EE499: Senior Design Project
W22_Team-08
Cost-effective Monitoring System for Biomedical and Cleanroom Facilities

Project Stakeholder's

W22_Team-11		
M1	Omar Abdulaziz Hussain	1945955
M2	Ibrahim Mohammed Ahmed	1459568
M3	Abdullah Abu Bakr Alkaf	1935764
Team Advisor	Dr. Nebras Sobahi	
Customer/Co-Advisor	Dr. Nebras Sobahi	

Introduction

Cleanrooms are controlled rooms that have specific regulated environments and include critical process and operations. These rooms need monitoring systems to ensure the reliability of a specific environments to offer the safety and best conditions for the operations and processes to be implemented inside the cleanroom.

Since that most of the current available monitoring systems in market are mostly expensive, this project aims to design a cost-effective monitoring system that is reliable and suitable for different kinds of small cleanrooms.

This poster will represent most of essential information required to understand the process and results of this design project.

Project Objectives

Strategic (High-level) Objectives:

- Design a cost-effective monitoring system for any regulated environment.
- Design an expandable monitoring system.

Technical (Low-level) Objectives:

- Monitoring the environment inside the cleanroom.
- Detecting the particles in air.
- Having an alarming system.

Project Design Specifications

In-scope specifications (Musts):

1. Expandable and capable to accommodate multiple subsystems.
2. Operating without any human intervention.
3. Backup power supply for black out situation.
4. Monitor the temperature, humidity, and particles in air inside the cleanroom.
5. Having an SMS alarming system.

Out-scope specifications (Wants):

1. Having a cost lower than 2,500 SR.
2. Detect the motions inside the cleanroom.
3. Affordable design for any kind of cleanroom.
4. Use Wi-Fi for alarming system.
5. Continuously display the data via internet.

Project Assumptions:

1. Provided power supply.
2. Availability of Product's components in local markets.
3. Controlled air conditioning.

Project Constraints:

1. Cost limit with 3000 SR.
2. Do not affect the operations inside the cleanroom by the product's materials.
3. Always be on operating mode
4. Ability to be completed within the scheduled time.

Engineering Standards:

1. ISO 14644-1 (particle classification standard).
2. P802.11 (IEEE standard for information technology).
3. GE-T9, GE-T12, GE-T13 Standards from Saudi council of Engineering (SCE).

Project Baseline Design

Block Diagram

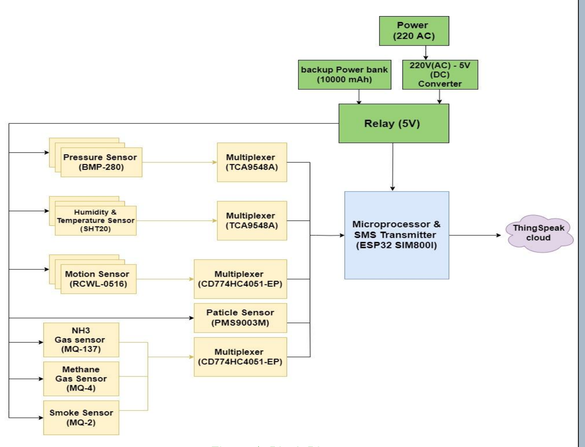

Figure 1: Block Diagram

Implementation

Gases Monitoring Subsystem

GASES MONITORING SUBSYSTEM

Equipment
- Breadboard
- Connection wires
- ESP32 SIM800l microcontroller
- 1K ohm Resistor
- Mux CD774HC4051-EP
- Gas sensor MQ-137
- Gas sensor MQ-4
- Gas sensor MQ-2

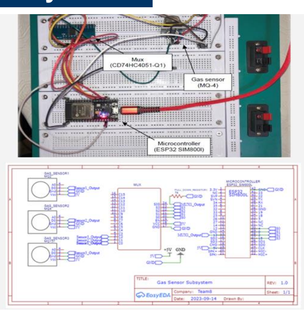

Figure 2: Gases Monitoring Subsystem Schematic & Hardware Connection

Motion Monitoring Subsystem

MOTION MONITORING SUBSYSTEM

Equipment
- Breadboard
- Connection wires
- ESP32 SIM800l microcontroller
- 1K ohm Resistor
- Analog Mux CD774HC4051-EP
- Motion sensor RCWL-0516

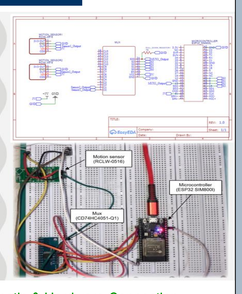

Figure 3: Motion Monitoring Subsystem Schematic & Hardware Connection

Temperature and humidity Monitoring Subsystem

TEMPERATURE, AND HUMIDITY MONITORING SUBSYSTEMS

Equipment
- Breadboard
- Connection wires
- Arduino Uno
- I2c Mux TCA9548A
- Temperature and Humidity sensors (SHT20)

