Project Synopsis

Embedded Safety System for Gas Leak Detection, Unattended Cooking Monitoring, and Automated Shutoff Using IoT

1. Problem Statement

Gas leaks and unattended cooking are significant household hazards that can lead to serious accidents, including fires, explosions, and even loss of life. In many cases, these incidents occur when residents are unaware of a gas leak or forget to turn off their cooking appliances. The lack of an automated system to monitor and control such situations is a major safety concern, especially for the elderly and working individuals.

2. Project Objectives / Goals

- To design an embedded safety system using IoT that detects gas leaks in real-time.
- To monitor cooking activities and detect when cooking is left unattended.
- To implement an automated shutoff mechanism to prevent accidents.
- To provide immediate alerts to users via mobile notifications or alarms.
- Allow users to interact with the safety system using voice commands

3. Proposed Solution

Our project introduces a smart IoT-based embedded safety system that constantly monitors the kitchen environment for any signs of gas leakage or unattended cooking. It uses a gas sensor to detect leaks and a flame or temperature sensor to monitor the cooking status. If a risk is identified, the system sends alerts and automatically shuts off the gas supply through a solenoid valve, thus preventing potential accidents.

4. AI Integration into Embedded Safety System

a. Natural Language Alerts using AI (Text-to-Speech)

To enhance user experience and accessibility, our project integrates AI-powered natural language alerts that inform the user in clear spoken language about any safety-critical event.

Instead of traditional buzzer-based alerts, the system uses a Text-to-Speech (TTS) engine (e.g., Google TTS, gTTS, or pyttsx3) to generate contextual voice messages like:

- "⚠️ *Gas leak detected in the kitchen. Please evacuate immediately.*"
- "🔥 *Unattended cooking has triggered a fire. Shutting off gas supply.*"

This voice alert system is triggered through a central controller (like a Raspberry Pi or mobile app) upon receiving sensor data from the ESP8266. These alerts improve clarity during emergencies and are especially helpful for elderly, children, and differently-abled users.

b. Voice Assistant Integration for Smart Interaction

We have also added AI-powered voice assistant integration using Google Assistant SDK or Mycroft AI. This allows users to interact with the system through natural voice commands such as:

- *"Is there any gas leak right now?"*
- *"Turn off the gas supply."*
- *"Open the kitchen window."*

For implementation:

- We used Dialogflow to define intents and responses.
- A secure communication link (e.g., HTTPS or MQTT) triggers hardware actions via ESP8266 based on the command received.
- Voice input/output is handled through a microphone and speaker connected to a Raspberry Pi or through a smartphone running the Google Assistant app.

This integration transforms the system into a truly smart safety device capable of not just sensing danger but also communicating and responding intelligently.

5. Technology Stack and Implementation Plan

Hardware Components:

- MQ-2 Gas Sensor (for gas detection)
- Flame Sensor or Temperature Sensor (for cooking activity)
- Arduino/ESP32 Microcontroller
- Solenoid Valve (for automated shutoff)
- Buzzer and LED (for alerts)
- Wi-Fi Module (ESP8266/ESP32)

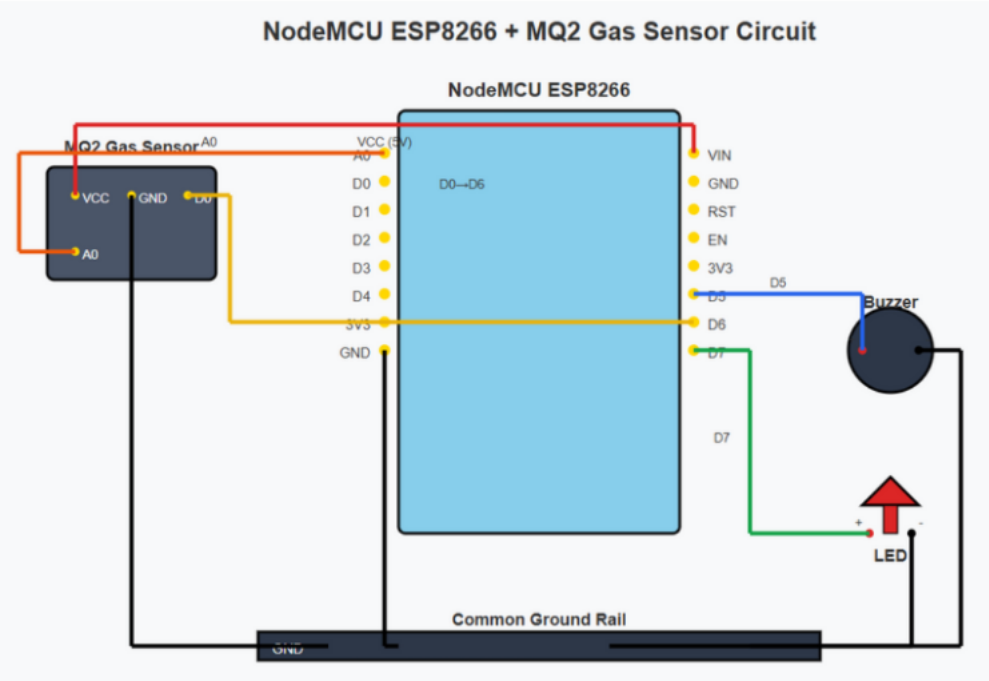
Software Tools:

- Arduino IDE (for firmware development)
- Blynk or similar app (for mobile notifications)

Implementation Plan:

1. Set up gas and flame sensors and connect them to the microcontroller.
2. Program logic to detect thresholds for gas concentration and flame absence.
3. Configure automated shutoff control and buzzer alerts.
4. Integrate with a mobile app for real-time notifications.

