Chapter 1
INTRODUCTION

A pulse oximeter is a medical device used to measure oxygen saturation levels and heart rates non-invasively. It plays a crucial role in monitoring the well-being of patients, particularly those with respiratory conditions, during medical procedures, or in critical care settings. Commercially available pulse oximeters are often expensive, limiting their accessibility, especially in resource-constrained environments or for personal use.

The working principle of a pulse oximeter involves emitting specific wavelengths of light into the tissue, detecting the transmitted light after it has passed through the blood vessels, and calculating the ratio of absorbed red to infrared light to determine SpO2. This information is then displayed on a digital screen, providing real-time feedback.

The Arduino Uno board serves as the heart of the project, providing the necessary computational power and connectivity to interface with the finger probe sensor. The finger probe sensor is responsible for emitting light and detecting the amount of light absorbed by the blood flowing through a person's fingertip. By analyzing the absorption of specific wavelengths of light, the oxygen saturation level and heart rate can be determined.

Chapter 2

Hardware and Software Requirements

Hardware Requirements

(a) Arduino UNO

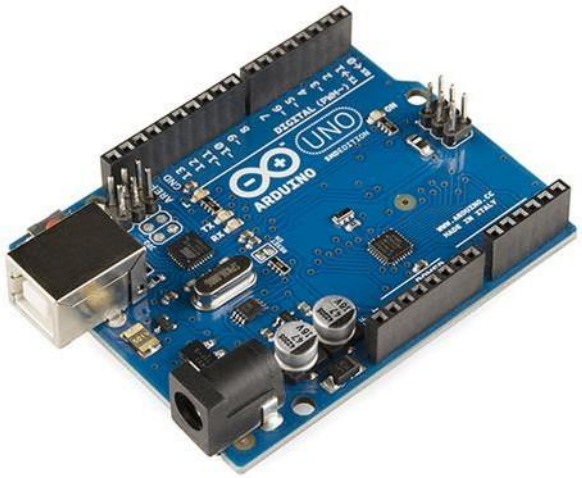

Fig (2.1)

Arduino / Genuine Uno is a microcontroller board based on ATmega328P(datasheet).It has 14 digital input/output pins(of which 6 are used as PWM outputs),6 analog inputs, a 16 MHz quartz crystal a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

(b) MAX30100 Pulse Oximeter and Heart Rate Sensor

Fig (2.2)

The MAX30100 is a popular integrated pulse oximeter and heart rate sensor module. It combines red and infrared (IR) LED light sources with a photodetector to measure the absorption of light by blood vessels and calculate oxygen saturation levels and heart rates. The MAX30100 pulse oximeter and heart rate sensor module provides a convenient and integrated solution for non-invasive oxygen saturation measurement and heart rate monitoring. Its compact size, low power consumption, and built-in signal processing capabilities make it a popular choice for a wide range of applications requiring vital signs monitoring.

(c) LCD Display (16*2)

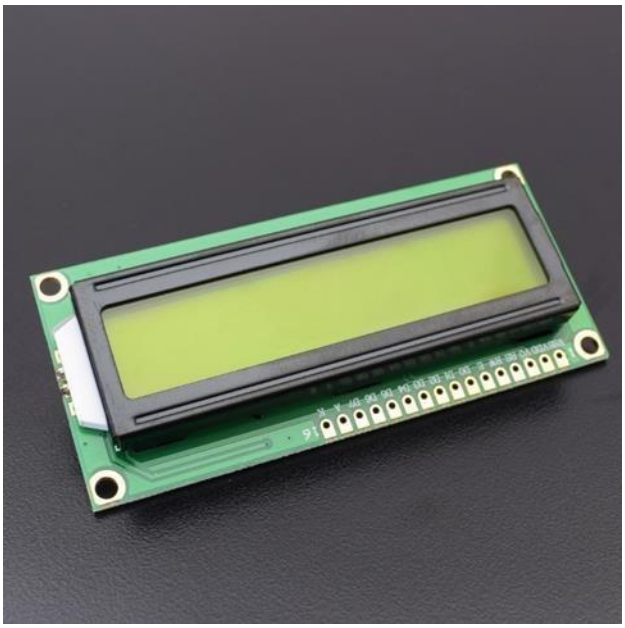

Fig (2.3)

A 16x2 LCD display refers to a liquid crystal display that can show 16 characters per line and has a total of 2 lines. It is a commonly used alphanumeric display module that can be interfaced with various microcontrollers and development boards, including Arduino Uno. A 16x2 LCD display can show 16 characters horizontally and has 2 lines vertically. Each character is typically represented by a 5x8 dot matrix, allowing for the display of alphanumeric characters, symbols, and basic graphical symbols.

