Mini-Project
-Lie Detector-

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Supervisor: Mircea Giurgiu

Made by:
Giurgiu Alexandru-Cornel

Year 3, Group e_2331

Contents

1. The Theme

The **Stress Detection and Monitoring System** (commonly referred to as a "Lie Detector") is a mini-project aimed at creating a hardware-based tool to monitor physiological indicators of stress. By integrating multiple sensors such as a pulse sensor, GSR electrodes, and a DHT11 temperature and humidity sensor, the system provides an innovative way to identify potential signs of stress. These physiological signals are measured and analyzed in real-time, with results visually represented via LEDs (green for normal and red for stress) and numerically displayed through the serial monitor and plotter.

The system operates by tracking variations in heart rate (BPM), skin conductance, temperature, and humidity. When a subject experiences stress or nervousness, physiological changes such as increased heart rate, higher perspiration (indicated by GSR), and changes in body temperature can be detected. These data points are cross-referenced against predefined thresholds to determine whether the subject is in a stressed state.

The process of using the system begins with calibration to establish a baseline for the individual being tested. This is done by asking the subject simple, non-threatening questions, such as "What is your name?" or "Where do you live?", which are designed to elicit truthful responses. The data collected during these baseline questions allows the system to understand the subject's natural physiological state under normal conditions. Any significant deviation from the baseline readings—such as a spike in heart rate, increased GSR, or changes in temperature—can indicate stress or dishonesty.

The system has potential applications beyond simple lie detection. It could be adapted for mental health monitoring, stress management, or biofeedback training. For example, it could help individuals track their stress levels in high-pressure environments, such as workplaces or during public speaking.

2. Introduction

You may hear about lie detector machines used by FBI or CIA or any another investigation by police. The main idea of the lie detection test is changing the reaction of the human body between when a person is telling the truth or answering to a normal and routine question like what's your name?, And his body reaction when he or she is lying. For example when a criminal is going to have a lie detection test the investigator attach sensors on his finger, head or maybe on his chest. These sensors measure the breathing rate, pulse, blood pressure, perspiration and etc.

3. Theoretical Background

3.1 Heart Rate Monitoring

The heart rate variability is often linked to stress levels.High BPM(beats per minute) can indicate stress or physical activity. If you touch this sensor used to monitor with any area of your skin that is closest to the arteries (such as the finger or earlobe), the sensor detects blood in the arteries. Each time the heart beats, blood is pumped through the arteries, and the sensor detects the flow of blood and increases the output voltage.

3.2 Galvanic Skin Response(GSR)

The GSR measures the electrical conductance of the skin,which increases with sweat gland activity during stress.So,basically our skin is amazing! It provides a medium for us to experience the sense of touch, it keeps infections out and keeps innards in but I bet you didn't know that our skin changes conductivity depending on many different things one being our mood! It called Electrodermal activity (EDA) .The basics are that our skin changes its conductivity depending on how we feel.

3.3 Temperature and Humidity Monitoring

The temperature variations may indicate changes in physical or emotional states.The humidity measurements are added for environmental context, ensuring proper calibration and interpretation of skin readings.

3.4 Calibration

For the calibration of the system some Electrodes that could stick on your body like(ECG pads).All sensors require initial stabilization to ensure accurate readings.A 5-second delay is included in the system to account for this

4. Implementation

4.1 Hardware components

4.1.1 Heart pulse sensor for BPM detection
4.1.2 GSR(galvanic skin response)system
4.1.3 DHT11 sensor for temperature and humidity
4.1.4 Arduino UNO for processing data
4.1.5 2 LEDs(one green for normal,red for stress)
4.1.6 2 Electropads(ECG pads)and a Velcro band
4.1.7 Wires,alligator clips

4.2 Connections

For **4.1.1:** The signal wire is connected to analog pin A0 on the Arduino. VCC and GND wires are connected to the Arduino's 3.3V and GND pins respectively. The sensor is secured to the finger using Velcro.

