CSE 360: Computer Interfacing Assignment

TOPIC: Health Monitoring System

GROUP NAME: Imperial

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Introduction:

The present modern age is the age of science and technology. Wherever we look, we can see the contribution of science. Every day, billions of people benefit from the progression of technology. In this modern age, everything comes with wireless, portability and ease to use. Technological developments of wireless devices and systems can also be found in the medical field. Wireless technology in the medical field has become readily apparent. It has allowed physicians and healthcare providers to connect remotely with patients and give a proper guideline. Nowadays, humans prefer an easy way to use the medical device without any prior medical knowledge. For example, glucometer, Digital BP machine and so on. This factor motivates us to develop our device named Health Monitoring System. We will be using three sensors in our device alone with two I/O device and a buzzer. The sensors are Fingerprint Recognition Module (AS608), Pulse Oximeter Spark Fun Photodetector Breakout - MAX30101 and LM35 Temperature Sensor Module and the I/O devices are 16*2 LCD monitor and a Micro SD module.

Application Area:

We're making this device because it's cheap, handy and easy to use. People can easily get to know about their body temperature, oxygen saturation, and pulse rate by using our device without having any prior knowledge about it. People could also be able to store their daily health checkup recording on the same device. Our device is intelligent. We will be using threshold values in our device, and if the value of oxygen saturation or body temperature which will be measured from our sensors, exceeds the threshold value the buzzer will beep. That means it will notify the user that they need to consult with a doctor and take proper rest. People can use it from home or and most importantly users can easily use our device without having any prior knowledge about it.

Technology and Tools:

Fingerprint Recognition Module (AS608) :

Fingerprint module's sole purpose is to keep the track of the patient's previous health records. The AS608 is capable of storing up to 128 individual fingerprints. Whenever a patient uses the fingerprint module his data will be saved.

Pulse Oximeter SparkFun Photodetector Breakout - MAX30101 :

It will be used to measure the oxygen level (oxygen saturation) of the blood and heart rate of the patient.

LM35 Temperature Sensor Module:

This temperature module will take the reading of the body temperature of the patient and will display it in Fahrenheit.

16x2 LCD Module:

This LCD module will display the oxygen level, heart rate , body temperature of the patient . It will also display the comparison health graph of a patient when the patient uses the fingerprint module multiple times.

Memory Module:

As we are using a fingerprint module for the patients who want to see the comparison health graph, we need memory to store those data. This memory module will store the patient's data containing their oxygen level, heart rate and body temperature.

Buzzer:

Buzzer will send a beep sound when the threshold value exceeds the emergency borderline.

Language:

Arduino, natively, supports a language that we call the Arduino Programming Language, or Arduino Language. The Arduino Programming Language is basically a framework built on top of C++.A program written in the Arduino Programming Language is called sketch. A sketch is normally saved with the ".ino" extension (from Arduino).

Working Mechanism of Sensors:

Optical Fingerprint Sensor (AS608):

Optical fingerprint sensors take low-resolution snapshots of the tip of a finger and create arrays of identifiers that are then used to uniquely identify a given fingerprint. Optical fingerprint scanners are the oldest method of capturing and comparing fingerprints. As the name suggests, this technique relies on capturing an optical image, essentially a photograph, and using algorithms to detect unique patterns on the surface, such as ridges or unique marks, by analyzing the lightest and darkest areas of the image. Just like smartphone cameras, these sensors can have a finite resolution, and the higher the resolution, the finer details the sensor can discern about your finger, increasing the level of security. However, these sensors capture much higher contrast images than a regular camera. These scanners typically have a very high number of diodes per inch to capture these details up close. Of course, it's very dark when a finger is placed over the scanner, so optical scanners also incorporate arrays of LEDs as a flash to light up the picture come scan time.