(d) I2C Module

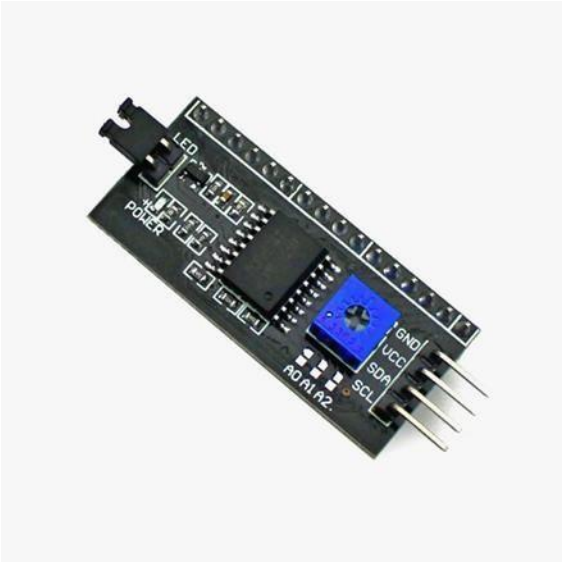

Fig (2.4)

An I2C (Inter-Integrated Circuit) module refers to a hardware module or interface that enables communication between devices using the I2C protocol. I2C is a popular serial communication protocol that allows multiple devices to communicate with each other using a shared bus. The I2C module facilitates serial communication between devices. It uses two wires, a serial data line (SDA) for transmitting data and a serial clock line (SCL) for synchronizing the communication.

(e) Breadboard

Fig (2.5)

A breadboard is a fundamental tool used in electronics prototyping and circuit design. It provides a convenient platform for quickly building and testing electronic circuits without the need for soldering or permanent connections. Breadboards are an essential tool for electronics enthusiasts, hobbyists, students, and professionals to prototype and test circuits quickly and efficiently. They provide a convenient and reusable platform for building and experimenting with electronic projects before committing to permanent soldered connections on a printed circuit board (PCB).

(f) Jumper Wire

Fig (2.6)

Jumper wires are a type of electrical wire used to connect two points in a circuit temporarily or permanently. They are commonly used in electronic projects to make quick connections between components on a breadboard, PCB, or other circuit board.

Software Requirements

Arduino IDE Software

Arduino IDE software is an open source software to which a hobbyist can connect the AT mega chips. In this software the code can be written and uploaded to any AT mega chip and then the code can be executed on the chip. Many 3D printed electronics and Arduino-compatible use AT mega chip and hence the user can upload the program. Arduino can also be used firmware any electronics.

Fig (2.7)

