FPT Education

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FINAL PROJECT
IOT102t

IOT-BASED ENVIRONMENTAL MONITORING

Group 3

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IoT-Based Environmental Monitoring

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1 Introduction

The food industry increasingly focuses on preserving and ensuring product quality. Monitoring environmental factors such as temperature, humidity, and gas levels in food storage is crucial to prevent microbial growth while maintaining the freshness and quality of the products. Abnormal changes in temperature, humidity, or the presence of gases can directly impact food safety and the quality of preserved products. To address this need, an automated system using Arduino has been developed. This system integrates temperature, humidity, and gas sensors, enabling continuous monitoring of environmental indicators, early detection of unusual fluctuations, and timely alerts.

2 Methods and Materials

2.1 Components and Peripheral Devices

The following components are used in the system:

- The DHT11 temperature and humidity sensor.
- MQ-2 gas sensor.
- 5V passive buzzer.
- Arduino Uno R3.
- 5mm Universal LED.
- 2510 mini cooling fan (2.5cm, 5VDC).
- Breadboard MB-102 (830 Lô 165x95x10mm).
- LCD 1602 with I2C module.
- Module 1 Relay.
- Button

  The **DHT11** is a basic, low-cost sensor used to measure air temperature and humidity. It provides calibrated digital output and operates with a power supply of 3.3V to 5V. With an accuracy of ±2°C (temperature) and ±5%RH (humidity), it can be easily integrated with microcontrollers like **Arduino**.

The **MQ-2** gas sensor is used to detect combustible gases such as LPG, natural gas, and butane. It operates at 5V DC and outputs an analog signal proportional to the gas concentration, with a detection range of 200 to 10,000 ppm.

The 5V passive **buzzer** is a simple sound-producing device that operates with a voltage range of 3V to 5V. Unlike an active buzzer, it requires a PWM signal to produce sound, allowing flexibility in tone control.

The **Arduino Uno R3** is a popular microcontroller board based on the ATmega328P chip, designed for programming and controlling components in electronic projects. It features 14 digital I/O pins, 6 PWM pins, and 6 analog input pins, making it compatible with a wide range of peripherals.

The 5mm **LED** is a small light-emitting component that consumes minimal power and comes in various colors, such as red, green, white, and yellow.

The 2510 mini cooling **fan** is a compact cooling device that operates at 5V DC with a size of 25 mm $\times$ 25 mm $\times$ 10 mm. It provides efficient airflow to cool electronic components, preventing overheating.

The **MB-102** breadboard is a solderless prototyping board with 830 connection points, making it easy to assemble electronic circuits. With dimensions of 165 mm $\times$ 55 mm $\times$ 10 mm and support for wire gauges 20-29 AWG, this **breadboard** is ideal for testing circuits and designing prototypes.

The **LCD 1602 with I2C module** is a 16x2 character display that operates at 5V and features a backlight. The I2C module reduces the number of connection pins from 16 to 4, making it easy to integrate into Arduino systems, especially in compact or pin-limited projects.

