THE UNIVERSITY OF DANANG
THE UNIVERSITY OF TECHNOLOGY
FACULTY OF ELECTRONICS AND TELECOMMUNICATION

FINAL REPORT

MICROPROCESSOR ENGINEERING

TOPIC:

CO AND PM2.5 CONCENTRATION MONITORING DEVICE

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1. Introduction:

- Carbon monoxide (CO) and PM2.5 are hazardous air pollutants that pose serious risks to human health if not monitored and detected in a timely manner. Prolonged exposure can lead to respiratory problems, cardiovascular diseases, and life-threatening conditions. For example, the AQI in Hanoi city during winter is usually around the alarming level due to these two pollutants. Therefore, developing an effective air quality monitoring and warning device is essential.
- This project aims to design a device for monitoring and warning of CO and PM2.5 concentration levels.
- The system uses CO and PM2.5 sensors and an ESP32-C3 microcontroller to measure the concentration of these two elements and generate warning signals.
- Useful applications: indoor air quality monitoring, fire detection, smart safety systems.

O_3 (ppb) 8-hr	O_3 (ppb) 1-hr	$PM_{2.5}$ ($\mu g/m^3$) 24-hr	PM_{10} ($\mu g/m^3$) 24-hr	CO (ppm) 8-hr	SO_2 (ppb) 1-hr; 24-hr	NO_2 (ppb) 1-hr	AQI	AQI Category
0–54	—	0.0–9.0	0–54	0.0–4.4	0–35	0–53	0–50	Good
55–70	—	9.1–35.4	55–154	4.5–9.4	36–75	54–100	51–100	Moderate
71–85	125–164	35.5–55.4	155–254	9.5–12.4	76–185	101–360	101–150	Unhealthy for Sensitive Groups
86–105	165–204	55.5–125.4	255–354	12.5–15.4	186–304	361–649	151–200	Unhealthy
106–200	205–404	125.5–225.4	355–424	15.5–30.4	305–604	650–1 249	201–300	Very Unhealthy
—	405–604	225.5–325.4	425–604	30.5–50.4	605–1 004	1 250–2 049	301–500	Hazardous

Figure 1: Air Quality Index (AQI) Standards for Major Air Pollutants [1]

2. Hardware Schematic and Components Used:

- Components used:
  - Main MCU: ESP32-C3 DevKit-M1.
  - Smoke Sensor: MQ-2.
  - PM2.5 Sensor: GP2Y1010AU0F.
  - Indicators: 2 LEDs, 1 buzzer, and 1 push button, 3 resistors.
  - Displays: 1 LCD 16x2 I2C.
  - Capacitor: 220uF/16V.

- General block diagram:

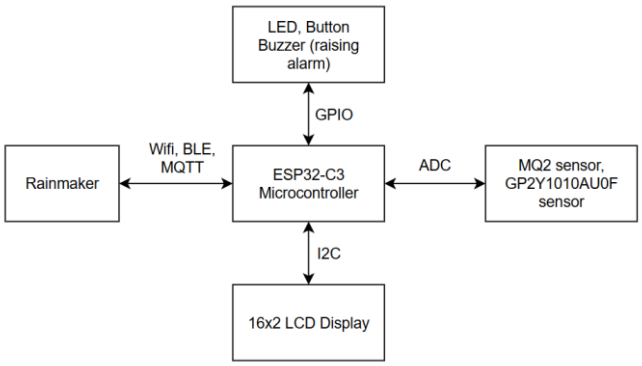

Figure 2: Block diagram

- Circuit diagram:

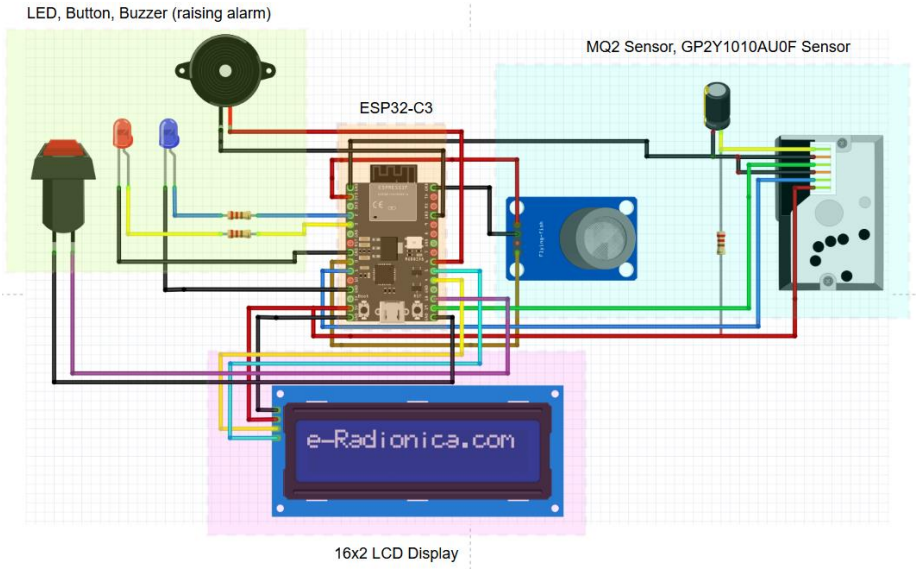

Figure 3: Circuit diagram

- Functions of the components:
  - ESP32-C3 microcontroller: Acts as the central processing unit of the system.
  - MQ-2 sensor: Detects CO gas and converts it into a concentration value in ppm. (AO connected to GPIO0, and VCC=3.3V) [3]
  - GP2Y1010AU0F: Detects PM2.5 and converts the ADC values from PM2.5 to a concentration value in µg/m^3. (With VO connected to GPIO1, IR LED on GPIO19, and VCC = 5V) [2]
  - LEDs: Indicate status and alarm conditions. Current-limiting resistors are used to protect the LEDs (Blue LED on GPIO2, red LED on GPIO3).
  - Buzzer: Generates audible warning signals (GPIO6).

- Push button: Used to activate alarm mode or not (GPIO18).
- LCD I2C: Displays the CO and PM2.5 concentration value (SDA on GPIO4, SCL on GPIO5).
- Capacitor: Used for reducing noise and stabilizing the GP2Y sensor's ADC signal.

3. Implementation:

Software tools used by the team:

- ESP-IDF (C/C++): Used for programming, in order to run the entire system.
- Rainmaker: Used for monitoring the concentration of CO and PM2.5 and pushing warning notifications.
- Draw.io: Used to design the overall system flowchart and block diagram.
- Fritzing: Used to visualize the circuit diagram (mainly for reporting purposes, mentioned in Figure 3).

Flowchart:

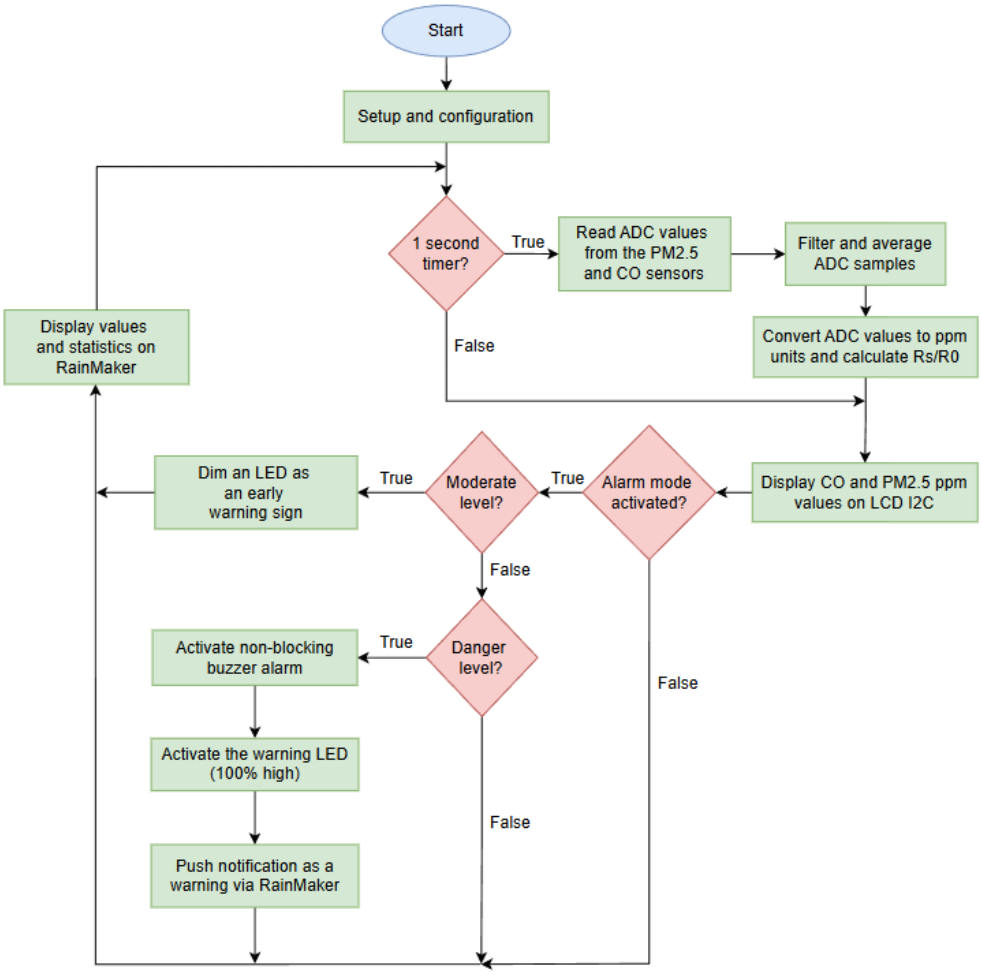

Figure 4: Flowchart

Implemented circuit and RainMaker:

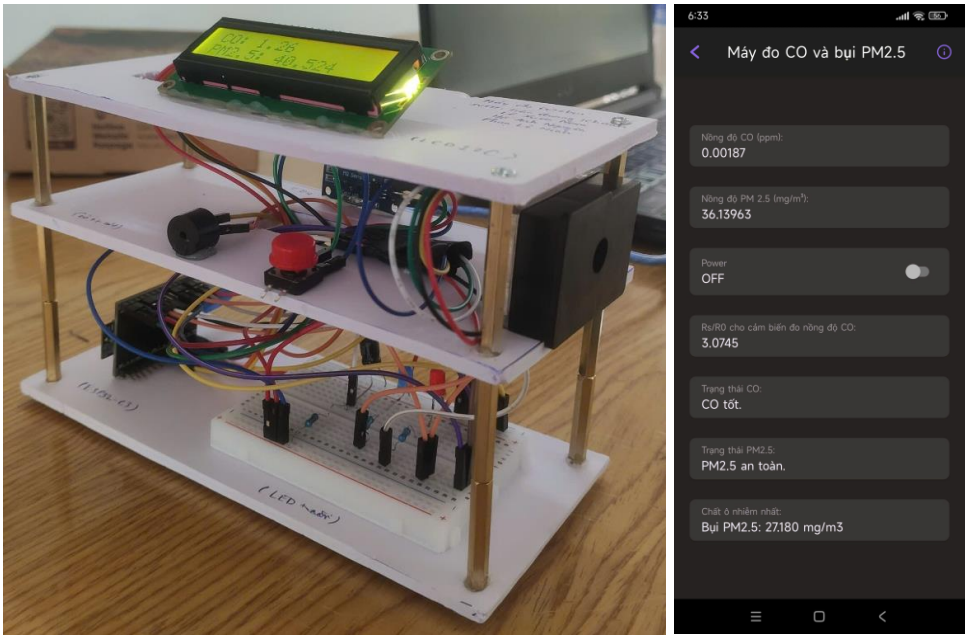

Figure 5: Implemented circuit and RainMaker

4. Conclusion:

- The project has implemented a CO and PM2.5 concentration monitor device based on the MQ-2 sensor, GP2Y1010AU0F sensor and an ESP32-C3.
- The system can monitor CO levels, display information, and activate alarms when the concentration reach the hazardous level.
- Thanks to ESP Rainmaker, this application has enabled remote monitoring, alarm mode control, and the display of hazardous warning notifications.

5. References:

[1] U.S. Environmental Protection Agency, Air Quality Index, Wikipedia.

[2] ESPBoards, GP2Y1010AU0F Dust Sensor – Overview and Usage.

[3] M. Karim, Arduino and MQ-2 Gas Sensor, Arduino Project Hub.