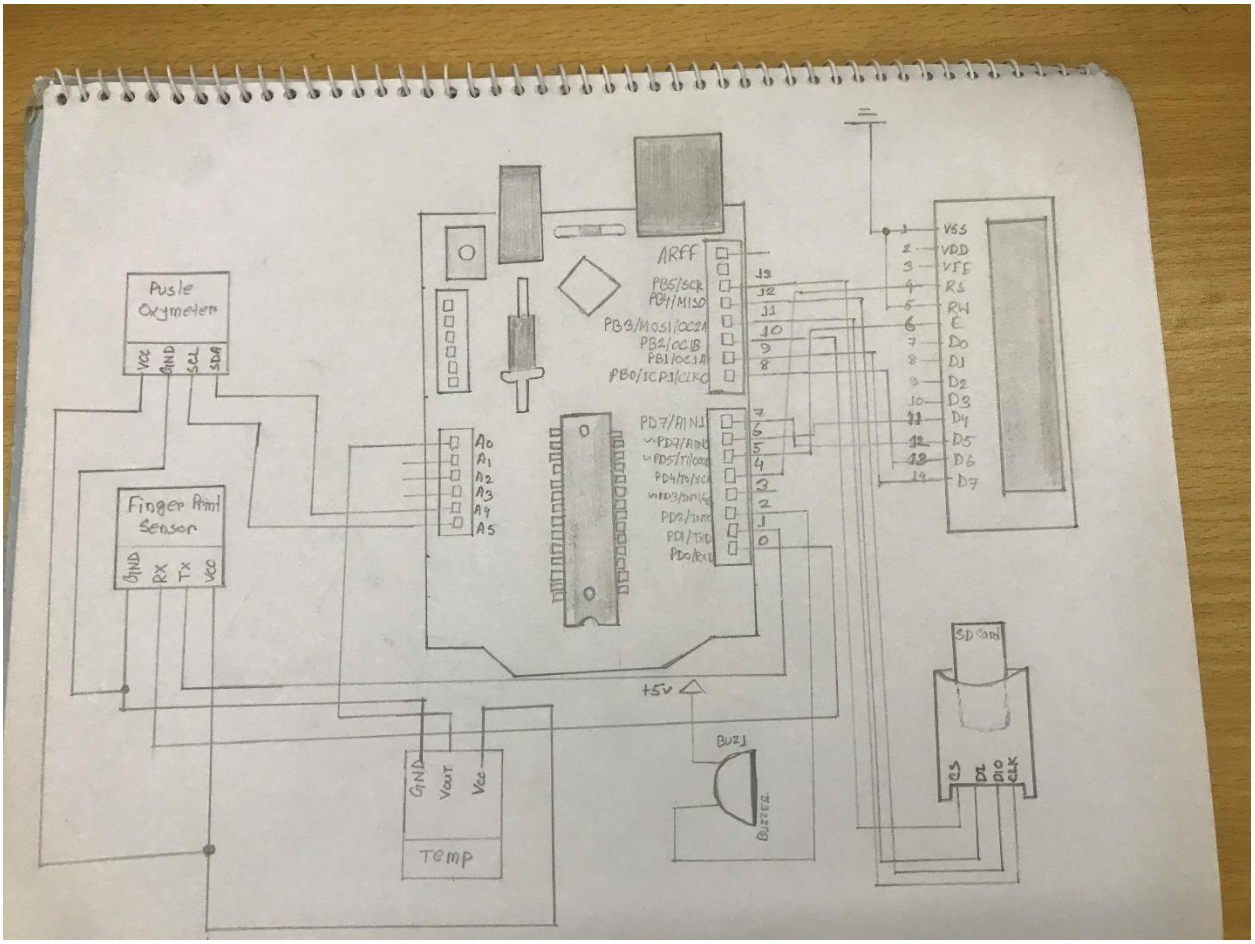
Pulse Oximeter MAX30101 :

Pulse oximeters measure how much of the hemoglobin in blood is carrying oxygen (oxygen saturation) along with heart rate. Pulse oximetry uses light to work out oxygen saturation. Light is emitted from light sources which goes across the pulse oximeter probe and reaches the light detector. Hemoglobin contains oxygen. One of the really interesting things about hemoglobin is how it reflects and absorbs light. For example, Hb absorbs more (and reflects less) visible red light. HbO2 absorbs more (and reflects less) infrared light. Since blood oxygen saturation can be determined by comparing the values of Hb and HbO2, one method for doing this is shining both a red LED and an infrared LED through a body part (such as a finger or wrist), and then comparing their relative intensities. Fully saturated hemoglobin (SpO2) will absorb more infrared light radially and de-saturated hemoglobin will absorb red light and by passing this information how much light is absorbed both infrared and red light, the machine will able to calculate the amount of fully-saturated hemoglobin in the patients' blood. When our heart beats it pumps blood through our body. During each heartbeat, the blood gets squeezed into capillaries, whose volume increases very slightly. Between heartbeats, the volume decreases. This change in volume affects the amount of light, such as the amount of red or infrared light, that will transmit through the tissue. Though this fluctuation is very small, it can be measured by a pulse oximeter using the same type of setup that is employed to measure blood oxygen saturation.

