**SafeGas : A Smart IoT-Based Gas Leak Detection, Monitoring, and Automated Shut-Off System.**

**BANGLADESH UNIVERSITY OF BUSINESS AND TECHNOLOGY (BUBT)**

**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**

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| **Course Code :** | **CSE 498A** |
| **Course Title :** | **Capstone Project** |

**PROJECT PROPOSAL**

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**1.1 MOTIVATION**

Gas leaking is dangerous since it could cause explosions, fires, and damage to the environment and people. Currently in homes and industries noticing the gas leakage and preventive steps rely too much on people; thus, gas leaks go undetected in many places leading serious accidents. Reports from 2023 indicate 210-cylinder fires resulting in 23 injuries and 4 fatalities.

Cylinder leaks led to 539 incidents in 2024; explosions injured 53 people and 8 fatalities.

We want to solve this by using IoT technology to automatically detect gas leaks, send alerts to mobile phones, and shut off the gas before anything bad happens. It’s a smart, affordable way to keep homes, businesses, and industries much safer. We believe this system can save lives, protect property, and make daily life more secure.

**1.2 PROBLEM STATEMENT**

1. Most of the time gas leaks and fires go unnoticed until it’s too late.
2. Manual detection is unreliable, especially when there is no personnel present.
3. Lack of automatic detection and shut-off mechanism in the event of an emergency.
4. Slow response time may cause bigger accidents.
5. Most industries and homes lack sufficient safety equipment.
6. Panic and confusion in the event of a leak or fire worsen the situation.

**1.3 OBJECTIVES**

1. Create a highly sensitive and precise gas leak detection system by using Internet of Things ( IoT ).

2. Provide real-time monitoring and immediate alerts via mobile app.

3. For control and safety, offer remote shut-off capability.

4. Make sure it can be applied in households, businesses, and smart cities.

5. Reliable and cost-effective solution for total safety of industries and home.

**1.4 FEATURES**

1. Detects gas leaks or fire using multiple sensors and warns instantly through sound and led.
2. Shuts off the gas automatically or through the app.
3. Turns on the exhaust fan during an emergency to vent out the gas.
4. Monitors gas level and reminders to refill.
5. Built-in display to show device status and important information.
6. Sends quick alerts to your phone during a leak.
7. Sends SOS messages to your emergency contacts.
8. Capability to use the device through solar power in remote areas.

**1.5 REQUIREMENTS**

**IoT Connectivity:** ESP32 Development Boad.

**Gas Leak Detection:** MQ-2, MQ-6 Sensor.

**Fire and Smoke Detection:** Flame sensor, MQ-2, DHT11.

**Alarm:** Buzzer, Led.

**Gas Level Monitoring:** HX711 + Load Cell.

**Auto Shut-off Control:** MG 996R Servo with gas regulator.

**Power Backup:** 12V Rechargeable Battery Solar Power(optional) and Buck converter.

**Communication:** SIM800L/GSM Module, WIFI, Bluetooth.

**User Interface:** LCD Display & Mobile App.

**2.1 PROBLEM RAGES**

***Addressing Complex Engineering Problems (Ps) Through This Project –***

**P1: Depth of Knowledge Required**

* Natural sciences **(K1):** We are using knowledge from natural science to understand how gases like LPG, butane, propane, and natural gas behave and the risks they bring during fires.
* Mathematics **(K2):** We are using mathematics for tuning and calibration of sensor settings so the system runs as intended. For accurate values, we adjusted MQ-2 and MQ-6 gas sensors for leak detection, angel of MG 996R servo for proper rotation, HX711 load cell readings for gas level monitoring, and flame sensor/DHT11 for fire detection following mathematics.
* Engineering fundamentals **(K3):** We are using engineering skills to connect different types of sensors with ESP32 microcontroller and link it with mobile app using IoT tools like WIFI, Bluetooth and GSM. Also, our project requires wiring components, programming and managing power effectively for different components to make the system work properly.
* Specialist knowledge **(K4):** This project needs special knowledge in using IoT technology, like how to connect sensors and small devices to work together. It also requires understanding how gas and fire sensors work to detect danger. Coding skills are needed to program microcontrollers like ESP32. Knowing how to send alerts to phones through Wi-Fi or SMS is also important. The system must be designed to work safely and reliably, even during power cuts.
* Engineering design **(K5):** To solve real-life safety issues like gas leaks and fires, we designed a system that uses the ESP32 board to connect sensors like MQ-2, MQ-6, flame, and DHT11 and control parts like a buzzer, LED, and servo motor for gas shut-off. We will test and adjust the setup to make sure the system detects danger, sends alerts through the app or GSM module, and takes action like sounding an alarm and turning off the gas.
* Research literature **(K8)**: Much research has been carried out on LPG leak detection and immediate action. Here, we included some research projects where we found noticeable work already done.

