper describes an independent system that automatically logs vital parameters of patients for easy access.

II. RELATED WORK

Amruta Chopade et al. [1] proposed a system using ATMEGA controller for monitoring the heart beat, temperature of the patients. Adopting such a method is error prone and may lead to ruin in the case of a human error. T. Shany et al. [3] describes the development of body-fixed sensors for monitoring of human movement. Pietro Salvo et al. [12] (2010) proposed a sweat rate monitoring system. Sweat monitoring sensors integrated onto textile substrates that will be worn directly on the body. Sweat-rate sensor is based on two humidity sensors at different heights from the skin. The difference in their responses is proportional to the vapor pressure gradient and allows the sweat rate to be

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measured. Later T. Murugan et al. [11] proposed the simple low cost microcontroller based temperature monitoring system using GSM technique. The temperature monitoring system using GSM undergoes three stages signal conditioning circuit, analog to digital converter and with GSM Modem the message is sent to mobile.

III. HARDWARE DESCRIPTION OF HEALTH MONITORING SYSTEM

The functional block diagram of the proposed system is shown in the fig. 1. The system has designed to take several inputs to measure physiological parameters of human such as temperature, heart rate, detection of blood pressure and the sweat level. The inputs from the sensors are integrated and processed. The results are sent through the GSM Module to a host computer, which stores the data into an Access Database. The stored data are continuously displayed on the LCD. If it is inferred that the person is medically distressed immediately a SMS will be sent to the clinician.

Heart beat sensor is used to measure the pulse rate of the person and calculated data are analyzed using microcontroller. The pressure sensor is used to measure the systolic and the diastolic pressure level of the person. LM35 sensor is used to measure the temperature of the human body.

A sweat sensor is based on two humidity sensors at different heights from the skin. The difference in their responses is proportional to the vapour pressure gradient and allows the sweat rate to be measured. The sensor signals are processed by a microcontroller. This processed data are transmitted by GSM and finally the received data is sent to the PC.

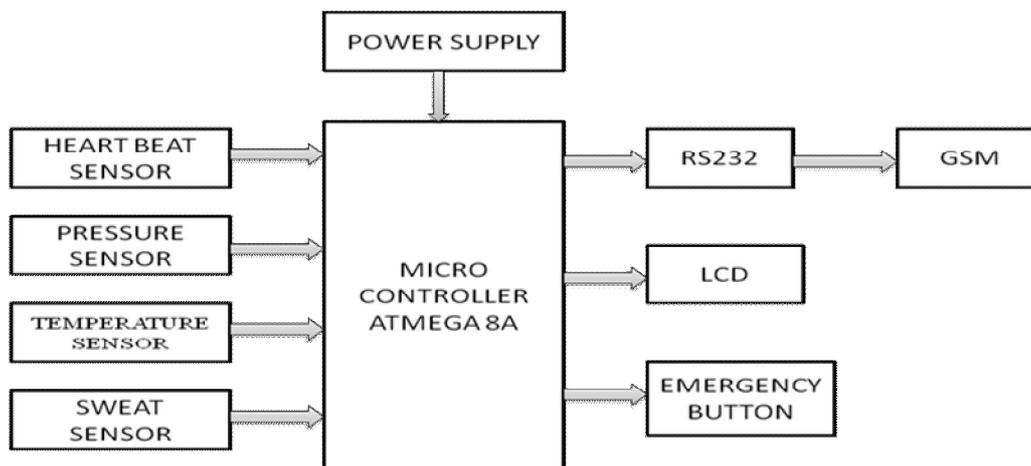


Fig.1: Functional Block diagram of proposed system

A. HEART BEAT SENSOR

The design system consists of an infrared LED as transmitter and an infrared photo-transistor as a receiver that acts as a sensor. Mohamed Fezari, et al. [4], describes the development of a heart rate monitor system based on a microcontroller. The sensor consists of a super bright red LED and light detector. The LED needs to be super bright as the maximum light must pass spread in tissue and detected by detector. When the heart pumps a pulse of blood through the blood vessels, the tissue becomes a little more opaque and low range of light reached the detector. The detector signal varies with each heart pulse. This variation is converted to electrical pulse. This signal is amplified through an amplifier whose outputs voltage lies between 0 to 5V logic level signal. The normal human pulse range is between 60 to 100 beats per minute. It may vary during a person is exercising, emotional or with injury and illness.

