Government of Gujarat

L. D. College of Engineering

A Project Report On

SMART PULSE OXIMETER

BE

(BIOMEDICAL ENGINEERING)

Semester IV

MICROCONTROLLER PROGRAMMING AND INTERFACING

Submitted By

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Program Name: BE
Semester: 5
Subject: MICROCONTROLLER PROGRAMMING AND INTERFACING

1. Introduction

Pulse oximeters are widely used to measure a person's heart rate and SpO_2 (oxygen saturation) level. In this project, we have developed a Pulse Oximeter using Arduino Nano, MAX30100 sensor, and a 0.96" SSD1306 OLED Display. The objective is to create a compact, portable, and cost-effective device that can display real-time readings of the user's pulse and SpO_2 levels.

This type of device is especially useful in current times where monitoring oxygen levels at home has become essential due to respiratory illnesses like COVID-19. It enables quick and easy assessment of patient vitals.

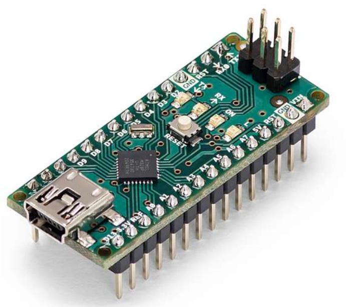
2.Components Description

Components List :

- Arduino Nano
- MAX30100 Pulse Oximeter Sensor
- 0.96" SSD1306 OLED Display
- Jumper Wires
- Breadboard
- USB Cable
- 4.7kΩ Resistors (for pull-up on I²C lines)

Components Description :

1 Arduino Nano :



The Arduino Nano is a compact version of the Arduino Uno based on the ATmega328P microcontroller. It is used in this project to collect data from the MAX30100 sensor and display it on the OLED display using I²C communication.

2 MAX30100 Pulse Oximeter Sensor :

The MAX30100 sensor integrates a pulse oximeter and heart rate monitor. It uses two LEDs (infrared and red) and a photodetector to measure oxygen saturation and pulse rate non-invasively through a fingertip.

3 0.96" SSD1306 OLED Display :

This OLED module with 128x64 resolution communicates via I²C and consumes low power. It offers excellent visibility and is ideal for displaying text output like pulse and oxygen levels.

4 Jumper Wires:

Used for interconnecting components on a breadboard.

5 Breadboard:

A solderless board used to prototype electronic circuits without permanent connections.

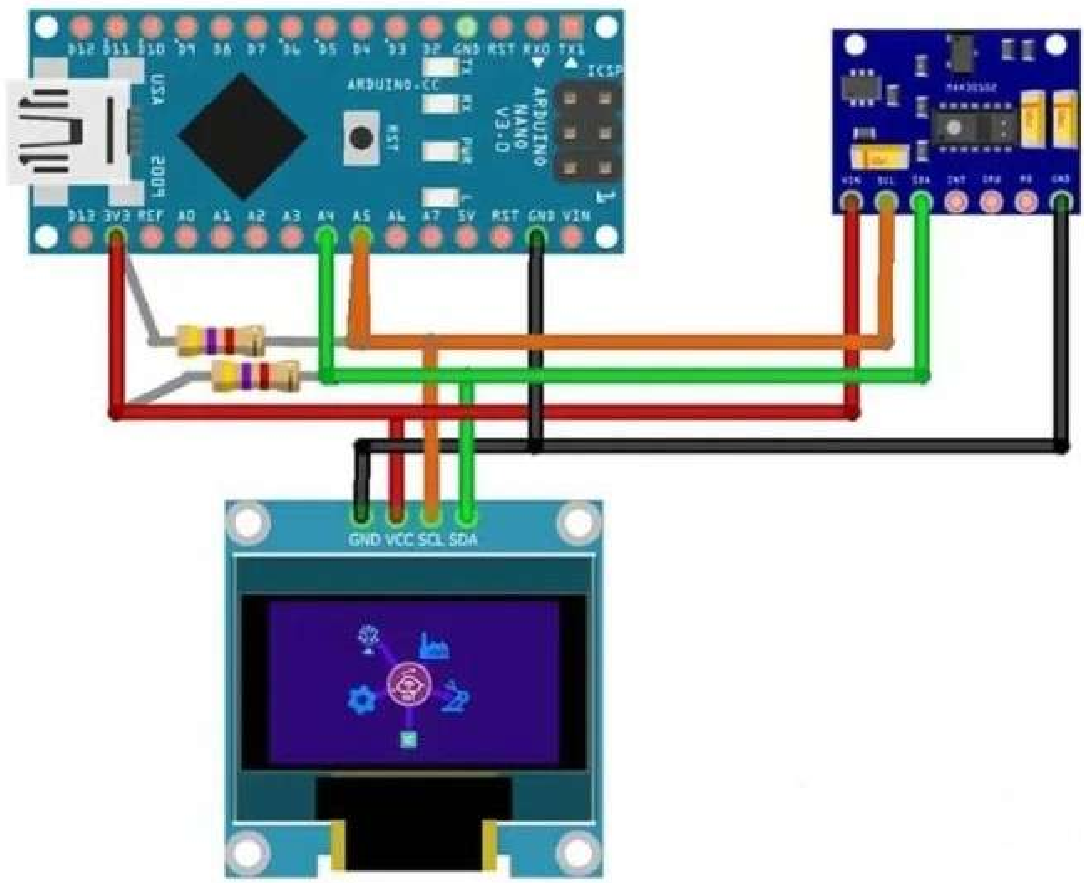
6 4.7kΩ Resistors:

