Implementation of a Portable Health Monitoring System using Arduino Uno

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ABSTRACT

An Aurdino Uno based health monitoring system is presented here that can be used for monitoring heart rate, blood oxygen saturation level, body temperature, and body sweat simultaneously and continuously. The data can be recorded and used later. To measure the crucial parameters, Aurdino UNO (R3) board, DS18B20 temperature sensor, MX30100 oximeter, and rain detector (used as sweat detector) have been used. The system is portable and works properly even without any physical contact with any person.

Keyword: - *Arduino Uno, Health Sensor, Rain sensor, Real Time Health Monitoring, Temperature sensor*

1. INTRODUCTION

Arduino Uno (R3) is an open-source microcontroller board used for many smart applications [1-5], which include Robotics, Smart home applications and Internet of Things (IoT) based agricultural mechanism for better growth and sustenance of agriculture sector etc. Smart health monitoring systems have also been proposed [6–10] that take into account the crucial parameters related with health. Present work reports a smart health monitoring system which is not only cost effective and smart, but also portable and includes many crucial health parameters. The patients can handle the system on their own and monitor their own health condition from time to time. This not only removes the burden on hospitals, especially in Covid prone times where many persons need simultaneous medication. It is also effective in remote areas where sophisticated modern facilities are not available. The data can be sent to the doctors via mobile and a quick and comprehensive prescription can be obtained in no time. The crucial parameters can be continuously monitored to avoid any emergency.

The advantages of the present smart health monitoring system over other health monitoring are self-evident. Data has been collected for five different persons and the time monitoring of 24 hours on one person has been reported. Life has become very stressful and its impact on health of individual needs serious attention. Heart related diseases are very common in the present life style. Not only the aged people, but also the young persons are becoming prone to these diseases.

In the present health monitoring system, crucial parameters related with heart functioning like pulse rate, temperature, sweating condition and oxygen saturation level have been monitored. These four parameters are very crucial in case of persons suffering from heart diseases. Temperature measurement is useful for indication of any infection in the body. Pulse rate is to be continuously monitored to avoid any chance of severe heart attack. Studies on oxygen saturation level in blood and its relation in patients diagnosed with the acute myocardial infarction have been reported. Further if a patient with history of heart disease is infected with Covid-19, it becomes the predominant factor. Excessive sweating is also related to many heart diseases like sub-acute endocarditis (infection of membrane of heart chambers and heart valves) and atherosclerosis (obstruction in arteries due to fat deposition). Excessive sweating can also be a sign of heart attack and angina or chest pain when sufficient oxygen rich blood is not able to reach heart. It becomes very important to measure the amount of sweating in patients suffering from heart diseases.

2. HARDWARE DESCRIPTION

The proposed portable health monitoring system utilizes Arduino UNO (R3), Liquid Crystal Display (LCD), DS18B20 temperature sensor, MX30100 Oximeter, Rain sensor (for sweat level detector) assembled on a breadboard with jumper wires. All these components are described here.

2.1 Arduino Uno (R3)

Arduino Uno (R3) is a microcontroller based on ATmega328P. It supports 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator and a USB connection. PWM (Pulse width modulation) outputs can be obtained from 6 pins out of 14 digital pins. All necessaries are available on the board to support the microcontroller. The board can be connected to the laptop directly.

Fig -1: Arduino Uno (R3) Board [Source–Internet]

2.2 Liquid crystal display (LCD)

In the present work, a 16×2 LCD has been used to display the value of temperature, heart rate, sweat level and oxygen level.