Chapter 3
System Implementation

BLOCK DIAGRAM

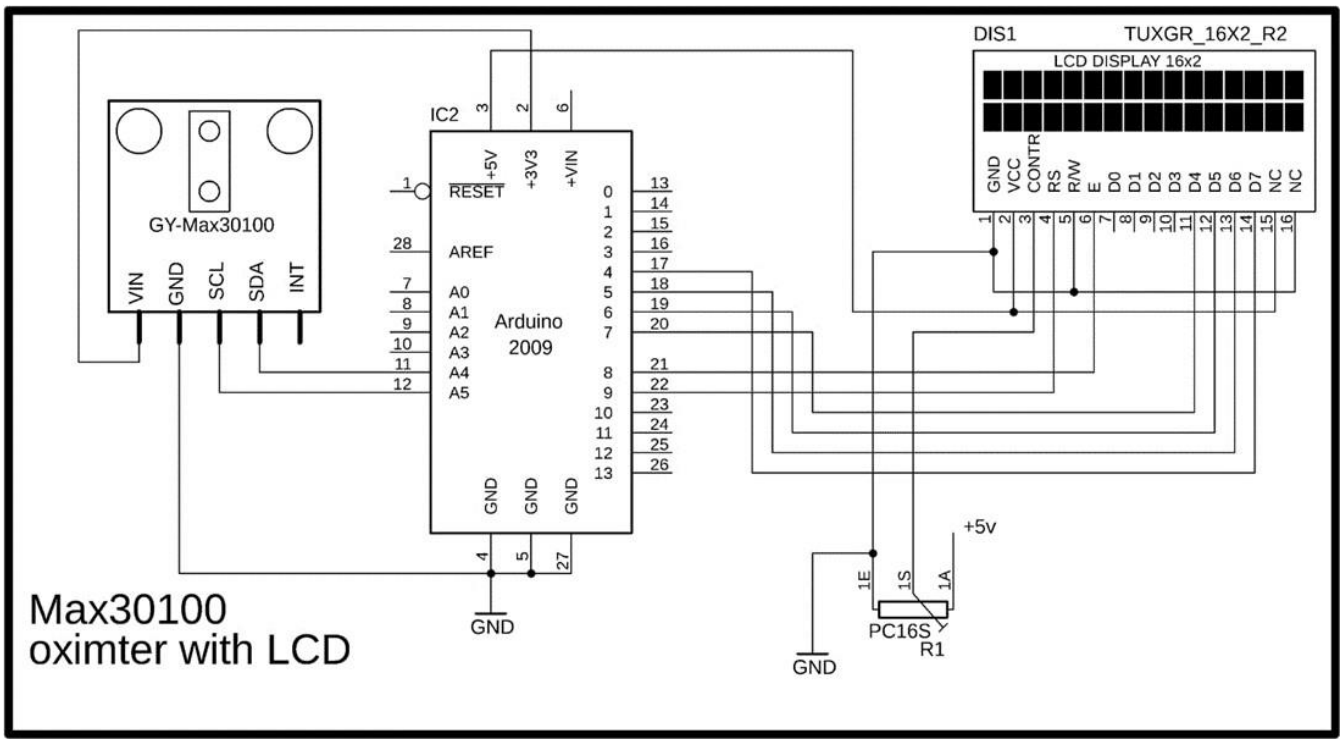

Fig (3.1)

Description of Block Diagram

A pulse oximeter is a medical device used to measure a person's oxygen saturation level (SpO2) and heart rate. It is a non-invasive and painless device that provides valuable information about the oxygen levels in the blood.

- The Arduino Uno serves as the main microcontroller platform, responsible for data acquisition, processing, and output.

- The MAX30100 sensor module is connected to the Arduino Uno via the I2C (Inter-Integrated Circuit) interface. It captures the red and infrared light absorption from the blood vessels.
- The 16x2 LCD display is connected to the Arduino Uno. It displays the measured SpO2 and heart rate values.
- Power supply connections provide the necessary voltage and current to the Arduino Uno, MAX30100 module, and LCD display.
- Sensors represent the components within the MAX30100 module, including the red and infrared LEDs and the photodetector.

This block diagram gives an overview of the main components and their connections in a pulse oximeter using Arduino Uno. It illustrates the flow of data and control signals between the Arduino Uno, MAX30100 sensor module, and LCD display.

