BCSE-420L

Sensors, Actuators and Signal Conditioning

Project Title:-

HEART RATE MONITORING SYSTEM

DONE BY:-

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Introduction:–

Vital parameters such as pulse rate are critical indicators of an individual's health status. Real-time monitoring of these parameters is essential for early detection and management of various medical conditions. The growing need for non-invasive, portable, and cost-effective health monitoring devices has spurred the development of wearable systems. This project endeavors to address this need by creating a hardware model using Arduino and the MAX30100 sensor to measure SpO2 and pulse rate.

Literature Survey:–

Wearable health monitoring systems have become essential for continuous and non-invasive monitoring of vital signs, including SpO2 and pulse rate. Zhang et al. (2018) introduced a novel approach utilizing 3D printed sensor bands for SpO2 and heart rate monitoring, emphasizing innovative sensor design but lacking in addressing real-time data transmission efficiency and user interface design optimization.

Hertzman and Spealman (1937) laid the groundwork for photoplethysmography (PPG) principles in pulse oximetry, yet overlooked modern challenges such as data transmission and usability. Mannheimer (1994) explored photoplethysmography's physiological principles, yet practical implementation challenges like sensor miniaturization were not extensively discussed. Allen (2007) emphasized photoplethysmography's clinical applications but overlooked emerging trends in wearable sensor technology, suggesting future research directions for enhancing measurement accuracy.

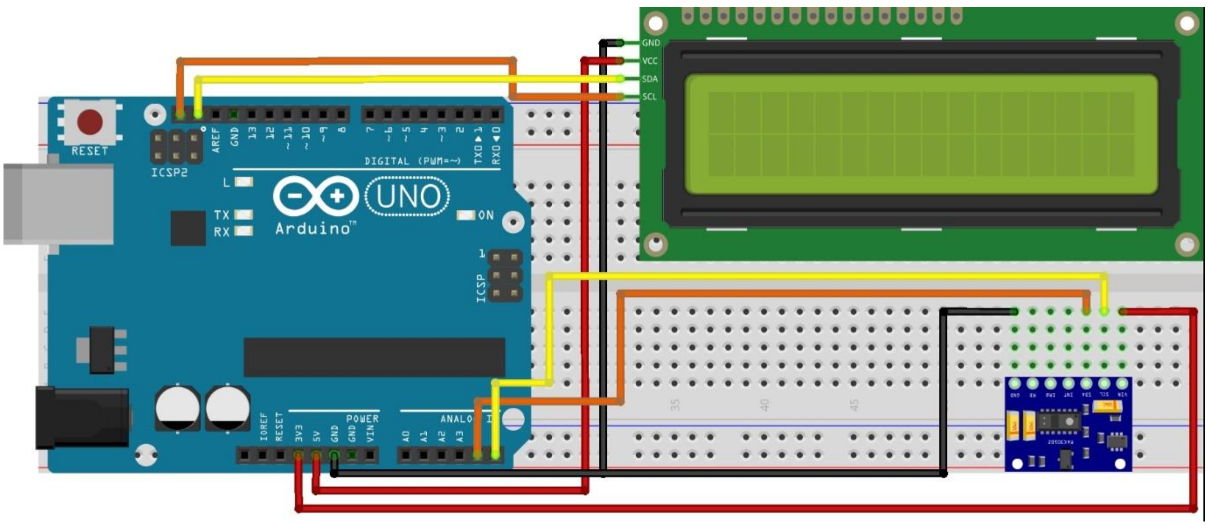
Laerdal (2022) provided clinical guidelines on capnography, yet lacked discussion on integrating capnography sensors into wearable devices for continuous respiratory assessment. Finally, the World Health Organization (2022) offered comprehensive guidance on pulse oximetry techniques but failed to address technological advancements like wearable pulse oximeters and their impact on global health initiatives.

Description:–

- Sensors: The MAX30100 sensor utilizes photoplethysmography (PPG) principles to measure SpO2 and pulse rate non-invasively.
- Arduino: Arduino serves as the primary processing unit to interface with the sensor and display the measured parameters.
- Connections: The MAX30100 sensor connects to the Arduino board as follows:

  V_{in} of the sensor to the 3.3V port of the Arduino.
  SCL port of the sensor to the A5 port in the Arduino.
  SDA port of the sensor to the A4 port in the Arduino.
  Ground connections provided to both Arduino and sensor.

Circuit Diagram:–



Arduino Code:–

```
#include <Wire.h>

#include "MAX30100_PulseOximeter.h"

#define REPORTING_PERIOD_MS     1000

PulseOximeter pox;

uint32_t tsLastReport = 0;

void onBeatDetected()

{

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

}

void setup()

{

  Serial.begin(115200);

  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 > REPORTING_PERIOD_MS) {
```

```
    Serial.print("BPM : ");
    Serial.println(pox.getHeartRate());
    Serial.print("Sp02: ");
    Serial.print(pox.getSpO2());
    Serial.println("%");
    tsLastReport = millis();

    if (pox.getSpO2() >= 96) {
      Serial.println("Condition: Good");
    }
    else if (pox.getSpO2() <= 95 && pox.getSpO2() >= 91) {
      Serial.println("Condition: Moderate");
    }
    else if (pox.getSpO2() <= 90) {
      Serial.println("Condition: Bad");
    }
  }
}
```

Results and Discussion:–

The project successfully measures SpO2 and pulse rate using the MAX30100 sensor and displays the values on an Arduino-based application. Real-time data acquisition and display provide immediate feedback on health parameters to users. Figures, tables, and graphs illustrating the project's functionality will be included in the final report.

Conclusion:–

In conclusion, the hardware model developed demonstrates the viability of using Arduino and the MAX30100 sensor for real-time health monitoring. The project addresses the need for non-invasive and portable health monitoring solutions. Future enhancements could include integrating additional sensors for comprehensive health monitoring and refining the user interface for improved usability.

Research Papers:–

1. Zhang, Y., Liang, T., Wang, S., & Huang, Z. (2018). Wearable 3D Printed Red/IR LED Sensor Bands for SpO2 and Heart Rate Monitoring. IEEE Transactions on Biomedical Circuits and Systems, 12(1), 69-78.

2. Hertzman, A. B., & Spealman, C. R. (1937). Observations on the finger volume pulse recorded photoelectrically. The American Journal of Physiology, 119(2), 334-335.

3. Mendelson, Y., & Ochs, B. D. (1988). Noninvasive pulse oximetry utilizing skin reflectance photoplethysmography. IEEE Transactions on Biomedical Engineering, 35(10), 798-805.

4. Mannheimer, P. D. (1994). Photoplethysmography. Circulation, 88(3), 1047-1060.