2.2 Circuit schematic and Block Diagram

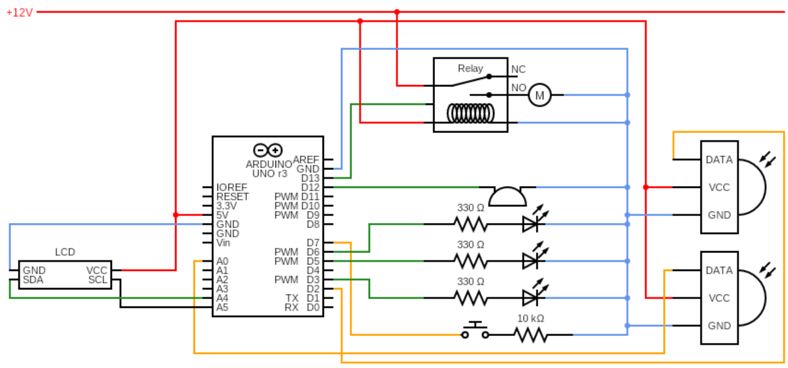

Figure 1: Circuit schematic

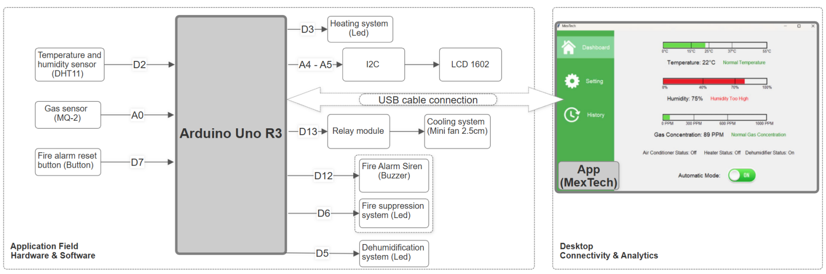

Figure 2: Block diagram

3 Software Programming and IoT Server Integration

3.1 Programming Flowchart

Below is the flowchart for the programming logic used in this project:

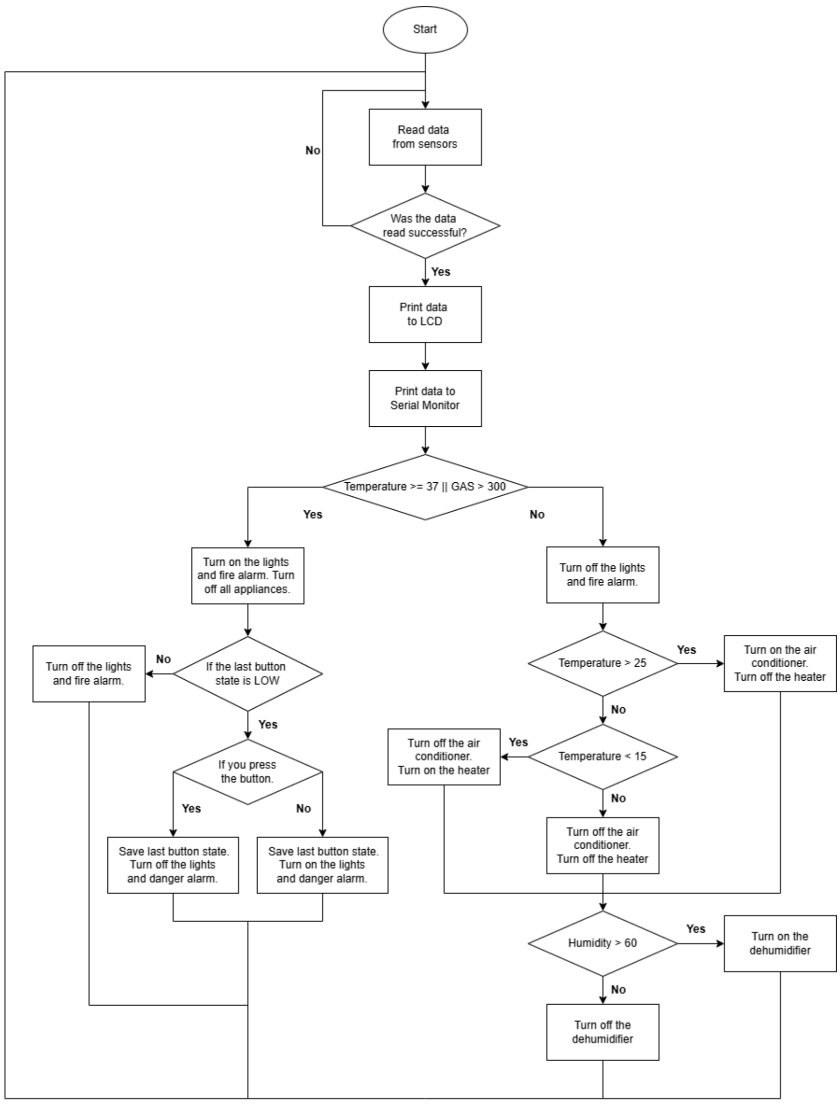

Figure 3: Programming Flowchart

3.2 Software to Control System

Application Overview

This application is developed to connect and interact with the Arduino Uno R3 board, collecting sensor data from devices such as temperature and humidity sensors in a real-world environment. The user interface is designed using Tkinter, a simple and efficient GUI library in Python, which allows users to easily monitor and control parameters from the Arduino. The `pyserial` library is used to establish a connection with Arduino, enabling real-time data transmission between the software and the Arduino Uno R3 board.

