Heartbeat and Temperature Monitoring System for Remote Patients using Arduino

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Abstract— This paper describes the working of a wireless heartbeat and temperature monitoring system based on a microcontroller ATmega328 (arduino uno). Most monitoring systems that are in use in today's world works in offline mode but our system is designed such that a patient can be monitored remotely in real time. The proposed approach consists of sensors which measures heartbeat and body temperature of a patient which is controlled by the microcontroller. Both the readings are displayed in LCD monitor. Wireless system is used to transmit the measured data from the remote location. The heartbeat sensor counts the heartbeat for specific interval of time and estimates Beats per Minute while the temperature sensor measures the temperature and both the data are sent to the microcontroller for transmission to receiving end. Finally, the data are displayed at the receiving end. This system could be made available at a reasonable cost with great effect.

Keywords— Arduino, Heartbeat Sendors, Health Monitoring System, Temperature Sensors.

I.   INTRODUCTION

In today's world, the maximum use of resource is always complimented. So, the use of wireless technology is enhanced to meet the need of remote control and monitoring. Remote patient monitoring (RPM) is a technology that helps us to monitor patient even when the patient is not in the clinic or hospital. It may increase access to health services and facilities while decreasing cost. Remote Patient Monitoring saves time of both patient and doctor, hence increasing efficiency and reliability of health services.

Heartbeat and body temperature are the major signs that are routinely measured by physicians after the arrival of a patient. Heart rate refers to how many times a heart contracts and relaxes in a unit of time (usually per minute). Heart rate varies for different age groups. For a human adult of age 18 or more years, a normal resting heart rate is around 72 beats per minute (bpm). The functioning of heart can be called as efficient if it is having lower heart rate when the patient is at rest. Babies have a much higher rate than adults around 120 bpm and older children have heart rate around 90 bpm.

If the heart rate is lower than the normal heart rate, it is an indication of a condition known as bradycardia and if the heart rate is higher than the normal heart rate, it is an indication of a condition known as tachycardia.

Like heart rate, normal body temperature also varies from person to person and changes throughout the day. The body temperature is lowest in the early morning and highest in the early evening. The normal body temperature is about 37° C or 98.6 ° F. However, it can be as low as 36.1° C (97°F) in the early morning and as high as 37.2° C (99° F) and still be considered normal. Thus, the normal range for body temperature is 97 to 100 degrees Fahrenheit or 36.1 to 37.8 degrees Celsius. Temperature can be measured by using different types of sensors. These sensors come in different forms such as thermocouples, thermistors, resistance temperature detectors (RTD), and integrated circuit (IC) sensors.

The temperature sensor produces analog output voltage which is proportional to the temperature. The temperature sensor requires analog to digital (A/D) converter so that the analog output voltage can be converted to digital form. The output of the temperature sensor is connected to the Port A of AT MEGA328R-PU arduino uno. The arduino uno processes this data and displays it in LCD as well as sends it to the receiving end for displaying at the remote place. This paper describes the design of a very low-cost remote patient monitoring system which measures heart rate and body temperature of a patient and sends the data to a remote end where the data will be displayed and physician or doctor will be able to examine him/her. This device will be much needed during emergency period or for saving time of both patient and doctor.

II.   LITERAURE REVIEW

- With emerging wireless techniques like Bluetooth and Zigbee technology wearable sensors are used for patient monitoring due to the advantages like mobility and low power consumption by the system.
- The advantages are treatment can be given to the patient in priority to the disease they have when comparing with other patients, when in critical situation they can be hospitalized.

- These types of communication will only work for shorter distance and duration. A study was done to determine the types of vital signs that are routinely measured for a patient by doctor.
- The vital signs are body temperature, pulse rate and detection of fall. Body tissues mass-weighted average temperature and skin temperature are measured.
- Direct temperature measurement of peripheral tissue is more complex than core temperature measurement. Vital signals of patient health can be monitored by biomedical system using zigbee.
- The system is two tiered, used for gathering and processing biomedical signals.
- First the device with number of biosensors has to be placed on the body and second is processing by a local base station using the raw data transmitted on request by the mobile device.
- Smart wearable remote health monitoring systems are increased in usage for good quality in health services and low cost, by avoiding unnecessary hospitalizations and to ensure urgent care.
- System contributes to the enhancement of disease prevention with cost effective telemedicine platform. For physiological parameters measurement the network is approached to deal with monitoring and analysis of patient health.
- Data from sensors are acquired and transmitted to server by the network. Physiological parameters can be processed and automated by system and displayed on the monitor.
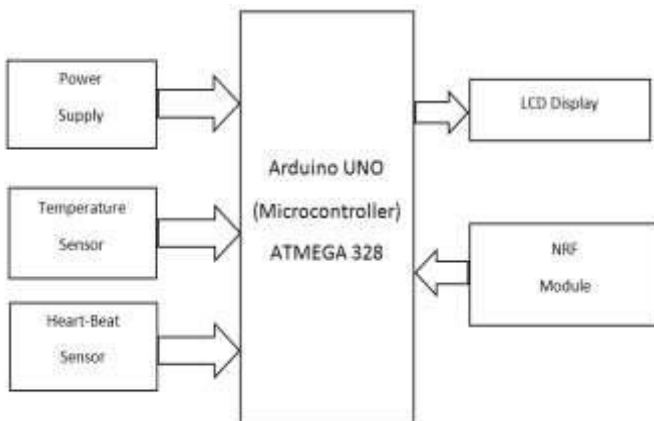