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The heart beat rate measuring circuit is shown in the fig. 2. This circuit is designed to measure the pulse rate in the blood flow. The pulse rate is measured by IR transmitter and receiver. Infrared rays are emitted by infrared transmitter which is one type of LED. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter. The important feature of this sensor is both IR transmitter and receiver should be placed straight line to each other [5]. The IR transmitter and receiver are placed in the pulse rate sensor. The pulse rate is to be measured by clipping the pulse rate sensor in the finger. When supply is ON the IR transmitter passes the rays to the receiver. The IR rays are interrupted based on the blood flow.

The IR receiver is interrupted when there is change in rate of blood flow, subsequently a pulse signals are generated in the potential divider which is connected to A1 amplifier through the capacitor C1. The coupling capacitor C1 is used to obstruct the DC component because the capacitor reactance is depends on the frequency. Shobaranimada and Sandhyarani S [6] have developed a biotelemetry system , in which biosensor has adopted to measure heart rate and blood pressure from human body.

The LM 324 quad operational amplifier is constructed in amplifier section. It consists of four independent, high gains and within frequency remunerated operational amplifiers named as A1, A2, A3 and A4 amplifiers. The changeable pulse from the potential divider is improved by the A1 amplifier. In order to remove any DC component in the amplified signal, the capacitor C2 is connected in parallel with feedback resistor. If any spikes in the amplified signals, they are further filtered by the C3 and C4 capacitors. After filtration the A2 amplifier is used to amplify the signal. Then amplified signal is connected to inverting input terminal of comparator. The comparator is constructed by the A4 amplifier in which the reference voltage is given to non inverting input terminal.

The amplified signal is connected to inverting input terminal of comparator. The A3 amplifier generates the reference voltage. Then the comparator compares the two signal and delivered the +12v to -12v square wave pulse at its output. In order to convert the TTL voltage between 0 to 5v level and it is given to the microcontroller.

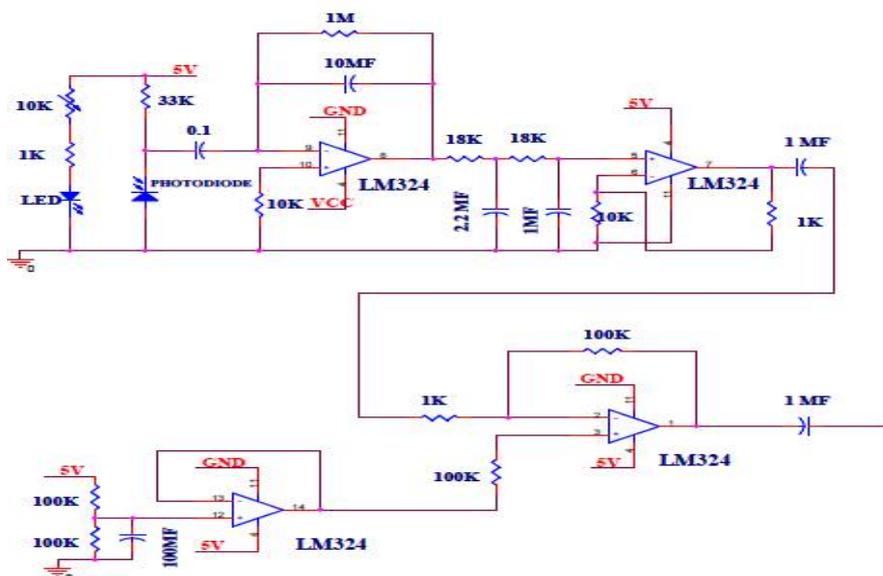


Fig.2: Heart beat sensor measuring circuit

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B. TEMPERATURE SENSOR

The LM35 series are correctness integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. Thus the LM35 has an advantage of calibrated in degree Kelvin, as the user is not necessary to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The working range of LM35 is -55°C to $+150^{\circ}\text{C}$ temperature range. The Temperature sensor LM35 circuit diagram is shown in the fig. 3