For **4.1.2:** The signal wire from the GSR module connects to analog pin A1 through a 220k resistor on the Arduino. The resistor is also connected to the VCC.One electropad is connected to analog pin A1 and the other one is connected at the ground of the resistor

For **4.1.3:** The data pin is connected to digital pin 2 on the Arduino. The VCC and GND pins of the sensor are connected to the Arduino's 5V and GND pins

For **4.1.5:** The green LED is connected to digital pin 9, and the red LED is connected to digital pin 10 via 220-ohm resistors to limit current

For **4.1.6:**The electropads needs to be attached on the skin for the GSR,so one electropad on the middle phalanx of your index finger and the other on the middle phalanx of your middle finger. Alternatively, you can place one pad on the palm of your hand and the other on the opposite palm if you're testing stress with both hands in contact. Ensure the pads are not overlapping but are spaced apart properly to avoid interference. Place the heart sensor on the underside of your index or middle finger (just above the knuckle). This area typically provides good blood flow and consistent readings. Using Velcro to create a band for the sensor is an excellent idea.

4.3 Software part and the code

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Libraries:PulseSensorPlayground and DHT

```
// Include libraries
#include <PulseSensorPlayground.h>
#include <DHT.h>

// Pin definitions
const int GSR_pin = A1;
const int pulsePin = A0;
const int greenLED = 9;
const int redLED = 10;

// Pulse sensor
PulseSensorPlayground pulseSensor;

// DHT sensor
#define DHTPIN 2
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

// Thresholds
const int GSR_threshold = 600;  // Adjust based on your GSR setup
const int BPM_threshold = 160;   // Stress threshold for BPM
const float TEMP_HIGH_THRESHOLD = 35.0;  // High temperature threshold in °C
const float HUMIDITY_HIGH_THRESHOLD = 80.0;  // High humidity threshold in %

void setup() {
  Serial.begin(9600);  // Start serial communication

  // Initialize sensors
  pulseSensor.analogInput(pulsePin);
  pulseSensor.setThreshold(625);  // Adjust based on setup
  pulseSensor.begin();
  dht.begin();

  // Initialize LEDs
  pinMode(greenLED, OUTPUT);
  pinMode(redLED, OUTPUT);

  // Calibration period
  Serial.println("Calibrating sensors... Please wait.");
  delay(5000);  // Wait 5 seconds for sensors to stabilize
  Serial.println("Calibration complete.");
}
```

```
void loop() {
  // Read GSR value
  int GSR_value = analogRead(GSR_pin);

  // Heart rate reading
  int bpm = pulseSensor.getBeatsPerMinute();
  bool beatDetected = pulseSensor.sawStartOfBeat();

  // Read temperature and humidity
  float temp = dht.readTemperature();
  float humidity = dht.readHumidity();

  // Check for valid DHT readings
  if (isnan(temp) || isnan(humidity)) {
    temp = 0;  // Use 0 to indicate invalid readings
    humidity = 0;
  }

  // Output to Serial Plotter (simple format for plotting)
  Serial.print("BPM ");
  Serial.print(bpm);
  Serial.print(" Temp ");
  Serial.print(temp);
  Serial.print(" Humidity ");
  Serial.print(humidity);
  Serial.print(" GSR ");
  Serial.println(GSR_value);
  Serial.println();

  // LED logic
   if (GSR_value > GSR_threshold || bpm > BPM_threshold) {
    // Stress or high BPM detected
    digitalWrite(redLED, HIGH);
    digitalWrite(greenLED, LOW);
    Serial.println("Stress detected or high BPM!");
  } else if (temp > TEMP_HIGH_THRESHOLD || humidity > HUMIDITY_HIGH_THRESHOLD) {
    // High temperature and humidity detected
    digitalWrite(redLED, HIGH);
    digitalWrite(greenLED, LOW);
     Serial.println("Extreme heat and humidity detected!");
  } else {
    // Normal state
    digitalWrite(redLED, LOW);
    digitalWrite(greenLED, HIGH);

  }

  delay(1000);  // Short delay for smoother plotting
}
```