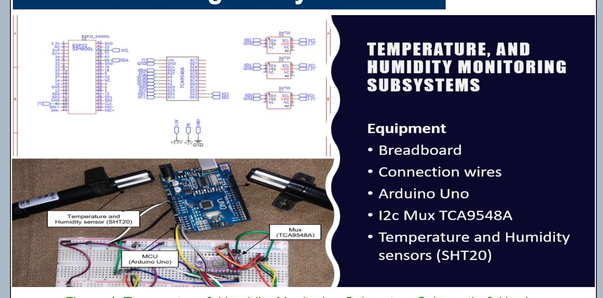

Figure 4: Temperature & Humidity Monitoring Subsystem Schematic & Hardware Connection

Pressure Monitoring Subsystem

PRESSURE MONITORING SUBSYSTEM

Equipment
- Breadboard
- Connection wires
- Arduino Uno
- I2c Mux TCA9548A
- Pressure sensors (BMP280)

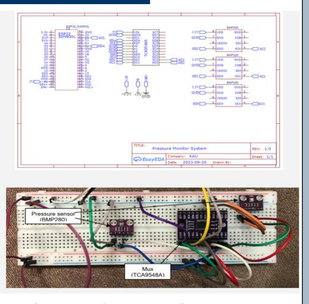

Figure 5: Pressure Monitoring Subsystem Schematic & Hardware Connection

Particle Detecting Subsystem

PARTICLE DETECTING SUBSYSTEM

Equipment
- Breadboard
- Connection wires
- ESP32 SIM800l microcontroller
- Particle sensor (PMS9003M)

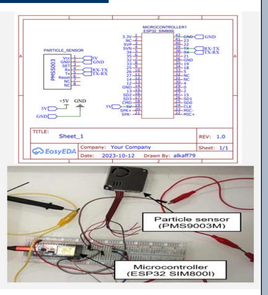

Figure 6: Particle Detecting Subsystem Schematic & Hardware Connection

Particle Detecting Subsystem

VALIDATING SMS ALARMING SYSTEM

Equipment
- Breadboard
- Connection wires
- ESP32 SIM800l microcontroller
- 1K ohm Resistor
- Switch