CIRCUIT DIAGRAM

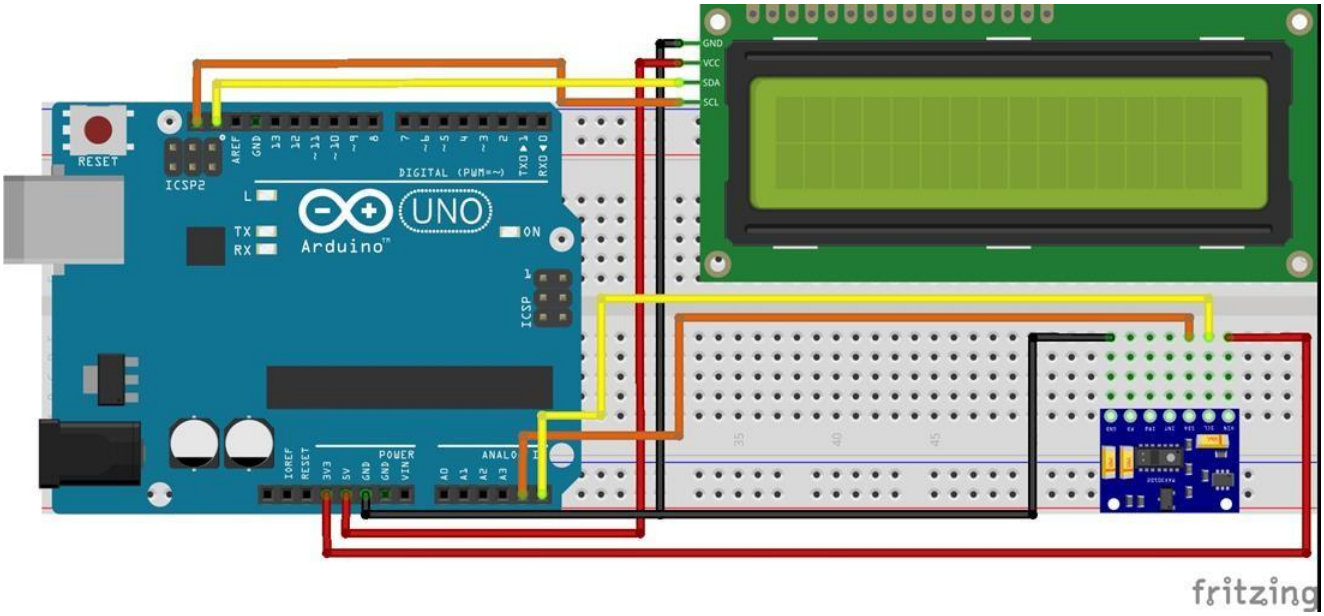

Fig (3.2)

Working Principle

The working principle of a pulse oximeter is based on the differential absorption of light by oxygenated and deoxygenated haemoglobin in the blood. The device emits specific wavelengths of light, usually red and infrared, into the tissue, typically by placing a sensor on a finger or earlobe. As the light passes through the blood vessels, it encounters oxygenated and deoxygenated haemoglobin, which absorb the light differently at the specific wavelengths used. A photodetector in the sensor detects the intensity of the transmitted light after it has passed through the tissue. The pulse oximeter analyzes variations in the detected light intensities to measure the person's heart rate. The calculated SpO2 and heart rate values are displayed on a digital screen, providing non-invasive and real-time information about the oxygenation status and heart function.

Chapter 4

Arduino Code

```
1. #include <LiquidCrystal_I2C.h>
2. #include <Wire.h>
3. #include "MAX30100_PulseOximeter.h"


4. #define REPORTING_PERIOD_MS     1000


5. LiquidCrystal_I2C lcd(0x27, 16, 2);



6. byte smile[] = {
7. B00000,
8.  B00000,
9.  B01010,
10.B00000,
11.B10001,
12.B01110,
13.B00000,
```

```
14.B00000
15.};
16.byte mod[] = {
17.B00000,
18.B00000,
19.B01010,
20.B00000,
21.B11111,
22.B00000,
23.B00000,
24.B00000
25.};
26.byte sad[] = {
27.B00000,
28.B00000,
29.B01010,
30.B00000,
31.B01110,
32.B10001,
33.B00000,
34.B00000
35.};


36.PulseOximeter pox;
37.uint32_t tsLastReport = 0;
```

```
38.void onBeatDetected()
39.{


40.Serial.println("Beat!!!");


41.}


42.void setup()
43.{
44.Serial.begin(115200);
45.lcd.init();
46.lcd.backlight();
47.lcd.createChar(1 , smile);
48.lcd.createChar(2 , mod);
49.lcd.createChar(3 , sad);
50.lcd.setCursor(0, 0);
51.lcd.print("      Pluse");
52.lcd.setCursor(0, 1);
53.lcd.print("    Oximeter");
54.delay(2000);
```

```
55.if (!pox.begin()) {
56.Serial.println("FAILED");
57.for (;;);
58.} else {
59.Serial.println("SUCCESS");
60.}
61. pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);


62. pox.setOnBeatDetectedCallback(onBeatDetected);
63.}


64.void loop()
65.{
66. pox.update();
67. if (millis() - tsLastReport > REPORTING_PERIOD_MS) {


68. lcd.clear();
69.lcd.setCursor(0 , 0);
70.lcd.print("BPM : ");
71.lcd.print(pox.getHeartRate());
72.lcd.setCursor(0 , 1);
73.lcd.print("Sp02: ");
74.lcd.print(pox.getSpO2());
```

```
75.lcd.print("%");
76.tsLastReport = millis();



77.if (pox.getSpO2() >= 96) {
78.lcd.setCursor(15 , 1);
79.lcd.write(1);
80.}
81.else if (pox.getSpO2() <= 95 && pox.getSpO2() >= 91) {
82.lcd.setCursor(15 , 1);
83.lcd.write(2);
84.}
85.else if (pox.getSpO2() <= 90) {
86.lcd.setCursor(15 , 1);
87.lcd.write(3);
88.}
89.}
90.}
```