Features

- **Monitor:** Tracks parameters such as temperature, humidity, and gas concentration.
- **Set Limits:** Users can set threshold levels for monitoring these parameters.
- **Alerts:** Provides warnings when parameter values exceed predefined thresholds.
- **Automatic Control:** Automatically activates devices to regulate parameters back within acceptable ranges.
- **Manual Control:** Allows users to manually control devices, such as lights, fans, etc., based on specific needs. Set the desired temperature and humidity, and the app will automatically control the devices to achieve the conditions we set.

4 Results

4.1 Temperature and Humidity Monitoring

Temperature and humidity are monitored and divided into specific value ranges, with each range displaying a particular status to help users easily monitor and assess environmental stability.

- **Temperature Control:** When the temperature falls below the set threshold, the system automatically activates the heating lamp. Conversely, if the temperature exceeds the threshold, the fan (or air conditioning) is triggered. Under normal temperature conditions, both the heating lamp and fan are automatically turned off to save energy.

- **Humidity Control:** If the humidity level exceeds the permissible limit, the system activates a dehumidifier to adjust the humidity of the surrounding environment.

4.2 Gas Concentration Monitoring

When the gas concentration exceeds the safe level, the system interface immediately sends an on-screen alert. A danger notification also appears to remind users of the potential risk of fire or explosion.

4.3 Emergency Response

In case of emergency, if the smoke/gas sensor detects values beyond the permissible range or if the ambient temperature exceeds 37°C, the system activates an emergency SOS mode:

- The software interface prominently displays the message **"SOS"**.

- The alarm siren and warning light are activated to alert users to the danger.

- Other devices, such as the heating lamp and fan, are powered off to ensure safety.

- If a supervisor is present, pressing a button will deactivate the siren and warning light.

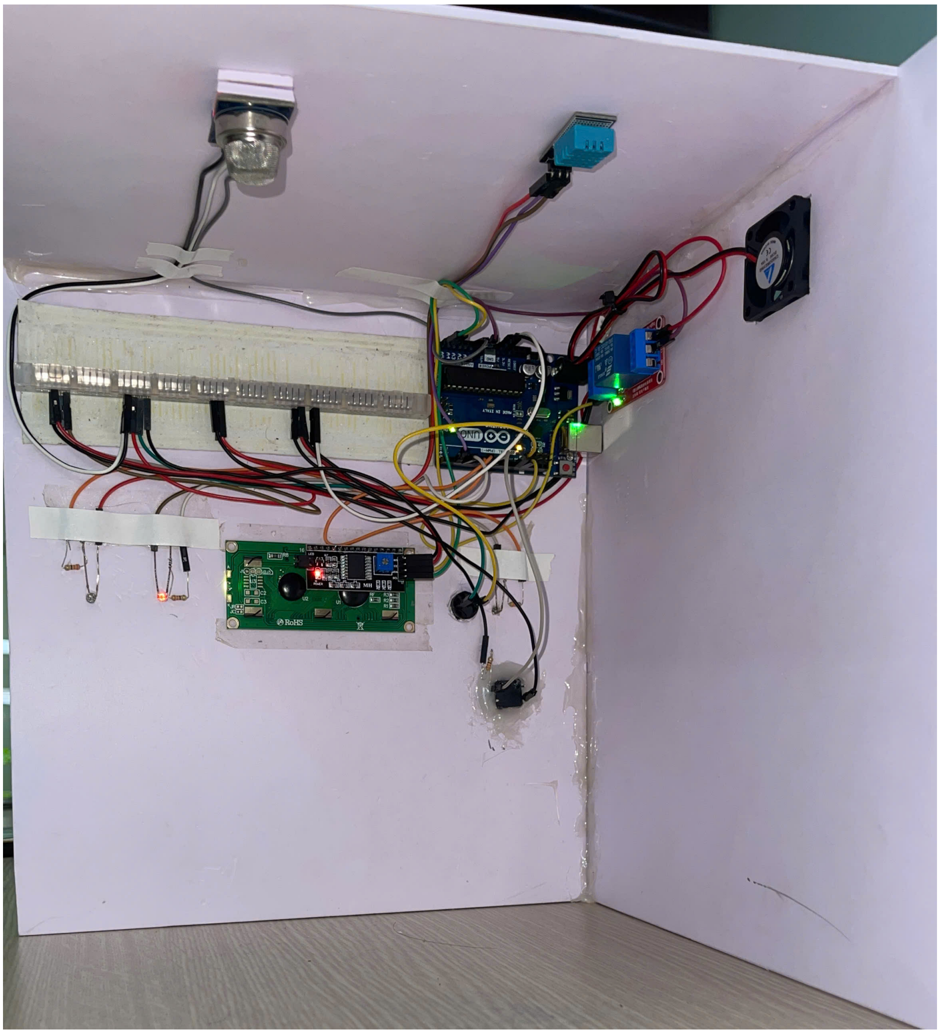

Figure 4: The image shows the devices inside the model.

