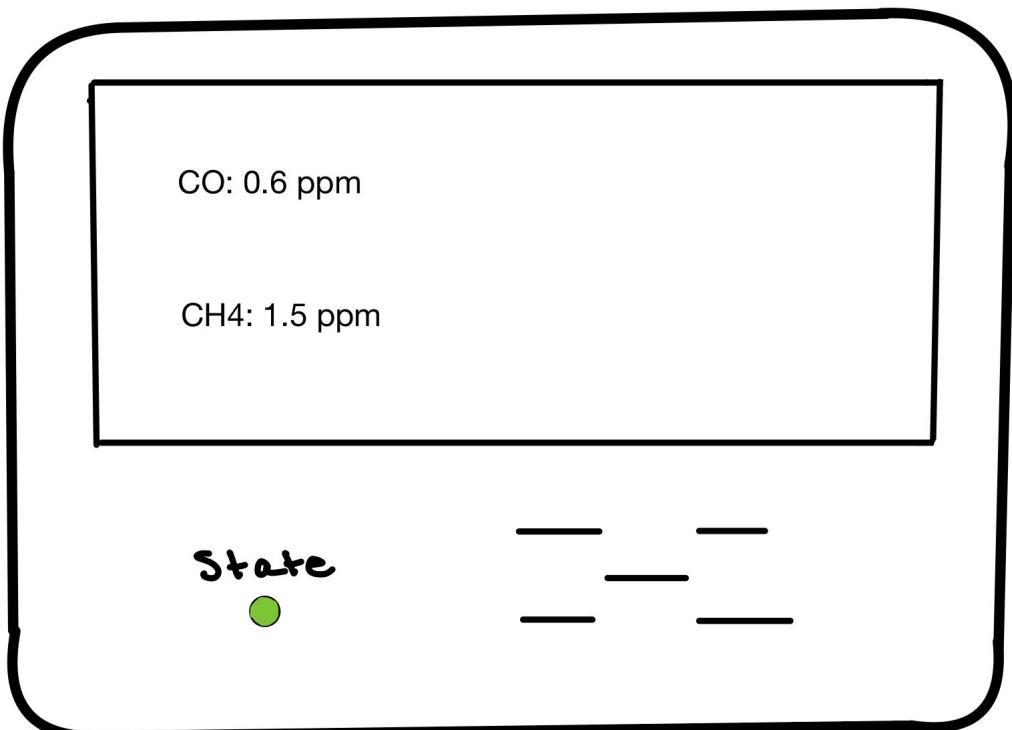


Gas Detector - Requirements Specification

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1 Overview

Gas leaks can be very dangerous when they occur and if left unnoticed by a homeowner or family member. During the day or night, a person can be so preoccupied with a task or sleeping that they won't notice gas leaking from the stove, furnace, water heaters or gas pipes. Depending on the type of gas, this can be fatal; for example, carbon monoxide (CO) is a colorless and odorless gas which means that it can build up high levels of concentration indoors, and people would have no way of detecting it until they start to show symptoms of CO poisoning. Another type lethal gas is methane (CH₄) which is a more potent greenhouse gas compared to carbon monoxide because it traps more heat in the air; it acts as a fuel source and is a primary component of natural gas that helps in powering homes, appliances and other domestic applications. However, high concentrations can lead to physical symptoms similar to carbon monoxide poisoning and since methane is a flammable substance, a potential leak can also lead to fires and explosions.

To resolve this issue a gas detector can help mitigate the issue of gas leaks within a person's home by notifying the user of a potential gas leak whether they're inside or outside of their home. This gas detector will be primarily focused on detecting methane and carbon monoxide since both gasses are the most commonly found in residential homes. The detector will be a stationary device that will be installed at wall and will display the gas concentration levels and notify the homeowner if there are high levels of carbon monoxide or methane.

2 Statement of the problem

Gas detectors typically consist of a pellistor sensor for detecting combustible gases and vapors, an lcd screen to display the gas concentration values, a buzzer and voice speaker to use as the alarm, and an led to help describe the air quality with its color. My design follows a similar approach consisting of an MQ-9 gas sensor, the hiletgo 3.5 tft lcd display, a 3-24V buzzer, an RGB LED, an internal power supply and intake/exhaust fans.

The MQ-9 gas sensor is decent for detecting carbon monoxide and flammable gases like methane and propane. This broad detection capability makes it versatile for general household or industrial use. The MQ-9 operates on the principle of varying resistance in the presence of target gases, providing an analog output that can be converted into a concentration reading. The HiLetgo 3.5" TFT LCD display will be used for displaying gas concentration levels in parts per million (ppm) because TFT (Thin-Film Transistor) displays offer better resolution, color depth, and viewing angles compared to basic LCDs, allowing for a more visually informative and user-friendly interface. The 3-24V buzzer provides flexibility in terms of power supply and potentially loudness, ensuring the alarm is noticeable. The RGB LED will be used to visually represent the air quality with its colors to provide a more nuanced visual feedback system—for example, green (very clean air) to warm red (hazardous gas levels). The Internal Power Supply ensures the device is self-sufficient and portable which is crucial for a safety device that might need to operate independently of external power sources. The intake/exhaust fans will be used to help detect accurate and reliable gas detection. Intake fans draw in ambient air to ensure the sensor is exposed to a representative sample of the environment. Exhaust fans help clear the sensor chamber after an alarm or to prevent saturation, allowing the sensor to quickly return to its baseline and be ready for subsequent readings. Proper airflow management also helps in distributing the detected gas across the sensor's surface for more accurate readings.