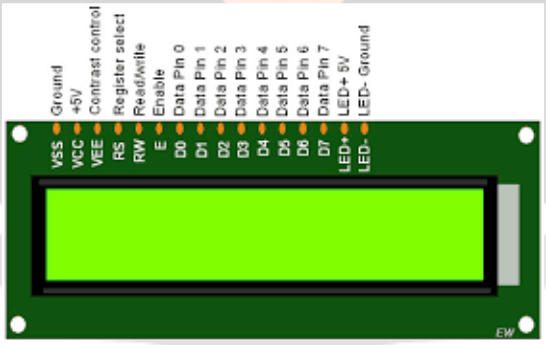

Fig -2: Liquid Crystal Display (LCD) [Source-Internet]

2.3 DS 18B20 Temperature sensor

Temperature sensor DS18B20 has been used to determine the temperature of human body as shown in Figure 3a. It is a water proof temperature sensor. The DS18B20 temperature sensor from maxim integrated is a 1-wire programmable bus communication. It operates at an applied voltage of 3.0 V – 5.5 V. It can be used in a wide range of temperature from -55 0C to +125 0C with accuracy of ±0.5 0C.

2.4 MAX30100 Pulse Oximeter Sensor

Measurement of heart rate and blood oxygen level in the body were done using MAX30100 sensor as shown in Figure 3b. The MAX30100 module has an integrated pulse oximeter and a heart rate monitor sensor. It functions on

the response of two LED's, a photodetector and optimized optics. A low noise analog signal processing is used to detect pulse oximetry (SpO2) and heart rate signals. The MAX30100 operates between 1.8-3.3V of power supply. The principle on which it works is that the blood coming from heart is rich in oxygen as compared to the blood entering the heart. When heart pumps blood, oxygenated blood increases and when heart relaxes, the volume of oxygenated blood decreases. The pulse rate is calculated by knowing the difference in time between the increase and decrease of oxygen rich blood. Further, oxygenated blood absorbs more infrared light and passes more red light where-as deoxygenated blood absorbs red light and passes more infrared light. Absorption levels of both light sources are recorded and pulse rate is calculated from these levels. It reads the absorption levels of both light sources and stores the result in a buffer.

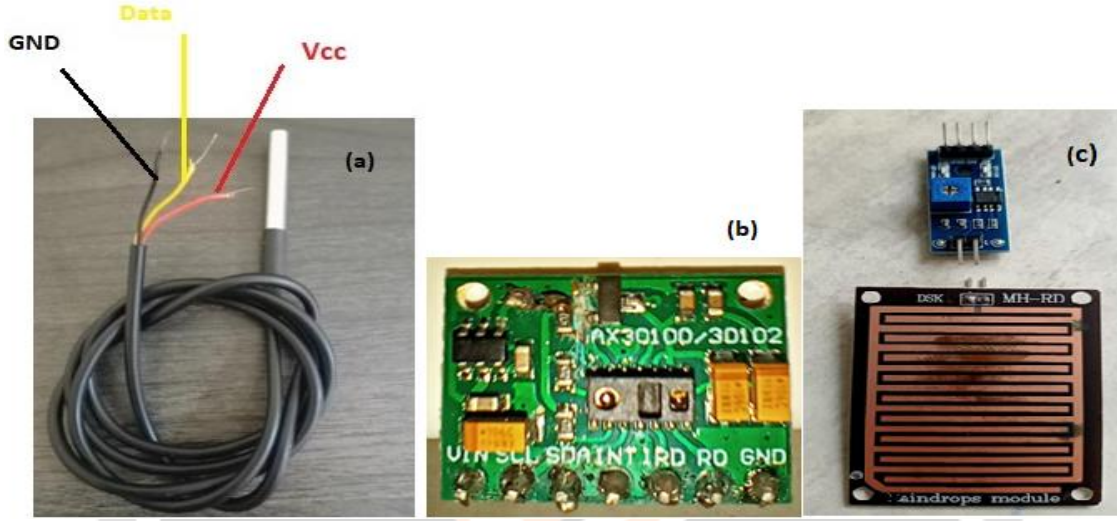

Fig -3: Sensors used in this work (a) Temperature sensor (DS18B20) (b) MAX30100 pulse oximeter (c) Rain (sweat) sensor

2.5 Rain Sensor Module

To detect the sweat condition of the patient, a rain sensor has been employed as shown in Figure 3c. A rain sensor is a resistive dipole based on the LM393 op amp and uses nickel coated line to measure the resistance change. Less resistance is observed when the system is wet and more resistance is observed when dry. The sensor module senses the moisture through analog pins and gives a digital output proportional to the amount of moisture. When there is no sweat/moisture on board the resistance is increased and a high voltage is found according to relation V=IR (V is voltage, I is current and R is resistance). When sweat is present, it reduces resistance because water is a conductor of electricity and presence of water connects nickel lines in parallel so reduces resistance and reduces voltage drop across it.