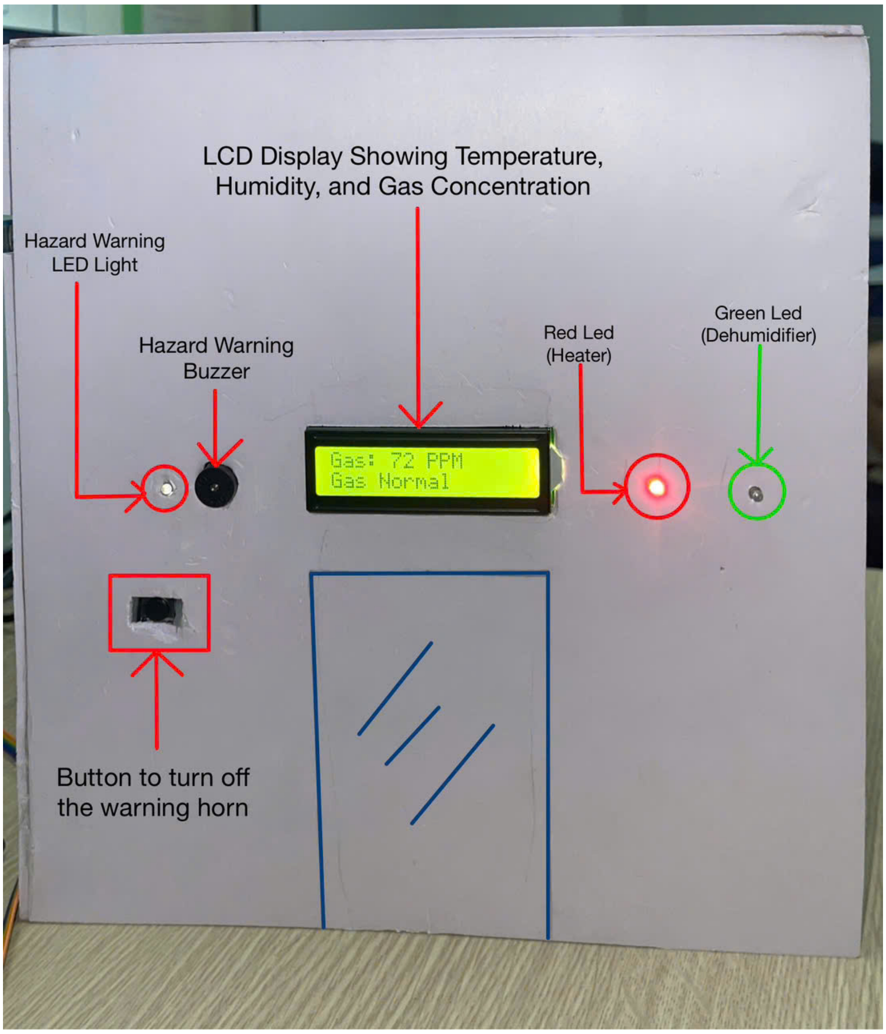

Figure 5: The image shows the devices outside the model.