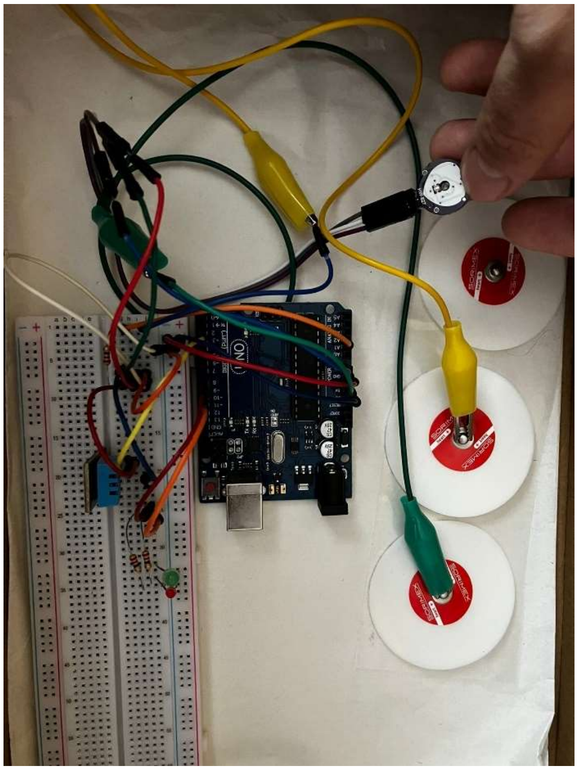
4.4 Placement of the sensors

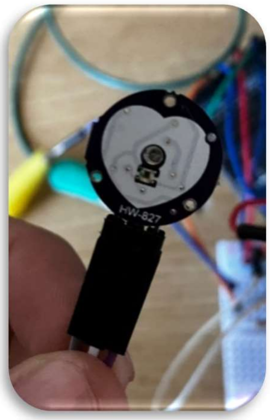
The pulse sensor is securely strapped to the index or middle finger using Velcro. Place the sensor on the underside of your index or middle finger (just above the knuckle). This area typically provides good blood flow and consistent readings. Alternatively, you can place it on your earlobe if you want to test other options. Wrap the Velcro band around your finger so it is snug but not too tight. It should not block blood flow. .Also, the sensor may need a moment to calibrate. Try to stay still while using it to reduce noise in the signal.

The electropad should ideally be placed on the palm or fingers, as these areas have higher sweat gland density.Place one pad on the middle phalanx of your index finger and the other on the middle phalanx of your middle finger. Alternatively, you can place one pad on the palm of your hand and the other on the opposite palm if you're testing stress with both hands in contact. Connect the alligator clips to the conductive part of the electropads.Ensure the pads are not overlapping but are spaced apart to avoid interference. The DHT11 sensor is positioned in proximity for accurate temperature and humidity reading