Pull-up resistors are connected on the I²C lines (SCL and SDA) to ensure correct signal levels.

3. Circuit Diagram Description

- I²C Communication: Both the OLED and MAX30100 sensors are connected to the Arduino Nano using I²C protocol.
- Pin Connections:
  - OLED: VCC → 3.3V, GND → GND, SDA → A4, SCL → A5
  - MAX30100: VCC → 3.3V, GND → GND, SDA → A4, SCL → A5
- Pull-up resistors of 4.7kΩ are placed between SDA/SCL and VCC.

➢ **Circuit diagram:**



4. Working Principle

The working principle is based on photoplethysmography:

- Heart Rate Detection: The blood volume in the fingertip varies with heartbeat, causing different light absorption. The sensor detects this variation.
- SpO_2 Measurement: Oxygenated and deoxygenated blood absorb different amounts of red and IR light. The MAX30100 computes SpO_2 using this light absorption difference.

The Arduino Nano reads sensor values and displays the BPM and SpO_2 readings on the OLED. Data is also printed via Serial Monitor for debugging.

5.Code

The complete Arduino code is provided in the Appendix. It initializes the OLED, communicates with MAX30100 over I²C, reads pulse and oxygen data, and displays the results.

Libraries Used:

- Wire.h
- MAX30100_PulseOximeter.h
- Adafruit_GFX.h
- Adafruit_SSD1306.h

➢ **C code :**

```
#include <Wire.h>
#include "MAX30100_PulseOximeter.h"
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
#define SCREEN_WIDTH 128
#define SCREEN_HEIGHT 32
#define OLED_RESET -1
#define SCREEN_ADDRESS 0x3C
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire,
OLED_RESET);
PulseOximeter pox;
uint32_t tsLastReport = 0;

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

void setup() {
  Serial.begin(115200);
  if (!display.begin(SSD1306_SWITCHCAPVCC, SCREEN_ADDRESS)) {
    Serial.println(F("SSD1306 allocation failed"));
    for (;;);
  }
  display.clearDisplay();
  display.setTextSize(1);
  display.setTextColor(WHITE);
  display.setCursor(20, 18);
  display.print("Pulse Oximeter");
  display.display();
  delay(2000);

  Serial.print("Initializing pulse oximeter.. ");
```

```
  if (!pox.begin()) {
    Serial.println("FAILED");
    for (;;);
  } else {
    Serial.println("SUCCESS");
  }
  pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);
  pox.setOnBeatDetectedCallback(onBeatDetected);
}

void loop() {
  pox.update();
  if (millis() - tsLastReport > 1000) {
    int bpm = pox.getHeartRate();
    int spo2 = pox.getSpO2();
    Serial.print("Heart rate:"); Serial.print(bpm);
    Serial.print(" bpm / SpO2:"); Serial.print(spo2); Serial.println("%");

    display.clearDisplay();
    display.setCursor(0, 0);
    display.print("BPM: "); display.println(bpm);
    display.setCursor(0, 10);
    display.print("SpO2: "); display.print(spo2); display.println("%");
    display.display();

    tsLastReport = millis();
  }
}
```

6. Applications

- Hospital and clinical use for patient monitoring
- At-home healthcare monitoring systems
- Wearable health devices
- Fitness trackers and smartwatches
- Emergency and mobile health kits

7. Advantages & limitations

Advantages

- Non-invasive and user-friendly
- Low-cost and portable
- Real-time measurement
- Easy to use with minimal setup
- Compact form factor

Limitations

- May be affected by ambient light or motion artifacts
- Accuracy depends on proper sensor placement
- Not a substitute for professional medical-grade equipment
- Requires calibration for long-term accuracy

8. Conclusion

This project successfully demonstrates the use of a MAX30100 sensor and OLED display to build a functional Pulse Oximeter using Arduino Nano. The final device can accurately measure and display SpO2 and heart rate in real-time. It provides a cost-effective and compact solution for basic health monitoring needs.

The knowledge gained from this project enhances our understanding of biomedical sensors, I2C communication, and embedded systems development.