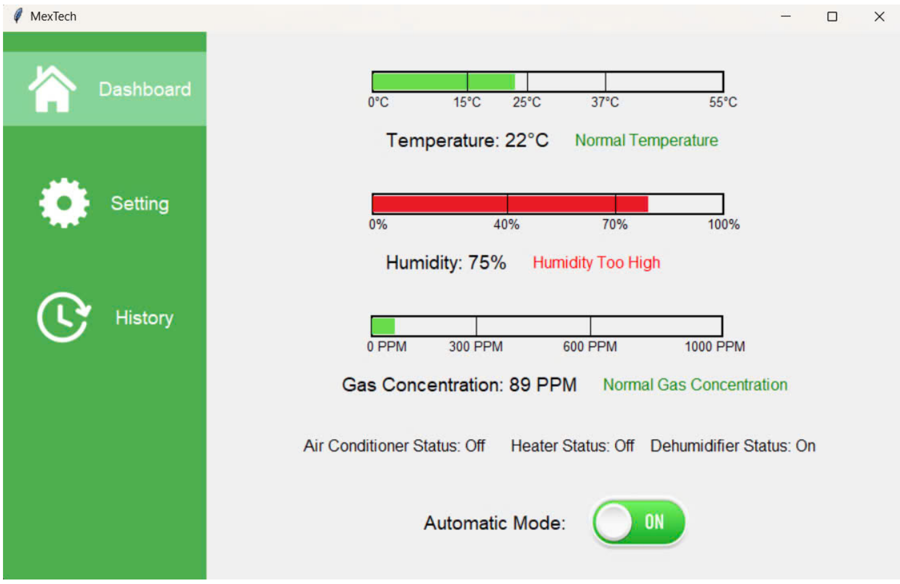

Figure 6: The image shows the dashboard screen interface of MexTech App.

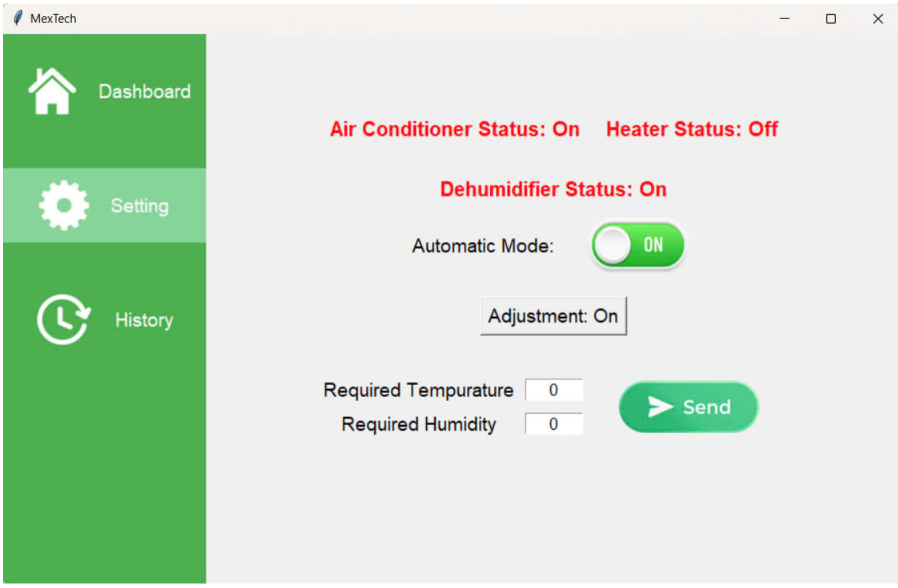

Figure 7: The image shows the settings interface of MexTech App.