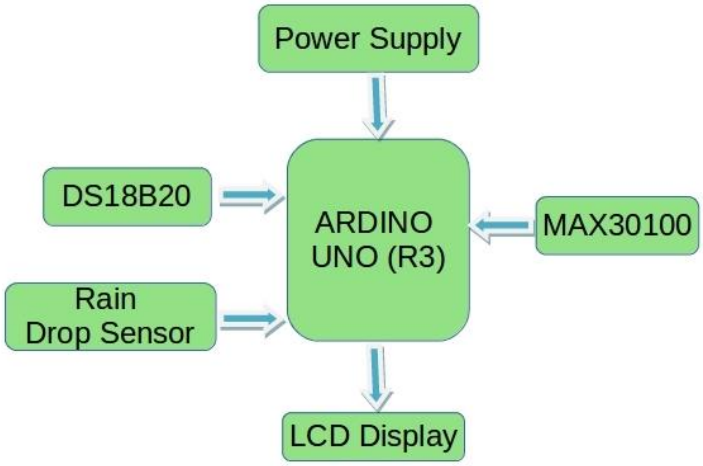

Fig -4: Block Diagram of the Health Monitoring Circuit

3. IMPLEMENTATION AND TESTING

3.1 Temperature Measurement

The set up for the temperature sensing is shown in Figure 5. The sensor converts temperature changes into voltage changes. It requires a DC voltage source of +5V and has a current consumption of 60 mA in operation. Three legs of the sensor are connected to the Vcc (+5V), pin A2 and ground of Arduino UNO (R3) board Figure 1. The intelligent temperature sensor DS18B20 is installed on body parts such as the armpit or wrist for continuous monitoring of temperature. Temperature of five different persons have been recorded and reported in Table 1. Continuous temperature monitoring for 24 hours has also been recorded and shown in Figure 8.

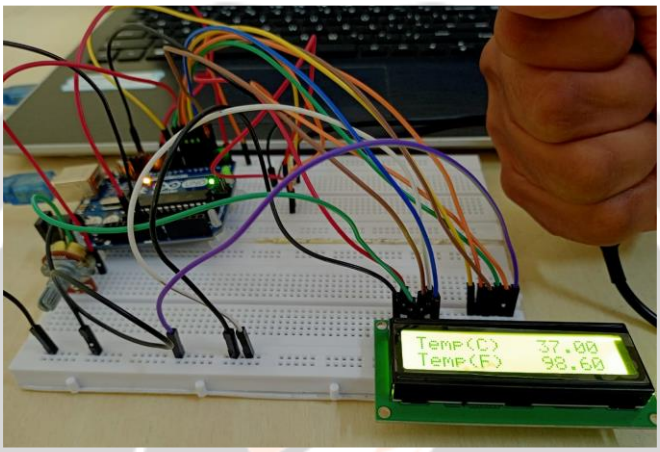

Fig -5: Temperature measurement set up

Table -1: Table showing the real-time monitored experimental data

Patient	Heart Rate	SpO2 level	Temperature (oF)
1	73.3	99	96.5
2	72.4	99	97.0
3	52.2	97	98.3
4	65.6	98	96.8
5	72.3	99	98.6

3.2 Sweat level measurement

To measure the sweat level of the body, rain drop sensor has been used Figure 6. The sensor is swiped on the forehead of the person two or three times. The sweating condition is indicated by the blue/green LED in the circuit. If it is not excessive (less than 30level set in the program), blue light is on and the LCD screen shows normal. If it is more than this level as in the case of excessive sweating then green light LED turns on and the LCD screen shows excessive as shown in Figure 6.