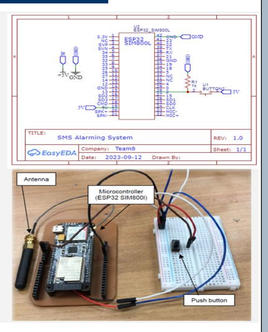

Figure 7: SMS Alarming System Schematic & Hardware Connection

Final Product

Circuit Schematic

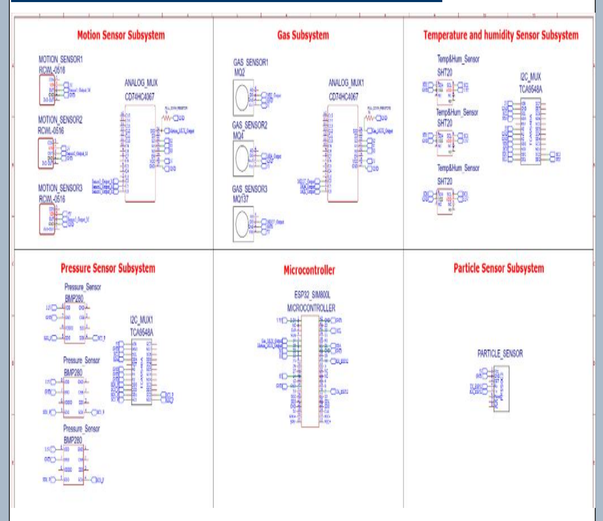

Figure 8: Final Product's Circuit Schematic

Prototype Version 1

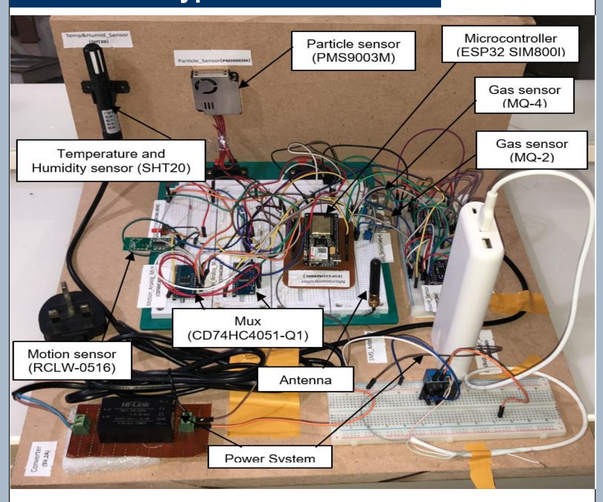

Figure 9: Final Product's Prototype version 1

Prototype Version 2

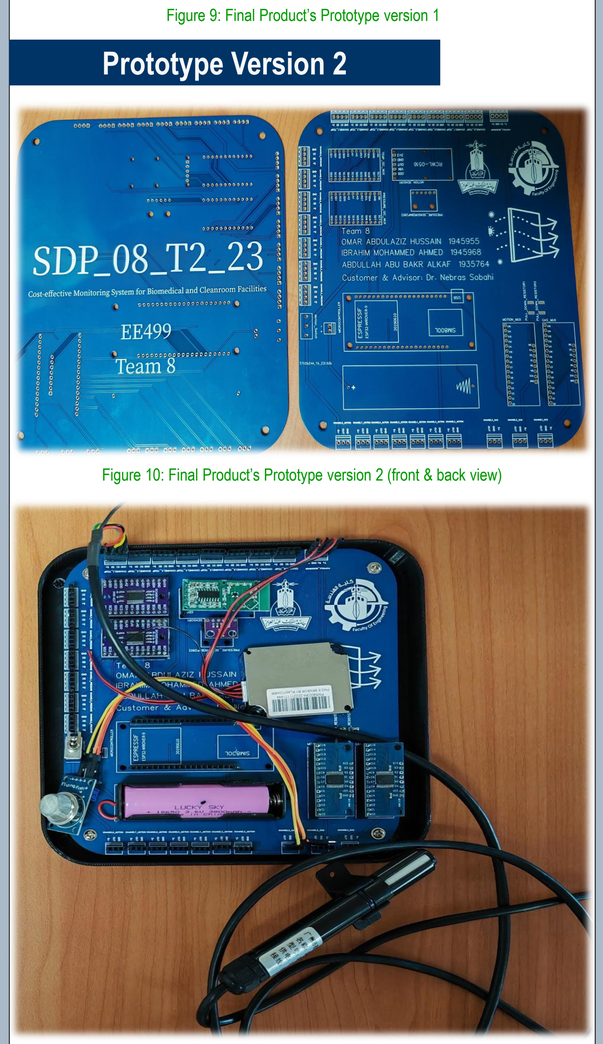

Figure 10: Final Product's Prototype version 2 (front & back view)

Figure 11: Final Product's Prototype version 2

Team's Rules and Responsibilities

M1 – Omar Abdulaziz Hussain
- Reports Responsible
- Power Point slides designer
- Motion Monitoring Subsystem (Software & Hardware)
- Gases Monitoring Subsystem (Software & Hardware)

M2 – Ibrahim Mohammed Ahmed
- Reports Assistance
- Power Points Slides Assistance
- Temperature & Humidity Monitoring Subsystem (Software & Hardware)
- Particle Detecting Subsystem (Software & Hardware)
- Pressure Monitoring Subsystem (Software & Hardware)

M3 – Abdullah Abu-Bakr Alkaf
- Team Leader
- Schematics and Blocks Designer
- PCB Designer
- SMS Alarming Subsystem (Software & Hardware)
- ThingSpeak cloud data representation
- Final Comprehensive Prototype (Software & Hardware)

Results and Discussion

The results and outcomes from this monitoring system have been shown as a statistical graphs in the ThingSpeak cloud and in the serial monitor. In addition, the SMS alarming system was effective since that we got a good and fast response in the abnormal conditions. the following figures(12,13,14) shows an example of the results in both normal and abnormal conditions.

Figure 12: Results of Gases and motion sensors in ThingSpeak cloud

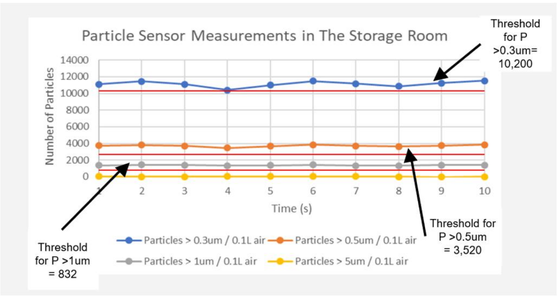

Figure 13: Results of particle detector

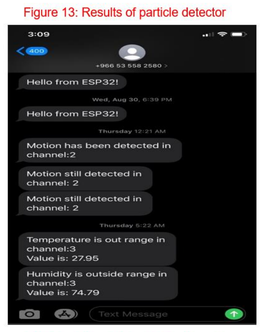

Figure 14: Results of the SMS alarming system

Conclusion

This design project was able to be achieved at the determined deadline and achieved the required objectives. In addition, there were some challenges and future work recommendations have been noted down to improve this project. The following list describe the solution and impact of this project.

The Challenges
- Analyzing all the collected data at the same time.
- The speed of the response from the microprocessor.

Solution
- Precise monitoring system, that monitor temperature, relative humidity, atmospheric pressure, motion, toxic gases, and particles inside the cleanroom that follows ISO-5 classification.

Impact
- Offering reliable and cost-effective monitoring system for small cleanrooms.

Future work
- Adding UART Mux.
- Develop Serial communication for long distances.
- Monitoring differential and positive pressure.
- Improve dual core performance for ESP32 SIM800l processor.

Product Demonstration Video

SCAN ME

To Watch the Video, Scan the QR Code or Click on the Link Below:

https://drive.google.com/file/d/1bkOzH7CbMqNSKNfpxcaliSrdiChiKqRv/view?usp=drive_link

Contact information

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