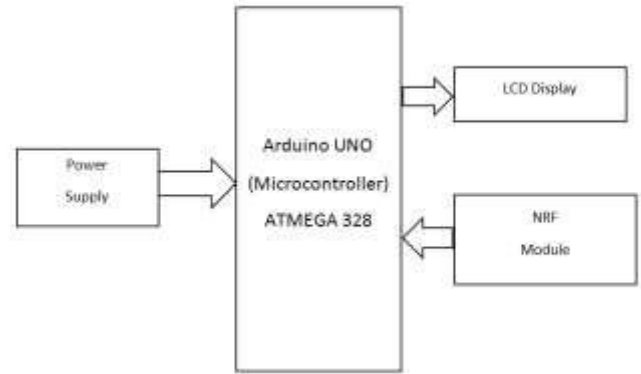*Fig. 2.1: Block diagram of transmitter section*

Fig. 2.2: Block diagram of Receiver section

III.   PLATFORM INTRODUCTION

A Remote Health Monitoring System consists of three main components such as data sensing module, data processing module and data communication module. The data sensing module consists of temperature sensor and heart beat sensor which senses the changes in the respective physiological parameters. The information is then conveyed to the PIC microcontroller of data processing module. The data processing module analyzes the input signals. The noise signals are filtered and if the processed value exceeds than normal value, medicine which is to be given as a first aid for patient is displayed on the personal computer using GUI. The communication module is used to transfer data between person and equipment. This has basic components such as the message, the sender, the receiver, the medium and the protocol by which the message is sent to the doctor through mobile phones by information gateway for the treatment to be taken.

IV.   WORKING OF SUGGESTED APPROACH
COMPONENTS USED

- Arduino ATmega328
- Temperature Sensor LM35
- Heart Beat Sensor (LM358)
- nRF24L01 Module
- LCD
- Potentiometer
- Power supply

WORKING

The aim of this proposed appproach is to design an automatic wireless health monitoring system. The objective is to monitor the temperature and heartbeat of the patient's body which should be displayed to the doctor using NRF technology. In hospitals, the monitoring of the patients' health is done by the staff members of the hospital. The temperature and heart rate of the patient's body is checked constantly and a record of it is kept.

The required components used in this system include a power supply, ATmega328 microcontroller, a temperature

sensor, an RF TX, an RX module and an LCD display. The ATmega328 microcontroller is used as a CPU for monitoring the temperature of the patient's body. The working of this proposed health monitoring system can be explained with the help of a block diagram. This block diagram includes a power supply block that supply power to the whole circuit, and a temperature sensor is used to sense the temperature and heartbeat of a patient's body.

The circuit diagram of the automatic wireless health monitoring system mainly includes transmitter section and receiver section. In the TX section, the temperature and heart beat sensor is used to detect the temperature and heartbeat of the patient's body and the data which are sensed by the sensor is sent to ATmega328.

The transmitted information can be encoded into serial data over the air through nRF module and the temperature of the patient's body values is displayed on the LCD display using an antenna arranged at the end of a transmitter and the data from the transmitter is transmitted to the receiver end.
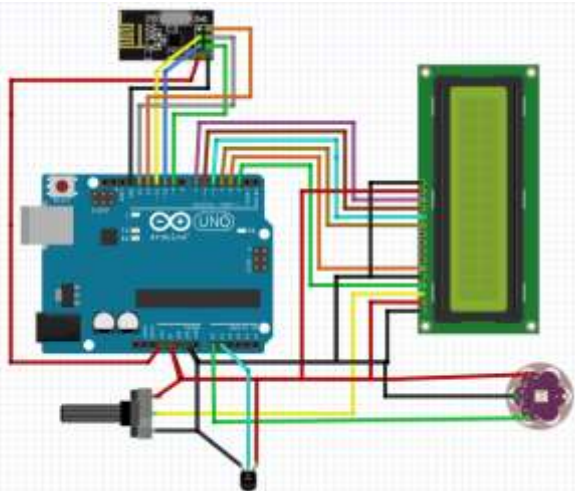