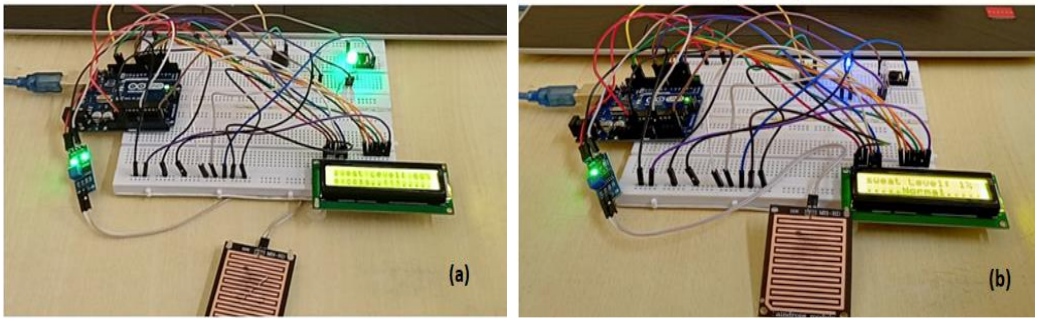

Fig -6: Measurement of Sweat Level (a) Case of excessive sweating, (b) case of normal sweating

3.3 Heart rate and oxygen level measurement

The SpO2 level and heart beat rate are measured using MAX30100 and the connections are shown in Figure 7. The SpO2 level is ~95% for a healthy person and agrees with the data shown in Table 1. If it is below this level, the person must be hospitalized. The continuous monitoring of SpO2 level and heart beat are reported in Figure 9 and Figure 10. Normal heart beat for adults (ages 18+) varies from 60 to 100. However, this varies with age and condition of the person. Lower heart beats sound an efficient heart.

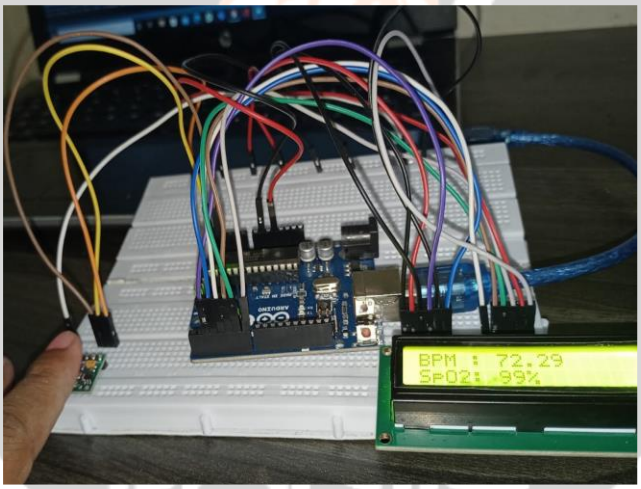

Fig -7: Measurement of heart rate and blood oxygen level (SpO2)

All these measurements were re-verified against the conventional methods and found to be in agreement within the acceptable error.