LM35 Temperature Sensor :

In general, a temperature sensor is a device which is designed specifically to measure the hotness or coldness of an object. The measurement of the temperature sensor is about the hotness or coldness of an object. The working base of the sensors is the voltage that read across the diode. If the voltage increases, then the temperature rises and there is a voltage drop between the transistor terminals of base & emitter, they are recorded by the sensors. If the difference in voltage is amplified, the analogue signal is generated by the device and it is directly proportional to the temperature.

Connection with ICs:



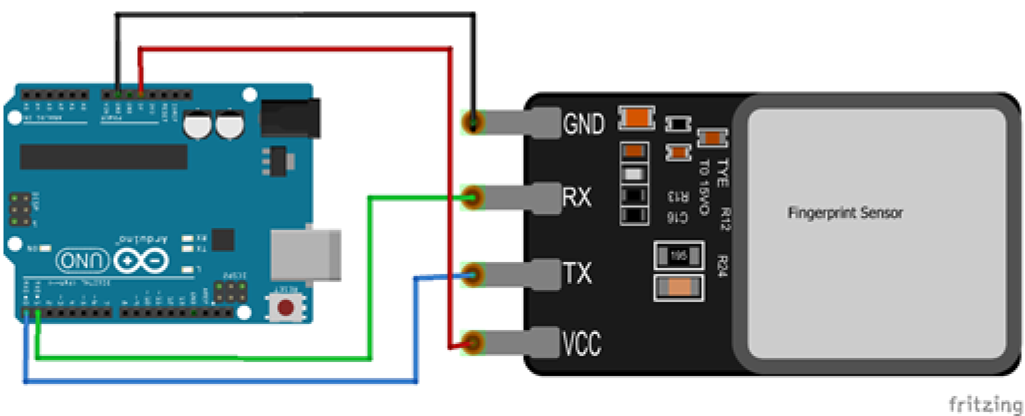
First of all, we connected the Fingerprint sensor's Rx with Arduino's Tx and sensor's Tx with Arduino's Rx so that they can transmit and receive data with each other. So, we decided to connect Rx with pin 1 and Tx with pin 0. Secondly, we connected the Micro SD Module. We connected the SCK with pin 13 to create Serial Clock, connected MISO with pin 12 to take Arduino's output as Micro SD's input, connected MOSI with pin 11 to take Micro SD's output as Arduino's input and connected CS with pin 10 to select the module for data transfer. Thirdly, we used pulse oximeter. For that, we connected SCL with A5 to produce pulse from Arduino to pulse oximeter and SDA to A4 pin to transfer data from pulse oximeter to Arduino. After that, we connected the V_{out} pin of Temperature sensor with the A0 pin of Arduino to get the data from the sensor.

Lastly, we connected 16*2 LCD and a buzzer with our Arduino. We connected the Rs with pin 4 to perform Register Select for different actions, E with pin 5 to Enable the LCD. Then we connected the D4, D5, D6, D7 with Pin 6, 7, 8, and 9 to transfer the data from Arduino to LCD. At last, we connected the buzzer pin with pin 2 of Arduino for a Digital Signal to turn on/off the buzzer.

Data flow from sensors through ICs to I/O devices:

Fingerprint Sensor Module-Arduino data flow:

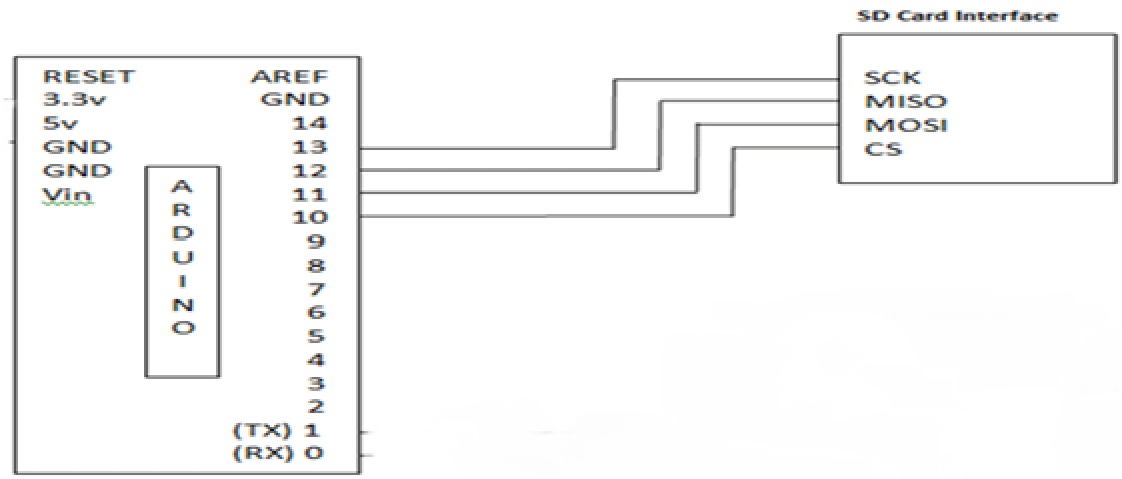
Fingerprint sensor module scans the fingerprint and sends the data through pin 0 and 1 of Arduino Uno. As, our fingerprint have to be secured, it uses the **Universal Asynchronous Receiver-Transmitter (UART)** to communicate with Arduino.



Fingerprint Module's Transmitter is connected with Arduino's Receiver pin 0 and Fingerprint Module's Receiver is connected with Arduino's Transmitter pin 1. As a result, when the fingerprint sensor transmits data through its Tx, Arduino receives it through its receiver Rx and when Arduino sends data through Tx the module receives through its own receiver Rx. UART's parity bit system makes the communication more secured.

Micro SD Module-Arduino data flow:

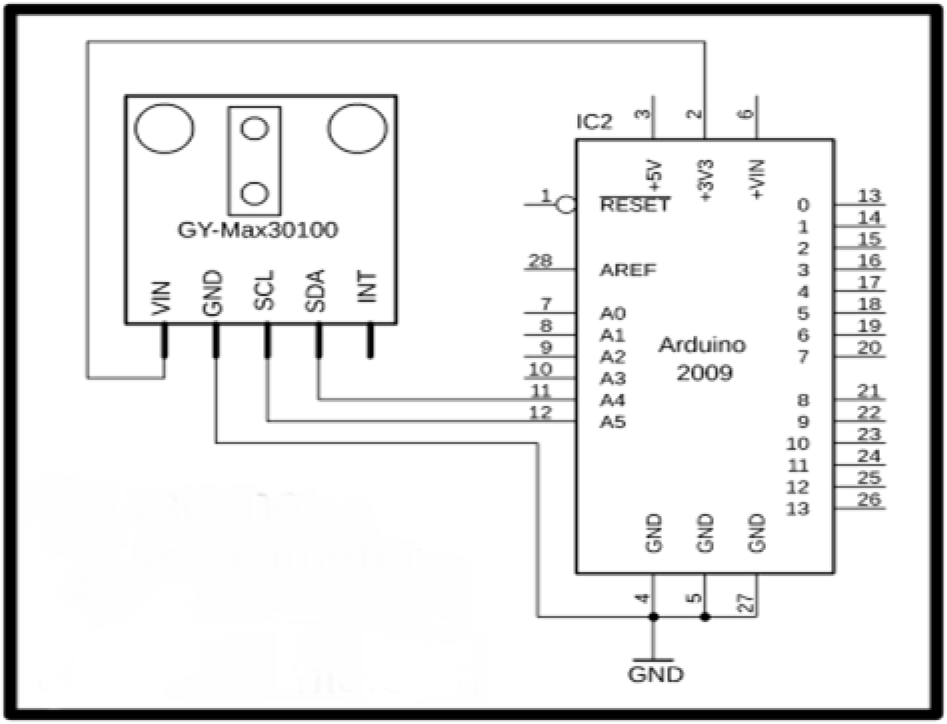
As we will save record for each of the user, we have to use some storage. We will use external Micro SD module to store our data to an external SD card as the Arduino doesn't have enough memory to store these much data.