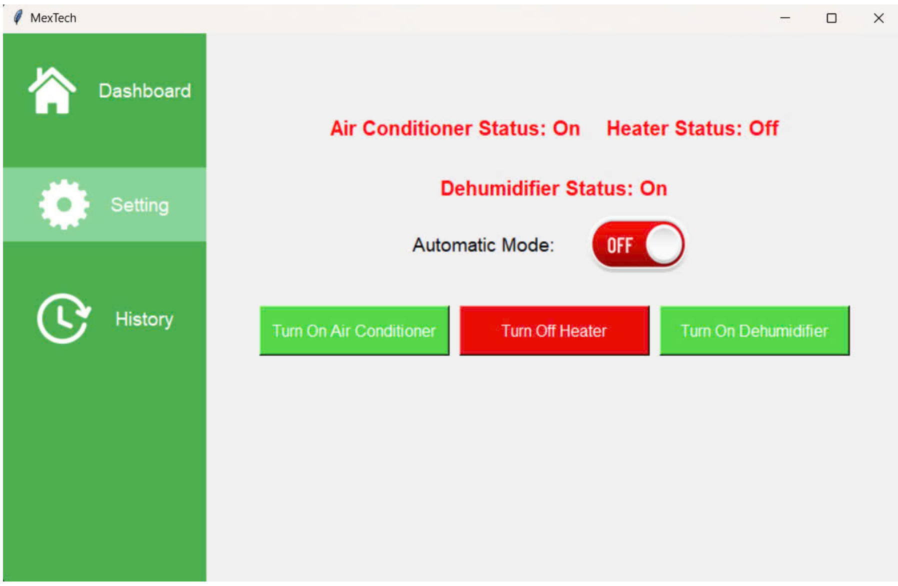

Figure 8: The imgage shows the setting not auto interface of MexTech App

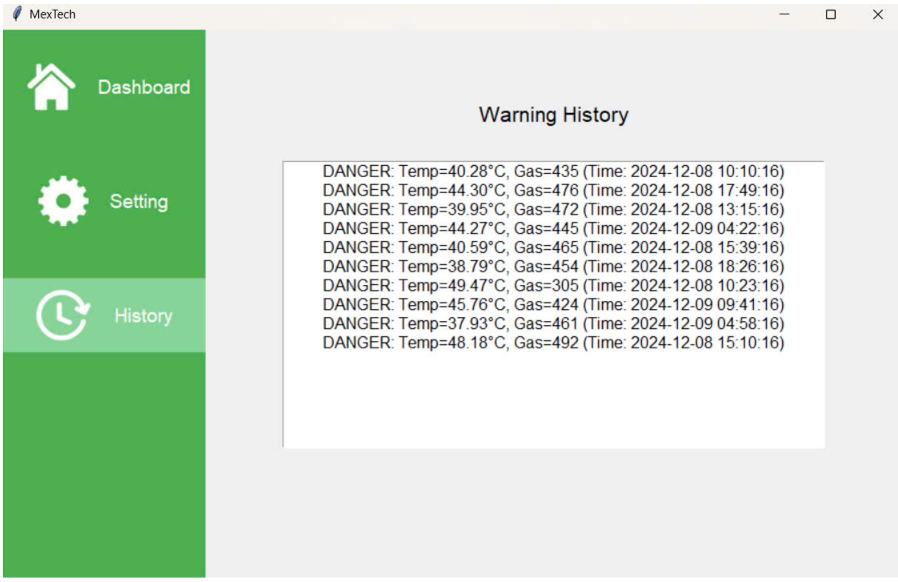

Figure 9: The image shows the history interface of MexTech App.

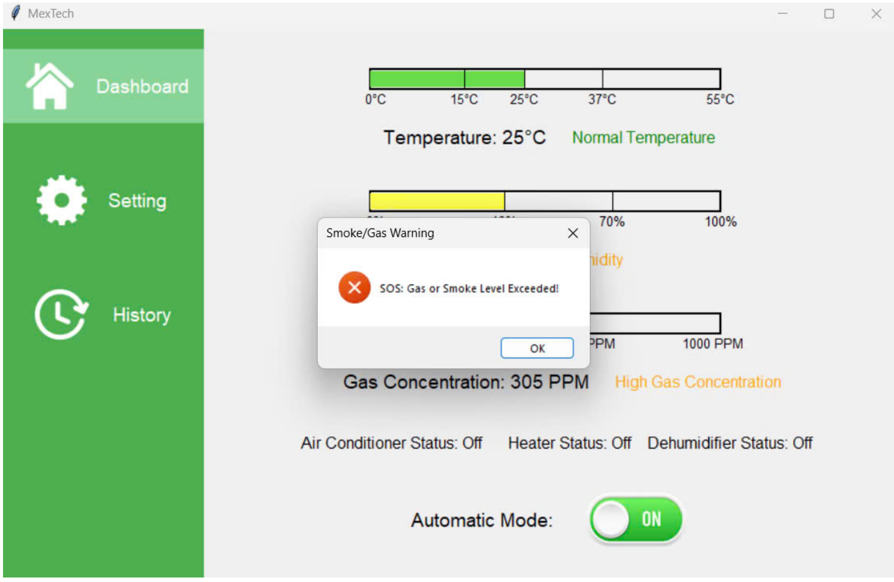

Figure 10: The image shows the interface when there is an alert in MexTech App.

5 Conclusion

The environmental monitoring system presented in this paper successfully integrates several sensors and an **Arduino Uno R3** board to provide real-time temperature, humidity, and gas concentration monitoring. The system offers both automatic control and manual intervention capabilities to ensure that environmental factors remain within optimal ranges for preserving food products. Future improvements could involve adding more sensors, integrating the system with cloud platforms for remote monitoring, and expanding its application to larger industrial settings.

6 List of Figures