6. Circuit Diagram



7. Unique Selling Points (USPs)

Our project, *"Embedded Safety System for Gas Leak Detection, Unattended Cooking Monitoring, and Automated Shutoff Using IoT"*, offers several key advantages that distinguish it from existing safety solutions:

a) Real-Time Automated Safety

This system goes beyond just detecting danger — it reacts instantly. Upon identifying a gas leak or unattended cooking, it automatically shuts off the gas valve, minimizing the risk of accidents without requiring manual intervention.

b) Smart Alert System

Integrated with a mobile interface, the system sends real-time notifications to users. Even when away from home, individuals can monitor and respond to safety alerts, ensuring peace of mind.

c) Cost-Effective and Easy to Implement

Built using widely available and affordable IoT components, the system is a budget-friendly alternative to commercial gas safety setups. It is designed for easy installation in both new and existing kitchens.

d) Scalable Design

The modular architecture allows the system to be scaled for use in larger environments such as apartment complexes, restaurants, or industrial kitchens, making it adaptable to various needs.

e) Family and Elderly Friendly

The system is especially useful in households with elderly members or children, where accidental gas leaks or unattended stoves are more likely. It provides an additional layer of smart, proactive safety

f) Expandable and Future-Ready

The system is designed to support further development, such as the addition of smoke sensors, voice control, or AI-based analytics. It offers flexibility for future enhancements and customizations.

8. Target Audience

- Homeowners
- Elderly individuals living alone
- Working professionals with busy routines
- Small restaurants or home kitchens

9. Features and Functionality

- Real-time gas leak detection
- Detection of unattended cooking (no flame detected while gas is on)
- Automatic gas shutoff to prevent accidents
- Loud buzzer alerts and mobile app notifications
- Option to manually override the system if needed

- Compact, low-cost setup suitable for home use

10. Impact and Benefits

- **Enhanced Safety**: Prevents kitchen-related accidents by acting early.
- **Peace of Mind**: Users can feel safe knowing their kitchen is monitored.
- **Affordable**: Uses low-cost sensors and microcontrollers.
- **Smart Integration**: Connects to a mobile app for remote monitoring.

11. Scalability and Future Scope

- **Scalability**: Can be deployed in multiple households and commercial kitchens.
- **Future Additions**:
    - Smoke detection
    - Voice command integration
    - AI-based cooking activity analysis
    - Battery backup for power failures

12. Challenges and Limitations

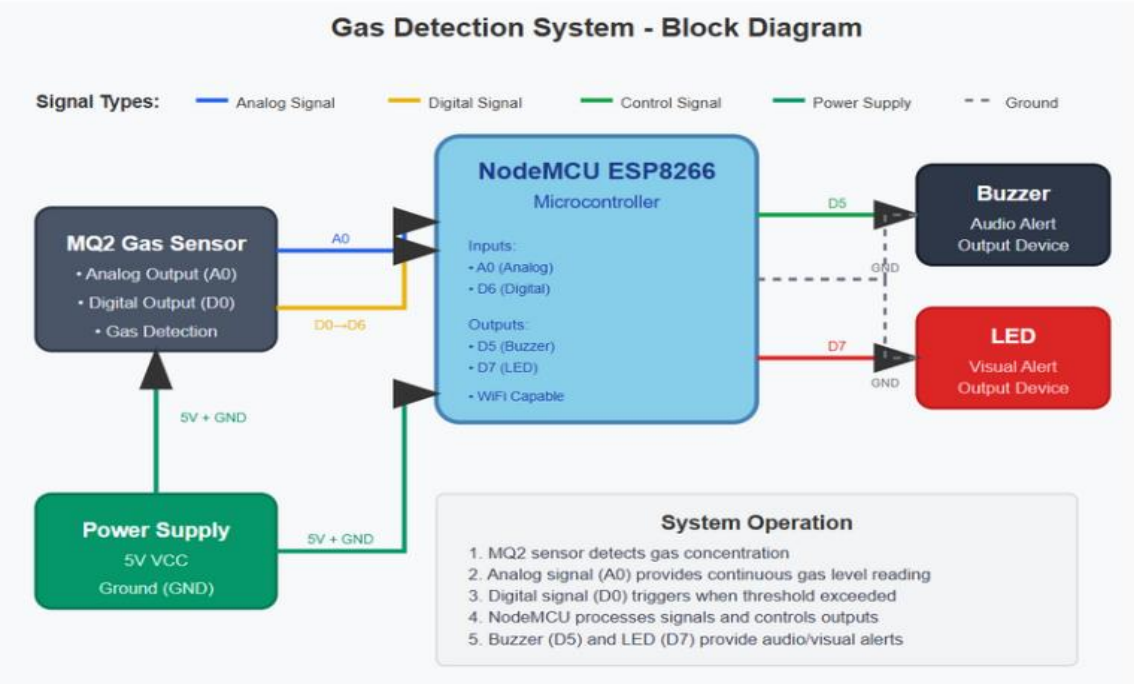
- Sensor calibration may vary depending on kitchen conditions.
- Wi-Fi dependency can affect performance if the connection is unstable.
- Installation may require minor kitchen modifications.

13. Conclusion

This project aims to solve a real-life problem using a practical and efficient embedded IoT system. By automating safety measures in kitchens, we can

significantly reduce the risks of gas-related accidents. The system is designed to be scalable, user-friendly, and adaptable to future enhancements.

14. Block Diagram



15. Pictographic representation