Chapter 5

SNAPSHOT OF THE PROJECT

The block diagram and the circuit diagrams are shown once the components were connected to each other. All the components are connected to each other and thus the system setup which helps one to understand the steps in simple and easy way**.**

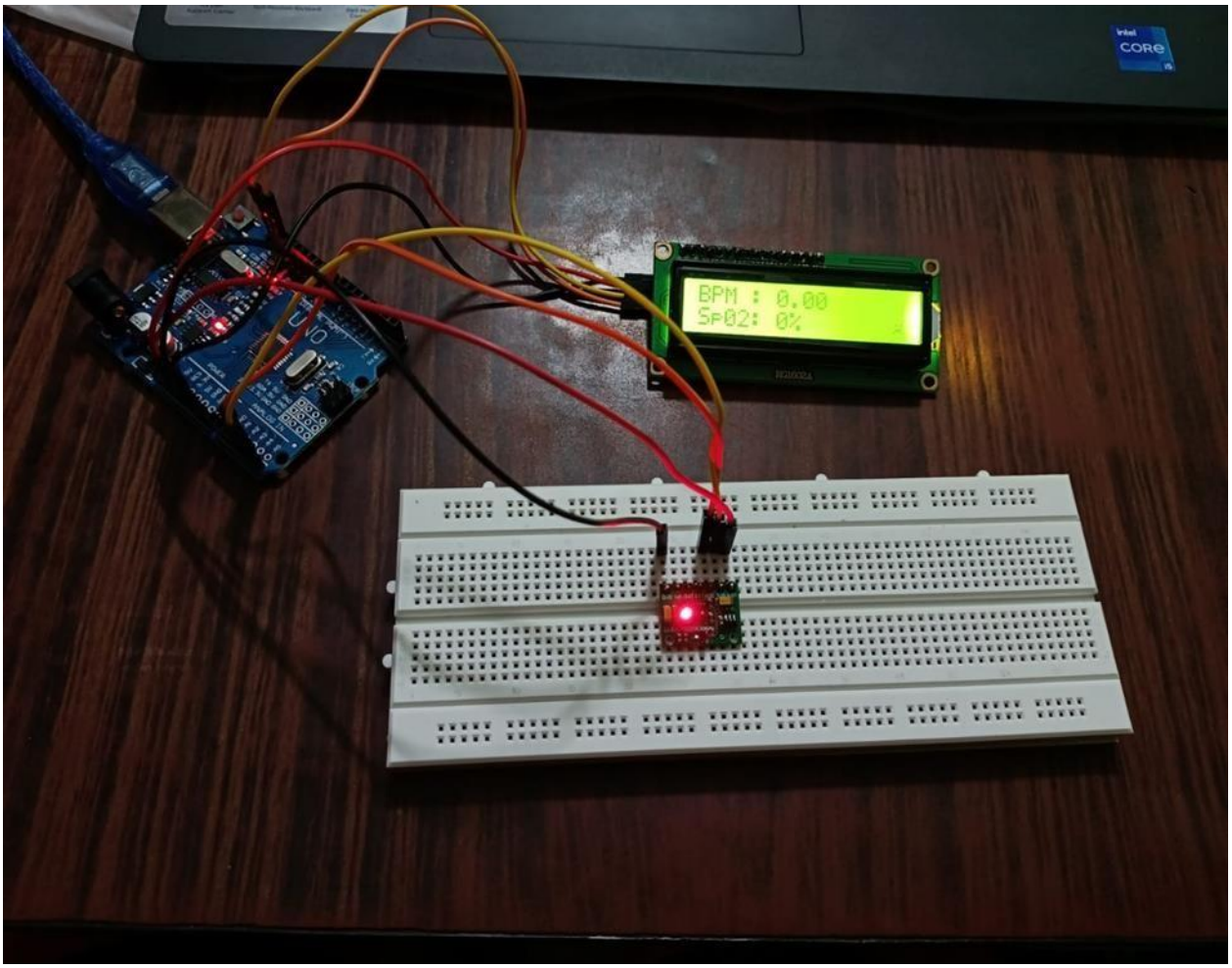

Fig (4.1)

Chapter 6
Applications

Pulse oximeters have a wide range of applications in various settings, including medical, sports, and aviation. Here are some common applications of pulse oximeters:

1. Medical Settings: Pulse oximeters are extensively used in hospitals, clinics, and healthcare facilities for monitoring patients' oxygen saturation levels and heart rates.
2. Home Use: Pulse oximeters are increasingly being used by individuals at home for self-monitoring, especially for those with chronic respiratory conditions or during COVID-19 pandemic for monitoring oxygen levels. Home use pulse oximeters provide a convenient way to track oxygen saturation levels and heart rates regularly.
3. Sports and Fitness: Athletes and fitness enthusiasts can utilize pulse oximeters to monitor their oxygen saturation and heart rates during exercise or high-altitude training. This information can help optimize training routines and ensure safety during intense physical activities.
4. Aviation: Pilots and aircrew members often use pulse oximeters to monitor their oxygen levels during high-altitude flights. It helps in detecting hypoxia, a condition caused by reduced oxygen levels at high altitudes, and allows timely intervention.
5. Emergency Medical Services: Pulse oximeters are crucial in emergency situations such as accidents or medical emergencies. They provide quick