To store the data, we need to have a speedy process to communicate with the storage. For this reason, will use Synchronous communication method as well as **Serial Peripheral Interface (SPI)** protocol. It will help us to transfer data faster by enabling the data packet transfer. Here, the Arduino will work as the Master and the Micro SD module will work as a slave. SO, it is single Master-single Slave connection. MISO will work when the data will be transfer from Arduino to Micro SD and the MOSI will work when the flow will be from SD to Arduino. SCLK will be used to produce Serial Clock during Data transfer. CS is used to select the slave.

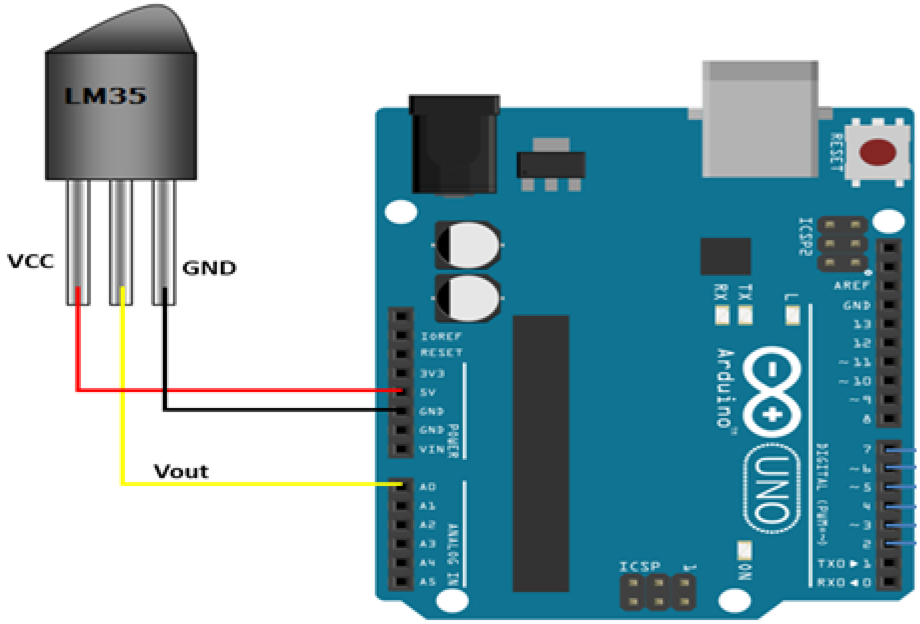
Pulse Oximeter-Arduino data flow:

This sensor module is different from other Modules we've used earlier in this project. Other modules communicate with Digital signals 0 and 1. But this module transmits different voltage level for different input. As a result, we have to use Analog pins for its diverse output. The output of pulse oximeter depends on the blood cell measurement. As a result, it transmits different signals for different numbers of blood cells. The more the blood cells, the more the output voltage will be transmitted.



So, we connect the **Serial Clock (SCL)** pin with A5 and **Serial Data (SDA)** pin with A4. This type of connection uses **Inter-Integrated Communication (I^2C)** protocol. With the SCL pic, Arduino can generate pulse. On the other hand, data is transmitted through SDA pin. It sends the device address, registrar address and the data through this register.

Temperature Sensor Module- Arduino Data flow: It is a simple sensor which produces its output according to the temperature. It communicates with Analog signa. The higher the temperature is, the more the Analog Signal will be.