5. Demonstration

The circuit **The pulse sensor**



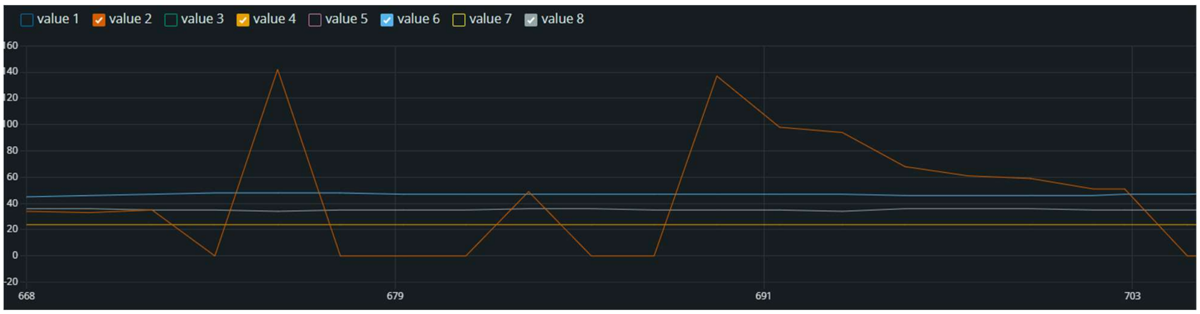


Plotting

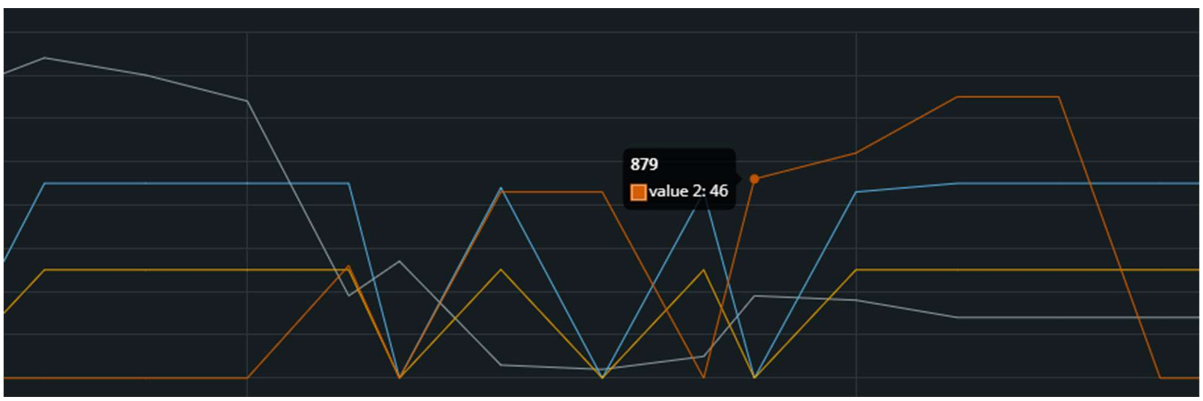
These are some plots where the value of the(BPM,temperature,humidity,GSR)is changing.

High BPM

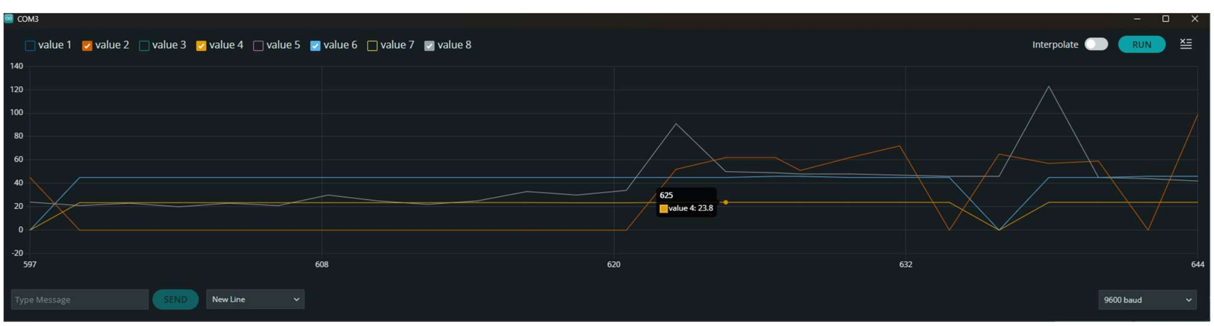
Some changes in the BPM sensor (after touching it and release and touching again)



Here I tried to keep my breathe and I obtained this



Here my mom asked me If I am hungry and I said no and the BPM and GSR went up(I lied)



More demonstrations are in the video.

6. Conclusions

The Lie Detector (stress monitoring) successfully integrates multiple sensors to monitor physiological responses indicative of stress. The use of LEDs for immediate visual feedback and a serial monitor for detailed data allows for real-time stress tracking. The system's calibration ensures reliable measurements and provides a foundation for further enhancements, such as data logging or wireless transmission. However, the system is not without its limitations. Due to the simplicity of the components, such as the DHT11 sensor and the basic pulse and GSR modules, the data accuracy may not match that of professional-grade medical devices. Factors such as movement artifacts, environmental conditions, and individual variations in physiological responses can also affect the readings. Despite these challenges, the project demonstrates the feasibility of integrating low-cost sensors into a functional prototype, offering a foundation for future enhancements. Possible improvements could include upgrading the sensors, improving signal processing algorithms, or integrating wireless communication for remote monitoring.

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7. Bibliography

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