The proposed system will help protect households from threats to a person's home. The device benefits the Nation Department of Economic and Social Affairs' 11th goal of making cities and human settlements safe, resilient, and sustainable. AI for social good(AI4SG) contributes to this goal by providing real-time analysis and proactive monitoring.

3 Operational description

The gas detector is a comprehensive solution designed to monitor gas leaks and provide real-time alerts to users and will integrate advanced components like an MQ-9 gas sensor module, RGB-LED, alarm buzzer, intake/exhaust fans and an LCD display module. The detector will be a stationary device installed on a wall in key areas of the home, such as the kitchen, basement, or near gas-powered appliances where gas leaks are most likely to occur.

Once installed, the gas detector will continuously monitor the surrounding air for dangerous levels of carbon monoxide (CO) or methane (CH₄). The MQ-9 sensor will detect gas concentrations, and the system will process this data in real time. If gas levels exceed safe thresholds then the detector will activate multiple warning mechanisms to alert the homeowner.

- **LCD Display:** The screen will show real-time gas concentration levels, allowing users to check the air quality at a glance.
- **Visual Alerts (RGB-LED):** The LED will change colors based on gas levels—green for safe, yellow for moderate levels (caution), and red for hazardous concentrations.
- **Audible Alarm (Buzzer):** If dangerous gas levels are detected, a loud buzzer will sound, ensuring immediate awareness even if the user is not looking at the display.
- **Automatic Ventilation (Intake/Exhaust Fans):** In high-risk scenarios, the detector can activate connected ventilation fans to help disperse harmful gases, reducing immediate danger.
- **User Controls:** A button interface will allow homeowners to silence false alarms (after verifying safety), reset the device, or test system functionality.

This intuitive, multi-layered alert system ensures that users are promptly informed of potential hazards, enabling quick action to prevent health risks or fire hazards. The design prioritizes ease of use, requiring minimal maintenance—only occasional sensor checks and battery replacements—while providing reliable, 24/7 protection. The following figures are visual representations of what the detector will look like and how the alarm will activate, where Figure 1 is the inside of the device and Figure 2 is the alarm going off due to high levels of carbon monoxide emissions.