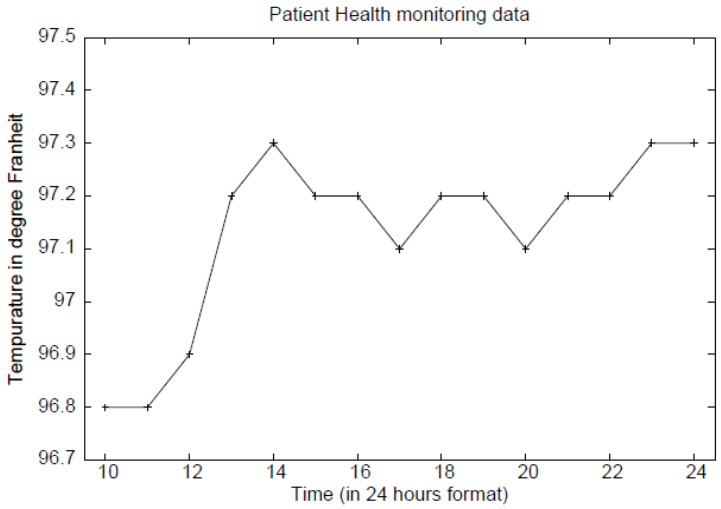

Fig -8: Monitoring of Temperature with time

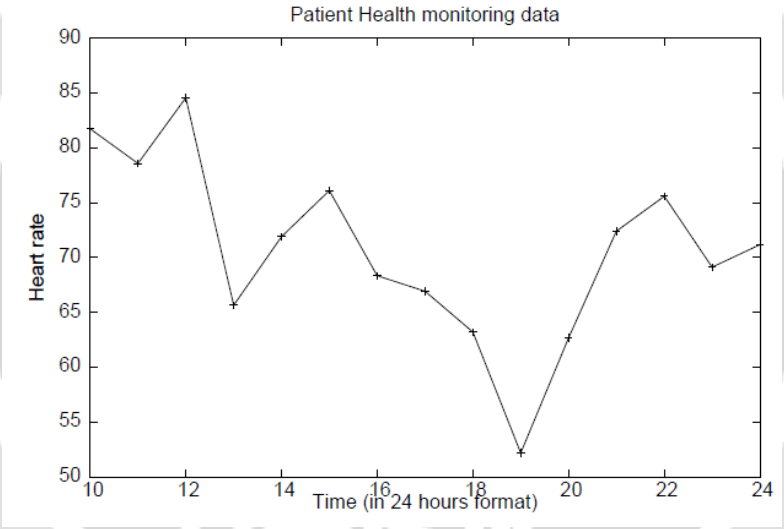

Fig -9: Monitoring of heart beat with time

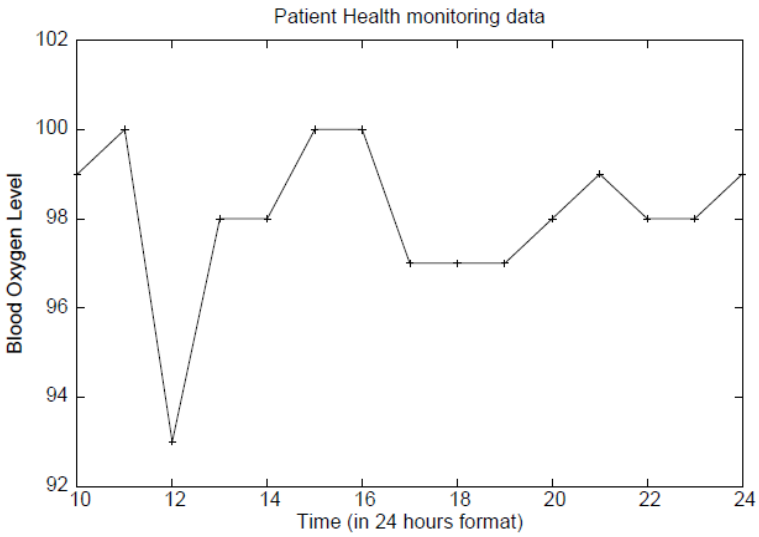

Fig -10: Monitoring of SpO2 with time

4. CONCLUSIONS

A low cost, portable health monitoring system has been implemented using Arduino UNO (R3), which works well with patients suffering from severe heart diseases. The system has been tested on a number of patients and found to provide the crucial parameters continuously for a day in an efficient manner with reasonably accuracy and thus is suitable to avoid any emergency. This system can also be used to monitor various crucial health parameters continuously and a record of the report can be maintained and/or shared with the doctor. This health monitoring system avoids any physical contact with doctor and can be extremely useful in unpleasant situations like Covid pandemic.

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