EE381A EC Lab Project Report

Project Name: Gas Leak Detection and Automatic Cylinder Shutdown

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- **Section:** D
- **Table No.:** 18
- **Lab Day:** Thursday

* *Link to Arduino Code: Click Me*

➢ Physical Problem Identified:

- Gas leaks pose a significant danger in India, often leading to explosions and harm. Forgetting to turn off the gas before leaving home adds to this risk and anxiety in people.
- Also, a common concern arises from the frequent occurrence of forgetting to check whether the gas was turned off, leading to heightened risks of potential hazards and accidents.
- Our project aims to address these concerns by developing a gas safety system akin to smart locks (in the sense of providing remote functionality and safety against hazards). Equipped with advanced sensors, it can detect even minor gas leaks promptly. Upon detection, the system automatically shuts off the gas supply, thus preventing potential accidents.
- We prioritize user convenience by enabling remote monitoring of the gas supply status. Whether through a smartphone app or a dedicated control panel, users can easily check their gas status from anywhere. Immediate alerts notify users of any issues, ensuring timely action.
- Our mission is to simplify gas safety for everyone, reducing accidents and safeguarding against gas-related disasters. By providing an accessible and efficient solution, we aspire to promote a culture of safety and well-being in Indian homes.

➢ Discussion on existing solutions:

The existing solutions majorly include detecting the gas leakage in any area and then raising an alarm.

○ Their Shortcomings:

1. **Passive Response**: Most existing solutions only raise an alarm when a gas leak is detected. While this alerts occupants of the premises, it does not actively mitigate the leak or prevent potential hazards. Users may not always be able to respond quickly enough to prevent an accident, especially if they are not at home or are asleep.
2. **Dependency on Human Intervention:** These solutions often rely on occupants to take action once the alarm is triggered, such as shutting off the gas supply manually. However, in cases where occupants are not present or are incapacitated, there is a significant delay in response, increasing the risk of accidents.
3. **Limited Scope:** Traditional gas leak detection systems may only cover a limited area or be installed in specific locations, such as industrial facilities. This leaves other areas such as household kitchens vulnerable to leaks, increasing the likelihood of accidents.
4. **Lack of Integration:** Many existing solutions operate as standalone systems and may not be integrated with other smart home or building automation technologies. This limits their effectiveness in providing a comprehensive safety solution and may inconvenience users.
5. **Limited Remote Monitoring:** Some existing solutions may lack remote monitoring capabilities, meaning users cannot check the status of their gas detection system or receive alerts when they are away from the premises.

○ Novelty of our solution:

Our project offers advanced control over LPG gas cylinders, including remote knob control through both Wi-Fi and Bluetooth connectivity. This allows users to employ a "soft" turn-off remotely, useful for addressing second thoughts about leaving the gas on after exiting home. Additionally, Bluetooth connectivity enables users to monitor air quality and receive readings from integrated sensors, such as the Air Quality Sensor and IR sensor, facilitating timely alarms and checks.

We meticulously define sensor thresholds to minimize false alarms, ensuring accurate detection of gas leaks while preventing unnecessary disruptions. Furthermore, we implement an auto-blocking system within the control applications, which disables remote knob control if a hazard triggers automatic gas shut-off as detected by sensors. This precautionary measure ensures that users cannot override safety protocols through the app during emergencies. Instead, users must manually reset the system, thus preventing unauthorized access, particularly by children, to the gas supply in critical situations. This comprehensive approach enhances safety, providing peace of mind to users while minimizing risks associated with gas-related incidents.

In our code, we prioritize the independent operation of applications, ensuring that each mode (i.e. Bluetooth and Wi-Fi) can give commands to turn the gas on or off without interference from the other mode. This design fosters seamless functionality and prevents conflicts between different control interfaces. This approach enhances user experience and system reliability, allowing for flexible control options without compromising safety or efficiency.

➢ Resources Used:

- Arduino Nano
- Buzzer
- Servo Motor SG90
- ESP 8266 Node MCU
- HC-05 Bluetooth Sensor
- IR Sensor (To detect flames)
- MQ135 Air Quality Sensor (To detect gas leaks)
- Breadboard, Jumper Wires and Resistances

* *We used MIT App inventor to make our applications for wireless interface and an Android phone to test the wireless functionality.*

➢ Week-by-Week Schedule:

- In **Week 1** of our project, we focused on assembling the necessary components and becoming familiar with the hardware. Basic tasks were undertaken to ensure a thorough understanding of our equipment's capabilities. This included identifying unknown resistor values by utilizing known resistors and output voltage measurements. Furthermore, we conducted tests to validate Bluetooth connections and observed readings for verification and turned buzzer on and off remotely.

- In **Week 2**, we progressed by assembling our project hardware, including connecting IR and Air Quality sensors, as well as integrating a servo motor. We programmed the Arduino Nano to function as a safety device, enabling the motor to turn off the knob upon detecting any anomalies in sensor readings based upon certain carefully chosen threshold values. We also meticulously set and fine tuned the comparator present in IR and MQ135 sensor to reduce the case of false alarms.

- Continuing into **Week 3**, we focused on configuring Bluetooth and Wi-Fi control. We developed an application to read and send commands from our HC-05 sensor. Additionally, we tackled the integration of the NodeMCU, configuring it to communicate with the Arduino Nano. This involved building an application to send commands to the NodeMCU, which then relayed them to the Nano to control the servo motor. These developments mark significant progress towards our goal of creating a comprehensive and functional gas safety system.

➢ Future Additions:

- We should replace MQ135 sensor by MQ2 sensor (which detects LPG and smoke) since MQ135 performed the function of demonstrating the proof of concept.

- We can add an AC to DC converter from the mains supply to power our Arduino to make our system a stand-alone (not powered form laptop) functioning device.

- Interfacing of High-Power Requirement Servo Motor: Currently we are giving both control signal and power supply to servomotor using Arduino nano which will be impractical in the case of a high-power requirement servo motor (which is very much a practical possibility). We can use a (servo) motor driver for this case, which will receive control signals from Arduino but the power for turning the motor will be supplied by the mains supply (via an AC to DC converter ≡ rectifier).