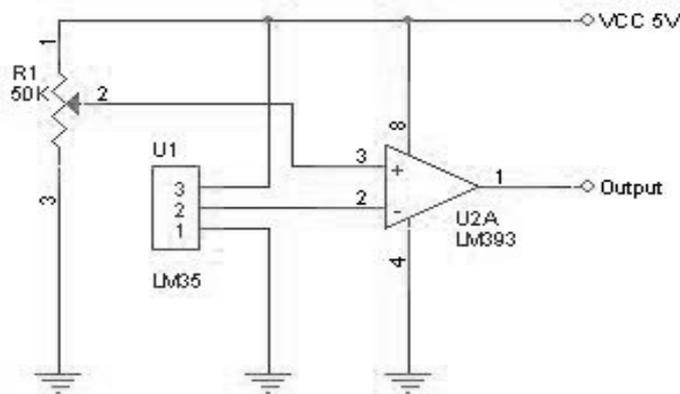


Fig.3: Temperature Sensor

It has less self heating error. In ambient temperature, the output voltage varies 10mv for every degree Celsius rise or fall. It has the scaling factor of $0.01\text{V}/^{\circ}\text{C}$. One lead of the LM35 is connected to power supply through a resistor and the other lead is connected to ground. The output of the LM35 depends upon the temperature of the person wearing the suit. The output is connected to the analog pin of microcontroller which provides the output in $^{\circ}\text{C}$. The resistance of the LM35 decreases when the temperature level is increased.

C. BLOOD PRESSURE SENSOR

Blood pressure sensor measures the force of blood against the walls of arteries. Blood pressure is recorded as two numbers such as the heart contracts between beats is known as systolic pressure and the heart relaxes between beats is known as diastolic pressure. The measurement is written in such way that one above or before the other, the systolic number on top and the diastolic number on the bottom. For example, a blood pressure aspect of 120/80 mmHg (millimetres of mercury) is expressed verbally as "120 over 80". Working voltage of the blood pressure sensor is +5v, 200mA Regulated.

The Pressure sensor circuit diagram is shown in the fig 4. This circuit is designed to measure the varying pressure. The pressure is calculated by diaphragm which is one type of transducer. When pressure is applied, the diaphragm is moving in the forward side. The movement of diaphragm depends on the pressure. So it generates the voltage pulse depends on the movement of diaphragm. The voltage pulses are in the range of milli voltage. Hence the voltage pulse is specified to Instrumentation Amplifier section in order to amplify the signals.

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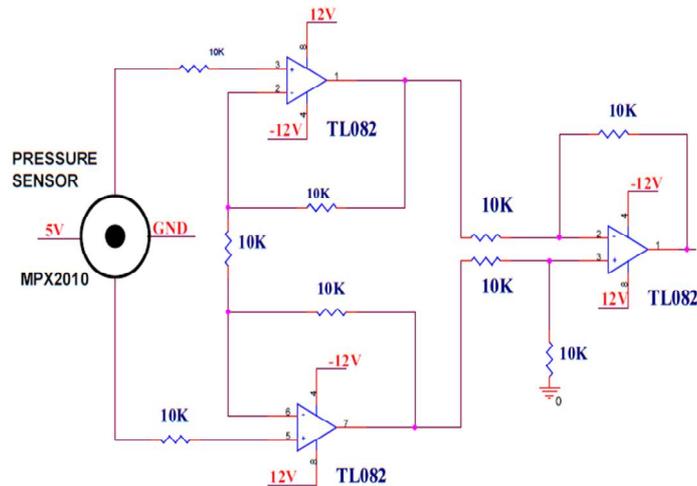


Fig.4: Blood Pressure Measuring Circuit

D. MICROCONTROLLER

An Atmega8a Microcontroller is used to collect and process the data. It collects all the outputs from the wearable sensor and process the data via GSM. It has high performance RISC architecture. It operates under the voltage of 2.7-5.5 V. he ATmega8 achieves throughputs approaching 1 MIPS per MHz, and allowing the system designer to optimize power consumption versus processing speed.

E. MAX232

The MAX-232 IC is used in the RS232 communication system for the conversion of voltage levels on TTL devices that are interfaced with the PC serial port and the Microcontroller based health monitoring system. It is a transmitter/receiver which includes the capacitive voltage generator to the supply of RS232 voltage levels through the 5V supply. These parts are particularly helpful in battery-powered systems, since their low-power shutdown mode which reduces power dissipation to less than 5μW.