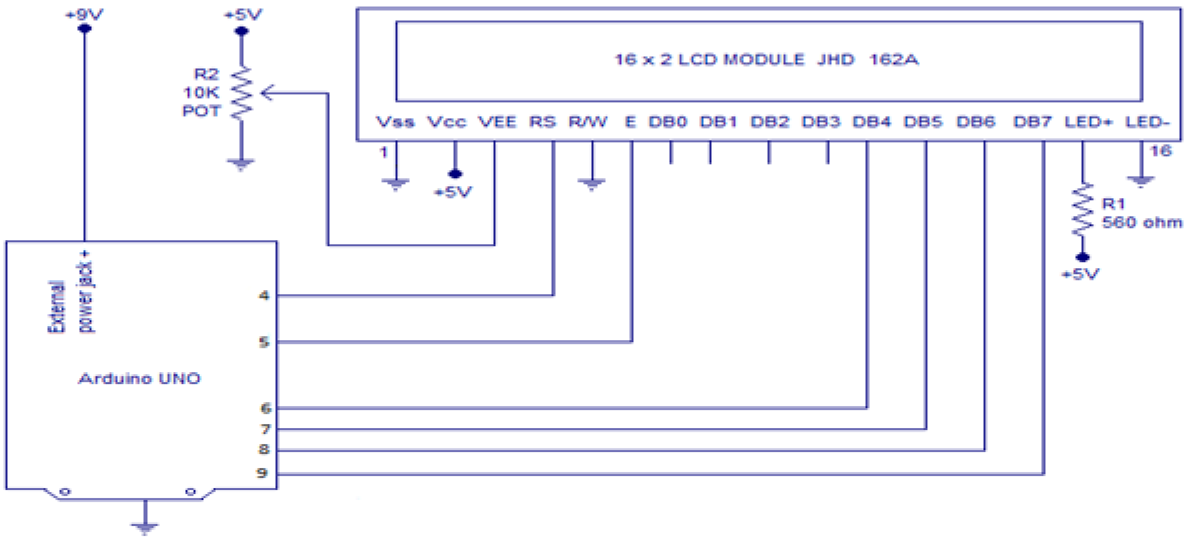


Output pin is connected with the A0 pin. It can produce up to 1023 Analog signal for maximum 5V. The voltage level and the signal changes with the temperature. Then we can calculate our temperature from this signal's value. In our project we used this equation:

F= (t*(5/1023) *100*9)/5+32

Arduino-LCD display Data flow:

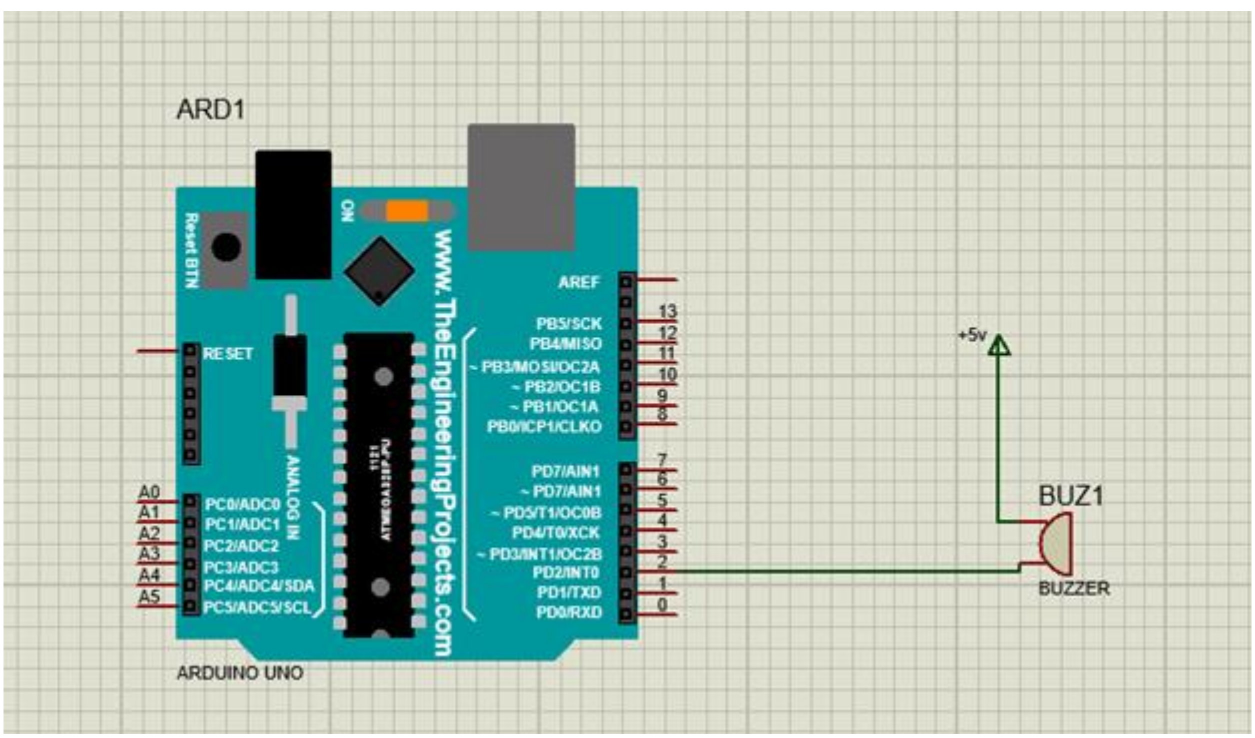
We are using 16x2 LCD display to display our heart rate, oxygen saturation and body temperature. We will connect the **Rw** pin with GND as we will always transmit data to LCD. We connected our **Rs** pin with Arduino's pin 4. Rs is used for register select to perform actions by sending commands in LCD (lcd clear, print) etc. We will connect E with the pin 5 to enable or disable the LCD.