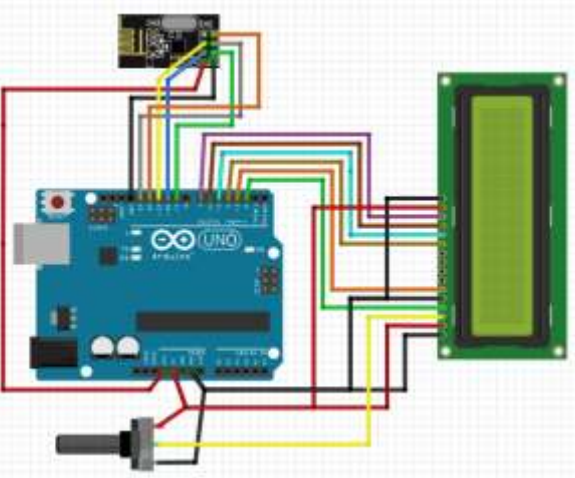*Fig. 4.1: Circuit Diagram of Transmitter section*

Fig. 4.2: Circuit Diagram of Receiver Section

V. DESIGN FEATURES

Health Monitoring System is done with modules of data sensing, data processing and data communication as shown in Fig. Three sensors are contained in data sensing module such as temperature sensor, heart rate sensor. Temperature sensor is used to measure the body temperature. Heartbeat sensor is used to measure the function of heart by blood flow through Finger. The output of each sensor is interfaced with Analog to Digital circuit (ADC) pins of microcontroller. Data processing module consists of ATmega328, 28-pin 8-Bit microcontroller of Harvard architecture which is a high-performance nRF circuit used to solve problems in conversion of RS232 signal voltage to TTL voltage and needed to communicate the receiver and sending SMS through information gateway, LCD is used as a display unit in connection with microcontroller for displaying the current details of physiological parameters.

Patient monitoring is applicable in different situations when a patient is in the following conditions:

- In unstable physiological regulatory systems – for instance, in the case of overdose of anesthesia.
- In a life threatening condition – for instance, when there is an indication of heart attack in a patient.
- In a critical physiological state.

5.1 Single parameter monitoring system: This system is used for measuring the blood pressure of a human body, monitoring ECG, monitoring SPO2 (oxygen saturation in blood), and so on.

5.2 Multi parameter monitoring system: This system is used for monitoring multiple critical physiological signs of patients by transmitting the vital information like ECG, respiration rate and blood pressure, etc. Due to these reasons, multi parameter patient monitoring systems play a significant role in the field of medical devices.

VI. RESULTS

6.1 Temperature Measurement

When the power is turned on, all the LEDs on PCBs starts glowing, indicating that circuit is working properly. Here there is a use of the industrial temperature sensor i.e. LM 35 which gives us room temperature in °C. That temperature is displayed on the LCD.

6.2 Heartbeat Measurement

There is a cavity for measurement of the heartbeat, which consist of an arrangement of LED and LDR. Patients' finger in placed between LED and LDR, and the heart pulses are detected. The analog voltages are further processed with an operational amplifier LM 358, and this chip has two built in OPAMPs. Result is displayed on the LCD. This collected data is transmitted using nRF24L01 module. This data is received at the receiver section using

same nRF24L01 module.

VII.   CONCLUSION

We have analyzed the wireless patient health monitoring system of temperature and heartbeat of humans using nRF24L01. The heartbeat was measured with the help of photodiode and bright LED while the temperature was measured by using precision integrated temperature sensor LM35. Both the data were processed in the arduino uno and sent to the remote end wirelessly by using nRF transmitter and received at the remote end by using nRF receiver. The received data was processed in the arduino uno and the data measured was displayed successfully with the help of LCD at the remote end. The wireless communication was preferred because it gives greater mobility to the sensor equipment and reduces the cost wherein there are multi-transmitting sections.

VIII.   FUTURE APPLICATIONS AND DEVELOPMENTS

- The device can be connected to PC by using serial output so that measured heartbeat and temperature can be sent to PC for further online or offline analysis.
- Warning for abnormalities of health condition can be displayed.
- Sound can be added to the device so that the device makes a sound each time a pulse is received and alarm is started for abnormal health condition.
- The output can be sent to mobile phones by using GSM module or Bluetooth module for further analysis.
- More parameters (like blood pressure) can be added to the device.
- In addition to the system can also provide more than one numbers so that more than one user can receive emergency message.
- According to availability of sensors or development in biomedical trend more parameter can be sense and monitor which will drastically improve the efficiency of the wireless monitoring system in biomedical field.

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