assessment of a patient's oxygenation status, helping emergency medical personnel make informed decisions and initiate appropriate treatments.

6. Research and Clinical Trials: Pulse oximeters are used in medical research and clinical trials to collect objective data on oxygen saturation levels and heart rates of participants, aiding in the evaluation of new treatments, interventions, or medical devices.

Pulse oximeters play a vital role in monitoring oxygen saturation levels and heart rates, enabling timely intervention and assessment of a person's overall health and well-being in various settings, from medical facilities to home use, sports, aviation, and emergency situations.

Conclusion

In conclusion, pulse oximeters are valuable medical devices that provide non-invasive and real-time measurements of oxygen saturation levels (SpO2) and heart rates. They are widely used in medical settings, sports, aviation, and home monitoring. The working principle of a pulse oximeter involves emitting specific wavelengths of light into the tissue, detecting the transmitted light with a photodetector, and calculating the ratio of absorbed red to infrared light to determine SpO2. Pulse oximeters offer numerous benefits, including the ability to monitor patients during surgeries, intensive care, and respiratory conditions. They also assist athletes in optimizing training and ensure safety during high-intensity activities.

Chapter 7

References

1. https://www.youtube.com/watch?v=DBEj7kSkNa8&list=WL&index=4
2. https://www.youtube.com/watch?v=5WI2lxr9CVE&list=WL&index=3
3. https://www.youtube.com/watch?v=PwDJ66yEGeg&list=WL&index=2
4. https://www.electroniclinic.com/max30100-pulse-oximeter-arduino-code-circuit-and-programming/
5. https://robocraze.com