Then connected out D4, D5, D6, D7 with pin 6, 7, 8 and 9 to take the data from Arduino. It selects the individual lcd to turn on from the Display segment. All these operations needed Digital signal, that's why we used Arduino's digital pins.

Arduino-Buzzer Data Flow:

This is the simplest connection in our project. One Digital pin is connected with the buzzer. We turn on the buzzer just by enabling the digital pin.



Code:

```
#include <Wire.h>
#include <MAX30100_PulseOximeter.h>
#include <LiquidCrystal.h>

#define REPORTING_PERIOD_MS     1000
float vout;
float temp;
// initialize the library with the numbers of the interface pins
//LiquidCrystal lcd(9, 8, 7, 6, 5, 4);
LiquidCrystal lcd(2, 4, 7, 8, 12, 13);

PulseOximeter pox;
uint32_t tsLastReport = 0;

void onBeatDetected()
{
    Serial.println("Beat!");
}

void setup()
{
    Serial.begin(115200);
    Serial.print("Initializing pulse oximeter..");
   // set up the LCD's number of columns and rows:
  lcd.begin(16, 2);
  // Print a message to the LCD.
  //lcd.print("Oximeter");
    // Initialize the PulseOximeter instance
    // Failures are generally due to an improper I2C wiring, missing power supply
```

```
    // or wrong target chip
    if (!pox.begin()) {
        Serial.println("FAILED");
        for(;;);
    } else {
        Serial.println("SUCCESS");
    }
     pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);

    // Register a callback for the beat detection
    pox.setOnBeatDetectedCallback(onBeatDetected);
}

void loop()
{
    // Make sure to call update as fast as possible
    pox.update();
    if (millis() - tsLastReport > REPORTING_PERIOD_MS) {



        lcd.clear();
        lcd.setCursor(0,0);
        lcd.print("BPM: ");
        lcd.print(pox.getHeartRate());

        lcd.setCursor(0,1);
        lcd.print("SpO2: ");
        lcd.print(pox.getSpO2());
        lcd.print("%");
```

```
        tsLastReport = millis();

        delay(5000);

        vout=analogRead(A0);
        temp=((vout*(5/1023)*100*9)/5)+32;
        lcd.clear();
        lcd.setCursor(0,0);
        lcd.print("Temperature(F): ");
        lcd.print(temp);
        delay(5000);
    }

}
```

Estimated cost analysis:

NAME	PRICE	QUANTITY	AUTHORIZED VENDOR
1.Fingerprint Recognition Module (AS608)	1436 TK	1	DARAZ
2.Pulse Oximeter SparkFun Photodetector Breakout-(MAX30101)	700 TK	1	DARAZ
3.LM35 Temperature Sensor Module	70 TK	1	Robotics BD
4.Arduino Uno	520 TK	1	Robotics BD
5.Buzzer	15 TK	1	Robotics BD
6.16*2 LCD	159 TK	1	DARAZ
7.Micro SD Card	80	1	Star Tech

Conclusion:

The medical technology industry is a very important part of the healthcare sector. It includes medical devices which simplify the prevention, diagnosis and treatment of diseases. The common thread through all applications of medical technology is the beneficial impact on health and quality of life. Medical technology continues to rely on sensors to help improve safety and effectiveness of medical instruments, as well as making them simpler to operate. With this motivation we decided to make a handy device which will measure human body temperature, heart and pulse rate, which will be shown in 16*2 LCD and will be notified with a beep of a buzzer. We also planned to secure the device with fingerprint sensor security. In this pandemic situation where we humans are fighting against a virus (COVID-19), we can understand the importance of health. To fight against this crucial situation continues monitoring of heart rate, pulse rate and temperature will help a lot. Our aim was to contribute a very little help in this pandemic circumstance by developing a user friendly, easy to use device which will generate three very important information regarding our health within very short time.