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# LPG Leakage Detection and Automated Prevention System Using Arduino

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**Abstract**: Liquefied Petroleum Gas (LPG) is widely used in domestic and industrial environments because of its high energy efficiency and affordability. However, accidental gas leakages present severe safety hazards including catastrophic fires, explosions, and suffocation. This paper presents the design and implementation of a compact, low-cost LPG leakage detection system equipped with an automatic regulator cut-off mechanism and real-time status monitoring. The proposed system employs an MQ-2 gas sensor for continuous detection of LPG concentration, an Arduino Uno microcontroller for processing sensor data, color-coded LED indicators for immediate visual status alerts, and a micro-servo motor mechanism that physically rotates the gas regulator knob to the OFF position when concentrations exceed a safe threshold. Real-time messages are provided through an integrated OLED module. The system operates reliably using a 5V supply and demonstrates quick response during testing by switching to alert mode and activating the cut-off mechanism within seconds of gas exposure, effectively removing human intervention from primary accident prevention.

**Keywords:** LPG leakage detection, Arduino Uno, MQ-2 gas sensor, automated safety mechanism, micro-servo motor, OLED display module, embedded systems.

## I. INTRODUCTION

Liquefied Petroleum Gas (LPG) plays a crucial role in modern domestic and commercial environments. It is widely used for cooking, heating, and industrial operations because of its high energy efficiency, affordability, and ease of storage and distribution. Despite these advantages, LPG is highly flammable, and even a small leakage in an enclosed space can lead to catastrophic accidents such as fires or explosions.

In many cases, gas-related incidents occur due to factors such as negligence while operating gas stoves, improper installation of cylinders, loosely fitted pipes, ageing pressure regulators, or accidental damage to hoses. Several studies and real-world accident reports indicate that a large percentage of household fire accidents are caused by undetected LPG leakage. The danger is intensified because LPG is heavier than air and tends to settle near the ground, making it difficult to disperse naturally without ventilation.

Traditional safety depends on human detection of the distinctive odor added to the gas. However, this method is highly unreliable, especially in situations where people are sleeping, elderly individuals have reduced senses, or users are not present in the vicinity. As urbanization increases and household gas usage becomes more widespread, the need for intelligent, automated safety systems becomes more apparent. Technology-based solutions combining sensors, microcontrollers, and electromechanical actuators can significantly reduce the risks associated with gas leakage by detecting leaks early and triggering preventive actions. Hence, an intelligent LPG leakage detection system can serve as a practical, lifesaving tool in modern homes and commercial establishments.

### A. Problem Statement

Although LPG is widely used, most homes still lack a reliable and automated leakage detection and prevention mechanism. In many households, safety is dependent entirely on manual detection through smell or observation, which is unsafe and ineffective. When leakage occurs during nighttime, when no one is nearby, or when individuals are unaware, a small leak can escalate rapidly into a major incident.

Traditional gas detectors mostly rely on a buzzer or alarm to notify users. While they are helpful, they fall short because they do not take any corrective action on their own. The gas continues to leak despite the alarm, and if the user is not present, the warning becomes meaningless. This gap highlights the need for a smarter system that not only detects gas

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leakage but also performs an automatic shut-off of the gas regulator to prevent further leakage. Thus, the core problem addressed in this project is the absence of an affordable, reliable, and fully automated system that can detect LPG leakage and take immediate action to stop gas flow without requiring human intervention.

B. Research Objectives

The primary goal of this project is to design and implement a microcontroller-based LPG leakage detection and prevention system. The detailed objectives are:

- To detect LPG leakage using the MQ-2 gas sensor, a commonly used and reliable semiconductor sensor capable of sensing LPG, methane, propane, smoke, and other combustible gases. The sensor continuously monitors gas concentration and sends analog data to the microcontroller.

To visually alert users through an OLED display and LED indicators. The OLED provides clear, readable messages such as "SAFE" or "LEAKAGE," while addressable LED indicators use color-coded indications (green for safe, red/blue for danger) to increase visibility of the alert status.

- To automatically turn off the gas regulator using a servo motor mechanism. When leakage is detected, the microcontroller activates a micro servo motor attached to the gas regulator knob using a physical linkage mechanism, rotating it to the OFF position.

- To design a compact, low-cost, and user-friendly system using affordable components, easy-to-assemble wiring, and simple power requirements.