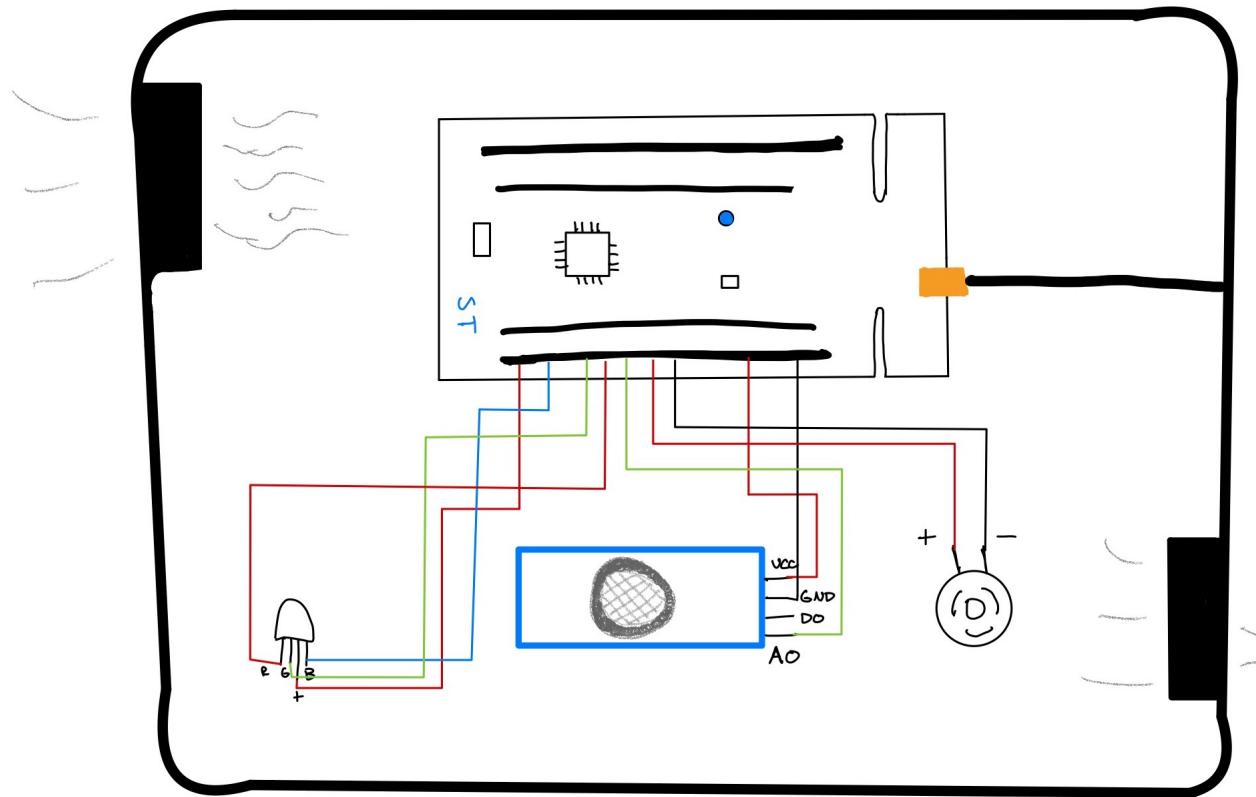


Figure 1: Components inside the device

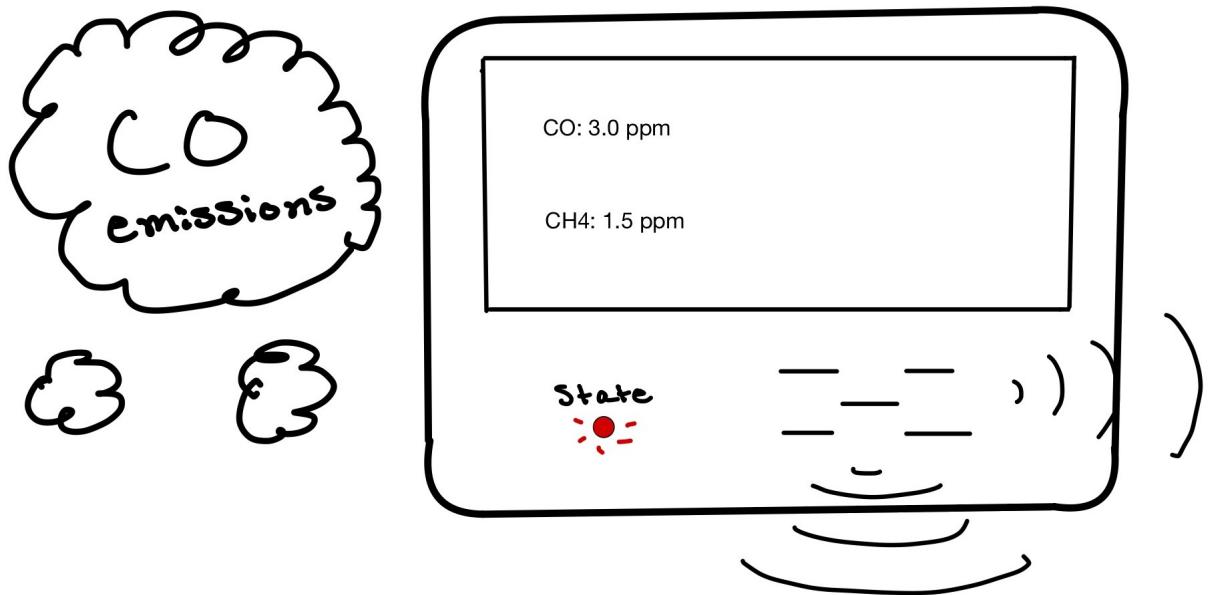


Figure 2: Example of the detector alarm

4 Requirements specification

The product will include a user-friendly hardware interface for the client to make the experience simple to use by silencing false alarms, reset the device, or test system functionality. The device will mostly function by itself with minimal user input.

Inputs

- MQ-9 Gas Sensor: Detects concentrations of carbon monoxide (CO) and methane (CH₄) in the air.
- Power Button: Allows the user to turn the device on/off.
- Alarm Silence/Reset Button: Lets the user mute a false alarm or reset the system after a gas leak incident.

Outputs

- LCD Display: Shows real-time gas concentration levels (in ppm) and warnings.
- RGB LED Indicator: Provides visual alerts:
 - Green = Safe (normal operation)
 - Yellow = Moderate gas levels (caution)
 - Red = Dangerous gas levels (evacuation needed)
- Buzzer/Alarm: Emits a loud, continuous sound when hazardous gas levels are detected.
- Intake/Exhaust Fans: Control the air flow with the casing to improve gas concentration detection.

5 Design deliverables

We plan on delivering different types of documentation to the customers to provide transparency and insight.

- The product will include a user guide; This will include instructions on installation of the device and setting it up on your smart device, an overview of the different features that are included in the device, and troubleshooting tips in case you run into some problems with the installation and configuration.
- Schematic diagram; This is to provide a detailed representation of the system with the interconnections of the components to the STM32 to help troubleshoot and to enable any custom modifications (if needed).
- Block diagram; This is to better understand the system in a less technical visualization to help simplify the complexity of the product, helping users learn the product's functionality faster, and reduce miscommunication during the development process.
- List of all components; This helps provide an understanding as to what the system consists of along with how these components are used.

There will be a functional prototype that gives the clients an idea of what the final product will be. This includes the key features and architecture of the product; The prototype will be used as a way to provide feedback and improve the quality for the product on release.