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| **S.No.** | **Paper Name/Subject** | **Technology/Algorithm/**  **Module/Components** | **Reference** |
| 1 | Smart LPG Leakage Monitoring and Control System Using Gas Sensor (MQ-X), AWS IoT, and ESP Module | LPG Sensor, ESP Module, AWS IoT | Sudip Chakraborty1 et al. (2024) SRINIVAS PUBLICATION |
| 2 | IoT-Based Intelligent Gas Leakage Detection and Fire Protection System | LPG Sensor, Node Mcu, Solenoid Valve, Servo Motor | Gazi Zahirul Islam1 et al. (2022)  DOI:10.3991/ijim.v16i21.30311 |
| 3 | Sensor based Smart Automated Gas Leakage Detection and Prevention System | LPG Sensor, Ublox NEO-6M GPS Module, Arduino UNO R3, SIM800L Quad-Band GPRS-GSM | Zarrin Tasnim1 et al. (2022)  IEEE Xplore |

**P2: Range of Conflicting Requirements**

In this project, one key conflict is that the MG 996R Servo needs an external power supply (around 6V) and cannot be powered directly by the ESP32, so proper power handling is required. Another conflict is between using multiple communication methods like GSM, WiFi, and Bluetooth, which can interfere with each other if not managed properly. Also, combining different sensors like MQ-2, MQ-6, DHT11, and the flame sensor means the system needs careful calibration to avoid false readings or overlap. Balancing these elements is important to keep the system accurate, safe, and reliable.

**P3: Depth of Analysis Required**

We need to create our own system because there’s no simple solution available. All the parts like gas sensors, the shut-off motor, and the mobile app have to work well together. This means we have to plan carefully, write the right code, connect the hardware properly, and test everything to make sure it all works during a gas leak or fire. Since it has to react in real time and send alerts or take action automatically, it takes more thinking and effort to get it right.

**P4: Familiarity of Issues**

We are working with real problems like gas leaks and fire risks things. We had to go beyond just connecting sensor/component’s we really need to understand how the system would work in a real place, like someone’s home. It’s not something we were already familiar with, so we had to learn a lot along the way to make sure everything works safely and reliably.

**P6: Stakeholder Involvement**

Our project affects different groups, including homeowners, industries, emergency services, and gas suppliers. Each group has unique needs: for example, homeowners need easy-to-use systems, while industries might focus more on advanced features.

**P7: Interdependence**

The SafeGas system has many parts that all need to work together like the gas sensor, weight sensor, motor, and mobile app. If even one part stops working, the whole system can fail to respond properly in an emergency. For example, if the app doesn’t get the alert or the motor doesn’t shut off the gas, it could be dangerous. That’s why everything has to be in sync, tested well, and work smoothly as one connected system.

**3.1 ENGINEERING ACTIVITIES**

***Addressing Complex Engineering Activities (As) Through This Project –***

**A1: Range of Resources**

We combined hardware resources like gas sensors and motors, software resources like mobile apps and data storage, and human resources like our team and project mentors. All these come together to create a complete and functional gas safety system.

**A2: Level of Interaction**

In our project, we solve problems like connecting the gas sensor, weight sensor, motor, and mobile app in such a way that all work smoothly together. For example, if a gas leak is detected, the system must quickly alert the user and automatically shut off the gas, all without delays or errors. Balancing speed, accuracy, and user-friendliness is a big part of our work.

**A3: Innovation**

We’re applying engineering principles in new ways. For example, we combined gas leak detection with smart alerts and automatic shut-off features. Instead of just detecting leaks, we created a system that actively prevents danger by turning off the gas remotely and notifying the user immediately.

**A4: Consequences for Society and the Environment**

If there’s a gas leak or a fire, the system can quickly shut off the gas and send an alert to the user through the app. This quick response can help prevent serious accidents, protect lives, and reduce damage. It also helps avoid harm to the environment by lowering the chances of gas and fire hazards, which are usually sudden and hard to predict. It’s a small system, but it can make a big difference in keeping homes and people safe.

**A5: Familiarity**

We’re working on challenges we haven’t dealt with before, like integrating different technologies (IoT, mobile apps, sensors) in a way that provides real-time safety alerts. While individual technologies are common, combining them in a smart gas safety system is a new challenge for us, and we're using engineering principles to make it work.

**5.1 CONCLUSION**

Our project is to simplify and make gas leak and fire hazard safety simpler and more reliable through the implementation of IoT technology. It automatically detects leaks and fires, monitors gas levels, and even shuts off the gas without anyone being required to manually do something about it. The system gives immediate warnings, making it so that dangerous gas and fire accidents cannot occur in the first place. It's inexpensive, easy to scale up, and can be applied in household environments, in commercial establishments, or in industry, making it a valuable in safeguarding people from gas risks.