C. System Scope and Applications

The scope of this project includes designing a complete automatic leakage detection and prevention unit based on simple electronic modules and a microcontroller. The system operates using an MQ-2 sensor for gas detection, an Arduino Uno for decision making, an OLED for status display, and a servo motor for actuating the regulator cutoff mechanism. While the current implementation focuses primarily on domestic safety, the system can be adapted for various environments with minimal modifications. These include small restaurants, cafes, school canteens, and small-scale industrial kitchens.

Practical applications include home kitchens where domestic gas cylinders are widely used, restaurants and hotels using multiple burners where the probability of accidents is high, industrial canteens, food trucks, and laboratories using gas burners.

## II. LITERATURE SURVEY

R. Pramana [1] developed an Arduino-based LPG leakage detection system enhanced with a Kalman Filter algorithm to improve the accuracy of MQ-2 sensor readings. Their work addressed the limitations of conventional threshold-based detection by filtering noise and stabilizing sensor output, thereby improving reliability in varying environmental conditions. The system included an automated exhaust mechanism and alarm unit for real-time mitigation.

M. S. Wibawa et al. [2] designed and implemented a low-cost LPG gas leak detector using an MQ-2 gas sensor integrated with an Arduino Uno platform. The authors demonstrated that the system achieved 97.97% accuracy when tested against a standardized measurement tool, proving its suitability for household applications. Their model incorporated both visual and audio alerts to ensure rapid user response during hazardous gas concentrations.

F. Maiza et al. [3] proposed an LPG leakage detection device equipped with an MQ-2 sensor and a hazard warning system consisting of a buzzer and indicator lights. The authors focused on designing a compact and efficient monitoring unit capable of detecting small variations in gas concentration. Their system responded quickly to leaks and provided reliable alarm activation under various test conditions.

M. I. Prananda et al. [4] developed an IoT-based LPG leak detection system using the MQ-2 sensor connected to a microcontroller with internet connectivity. The model enabled remote gas monitoring and real-time notifications sent to a mobile device using cloud-based platforms. Their work demonstrated how IoT integration significantly enhances safety by informing users even when they are away from the leakage site.

Aulia and M. Munasir [5] introduced a combined LPG and fire detection system utilizing an MQ-2 gas sensor and a flame sensor, interfaced through an IoT-enabled microcontroller. Their research aimed to enhance safety in environments where gas leaks could potentially escalate into fire hazards. The dual-sensor approach improved reliability by reducing false alarms and covering multiple emergency scenarios.

  

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## III. SYSTEM DESIGN METHODOLOGY

This section explains the overall design, working principle, and the methodology used to build the LPG leakage detection and regulator cut-off system. It includes the block diagram, flow of operation, and mechanical as well as electrical design considerations.

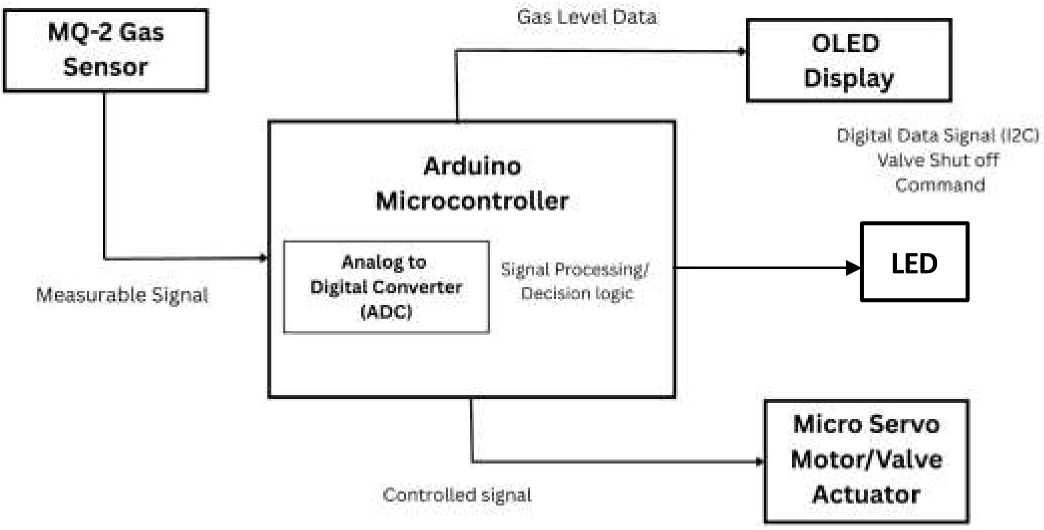


*Figure 1 . System block diagram and data signal flow.*

A. Block Diagram Explanation

The major components and data flow in the system are structured around the central processing module, receiving raw input values and outputting control variables accordingly:

***MQ-2 Sensor → Arduino Uno → OLED / LEDs / Servo***

The MQ-2 sensor continuously monitors gas concentration in the environment. The Arduino receives analog values from the sensor and analyzes whether the concentration is above the threshold. If leakage is detected, Arduino triggers the servo motor to rotate the regulator knob to the OFF position. The OLED display provides real-time status updates (SAFE/LEAKAGE), and the LEDs provide immediate visual color alerts.

B. Working Principle

The working is based on continuous gas concentration monitoring. Under normal conditions, LPG concentration is low, so the system displays "SAFE". When the concentration rises above the preset danger threshold, the LED changes from green to blue/red, the OLED displays "LEAKAGE DETECTED", and the servo motor rotates the regulator knob to the OFF position to stop gas flow immediately. This system ensures both early detection and automatic mechanical prevention.

C. Software Flowchart and Logic

The operational sequence follows an infinite loop execution path:

1. Initialize OLED, LEDs, and servo motor parameters.
2. Read analog value from the MQ-2 gas sensor module.
3. Compare the acquired sensor value with the predefined safe threshold level.
4. If the value is below the threshold, execute safe state commands (show SAFE, set LED to green).
5. If the value exceeds the threshold, execute alert state commands (display LEAKAGE, change LED color, actuate servo to shut off regulator knob).

  

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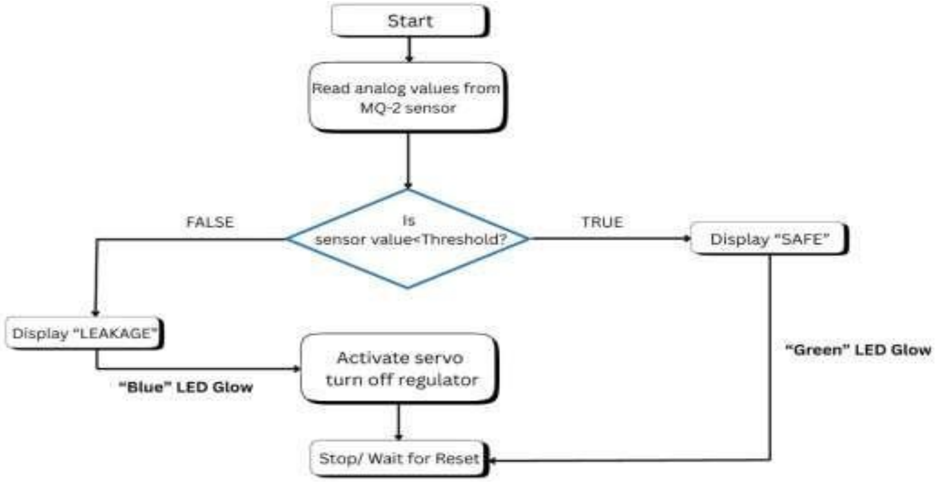


*Figure 2 System software operational flowchart.*

## IV. HARDWARE ARCHITECTURE AND IMPLEMENTATION

### A. Arduino Uno Microcontroller

The Arduino Uno works as the main brain of the whole project. It collects readings from the sensors, checks the conditional thresholds, and decides what actions to take during the execution. The MQ-2 gas sensor is connected to analog pin A0, while output devices like the OLED display, LEDs, and servo motor are connected to designated digital pins. Whenever gas is detected, the Arduino quickly processes the value and controls the display, LEDs, and servo automatically because of the firmware running inside the MCU memory.

*Figure 3 Arduino Uno*

### B. MQ-2 Gas Sensor Module

The MQ-2 is a metal-oxide semiconductor gas sensor used to detect gases like LPG, propane, methane, smoke, and similar combustible fumes. Inside the sensor, a small heater coil warms up the tin dioxide ($SnO_2$) layer, which reacts to as presence and changes its electrical resistance. The internal analog circuit converts this variation into an output voltage signal. As the gas level increases, the sensor outputs a higher analog voltage value read directly by the microcontroller ADC.