F. GSM

The Modem is approaching with RS232 interface, which allows us to bond PC as well as microcontroller with RS232 Chip (MAX232). The baud rate is configurable from 9600-115200 through AT command. AT commands need to be send from microcontroller and receive response from GSM and display it on LCD. Microcontroller's serial port is used to communicate with GSM, means using PIN 10 (RXD) and 11 (TXD). The GSM/GPRS Modem is having interior TCP/IP stack to permit us to connect with internet via GPRS. The onboard Regulated Power supply allows us to connect wide sort tolerant power supply. Using the modem, it can make audio calls, SMS, voice chat and internet etc. through simple AT commands.

G. DISPLAY

A liquid crystal display (LCD) is a thin, plane display device made up of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a feature of liquid crystal molecules floating between two

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transparent electrodes and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be disinfected by the other. The liquid crystal bend the polarization of light entering one filter to allow it to pass through the other. It is possible to display 16 characters on each of the 2 rows.

IV. SIMULATION AND RESULTS

The Schematic diagram of the system is shown in the fig 5. In this paper ATMEGA 8 microcontroller is used for processing the data. The simulation circuit is drawn as per circuit diagram by using proteus8 software. All the wearable sensors are connected to the microcontroller and the acquired output data is displayed in LCD.

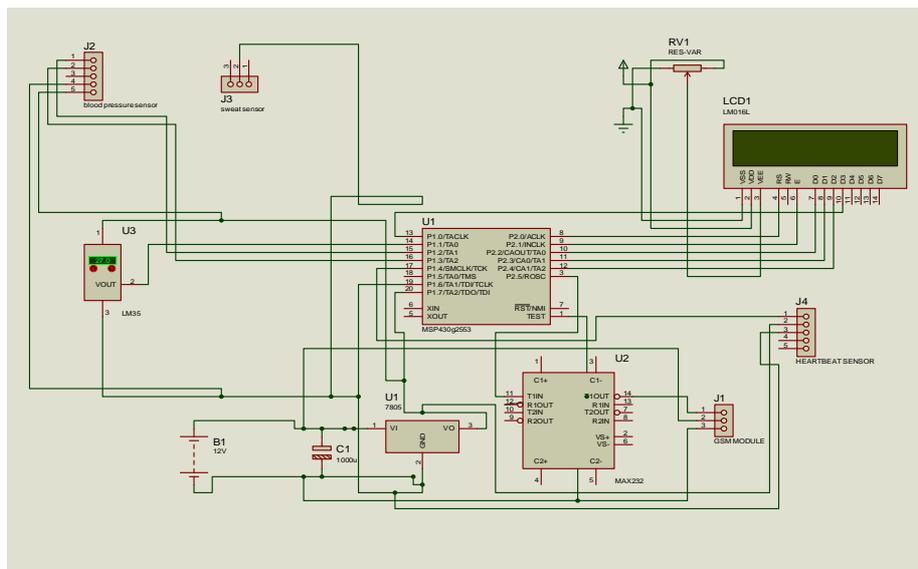


Fig.5: Schematic diagram of the Proposed System

The prototype model of health monitoring system using GSM is shown in the fig.6. This technique develops a system to upgrade existing health monitoring systems in the hospitals by providing monitoring capability and as a result a better treatment will be obtained. The hardware is implemented and the output is studied.

Higher accuracy in diagnosis of a patient can be obtained by this method, which plays an important role in health care unit in terms of more reliable and effective.

This proposed system provides early detection of heart attacks by alerting hospital staff or doctor in case a patient's heart rate, body temperature is detected as abnormal.

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Fig.6: Prototype model of Medical Power Suit

V. CONCLUSION

In this paper, the physiological parameters of patient such as Body temperature, heart rate, blood pressure and sweat level are monitored. This system can able to transmit the data which is sensed from the patient in the remote place to the doctor's PC by using GSM technology. Any abnormal change in patients health conditions are informed via SMS to the indicated mobile number through GSM. Suppose the proposed sensor unit is available in the patient's house, the caretaker need not being present with patient for monitoring his/her health condition. In the proposed system the patient health is continuously monitored and the acquired data is analyzed at a centralized microcontroller. The performance of this system shows that the high reliable operation, high efficiency, low cost, high speed with real time measurement. The proposed medical power suit is portable and, used in home, during travelling and in hospital. Tremendous development in the field of biomedical industry and highly sensible sensor more parameter can be sensed and monitored which will drastically improve the efficiency of the wireless monitoring system.

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