*Figure 4 MQ-2 Gas Sensor Module*

  

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C. OLED Display and Visual Indicators

The 0.96-inch OLED display shows the current status of the system using simple I2C communication pins (SDA to A4, SCL to A5). It displays explicit alerts such as "SAFE" or "LEAKAGE DETECTED". To supplement the text display, indicators provide rapid visual recognition from a distance, switching states instantly based on the environmental safety metrics.

The system uses simple indicator LEDs to provide clear visual alerts. These LEDs require minimal wiring and are directly controlled by the Arduino. They serve as an immediate visual indicator of system status:

- **Green LED** lights up when everything is safe
- **Blue LED** turns on when gas leakage is detected

*Figure 5 OLED Display and LED Indicators*

D. Micro Servo Motor Mechanical Cut-Off

A small SG90 servo motor serves as the physical electromechanical actuator. The Arduino sends PWM signals to control its precise angular rotation. Under normal conditions, the servo stays in its default resting position. When a leakage event occurs, the servo rotates and turns the regulator knob through a custom mechanical linkage, shutting off the primary gas source without requiring manual user intervention.

*Figure 6 Micro Servo Motor*

**V. Results, Discussion and Conclusion**

A. Experimental System Results

The developed system was tested under multiple operating conditions to verify accuracy, stability, and overall real-time execution performance. When gas concentration was within the safe range, the system continuously displayed "SAFE" and kept the actuator inactive. During controlled testing with small LPG exposures, the MQ-2 sensor detected a sharp increase in voltage. As soon as the readings crossed the predefined threshold, the system immediately switched to alert mode within a fraction of a second, demonstrating high reliability and rapid mechanical response times.

  

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Figure 7 Safe Mode

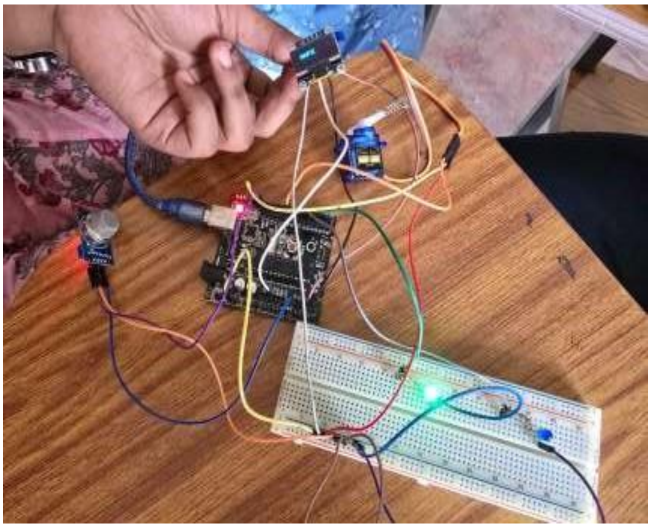
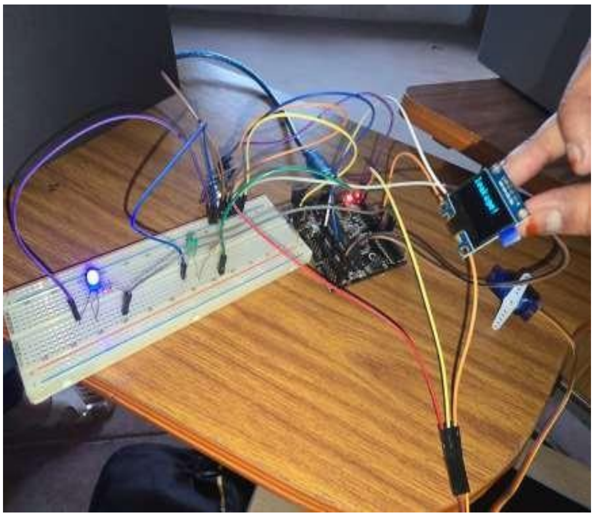


Figure 8 Leakage Mode



B. Conclusion and Future Work

The project successfully demonstrates a low-cost, real-time LPG leakage detection and safety system using an Arduino Uno microcontroller and MQ-2 gas sensor technology. The combination of active gas monitoring, immediate visual text alerts, and automatic physical actuator control makes the system highly effective for domestic and kitchen environment protection. Future upgrades can incorporate advanced features such as GSM or IoT cloud integration for sending remote SMS alerts, utilizing an electronic solenoid valve instead of a mechanical servo for more precise gas line isolation, and introducing dual-sensor configurations (MQ-2 + MQ-6) for higher specialized cross-sensitivity accuracy.

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