Smart Gas Leakage Detection System

Using Arduino and a GSM Modem

L Pranau Kumar
School of Computing Sciences and Engineering
VIT University
Vellore, India.

Parth Choudhry
School of Computing Sciences and Engineering
VIT University
Vellore, India.

***Abstract*— The project we have designed aims to provide a reliable solution to the problem of LPG gas leakage from gas cylinders through the implementation of a network connected sensor that informs the user of a gas leakage wherever he/she may be and immediately brings the leakage of gas to his/her attention.**

Keywords—Microprocessors;GSM;Arduino;Sensors;MQ5

I. INTRODUCTION

There has been an immense spike in urbanization in India in the recent decade. One of the trends of this urbanization is the switch from kerosene to LPG cylinders. One of the drawbacks of the cylinder is that faulty valve design or substandard connecting tubes can cause the LPG to leak. The inflammable nature of this gas has caused the loss of many lives and severe disfigurations in many people in this country. The only way to detect the gas is through the smell of the additive compound ethyl mercaptan but this requires the person to be present and alert to detect it.

The world around us is fast moving forwards to a technological singularity, a point in time where humans and machines will become one. This project includes an internet of things system that monitors its environment for spikes in liquefied petroleum gas levels using sensors and informs the concerned user about these levels. It is a cheap and effective solution that the user can install and forget about until the need arises to act upon the leakage.

The objective of this project is to provide a real-time solution to detect gas leakage in household environments and restaurant environments so that countermeasures can be deployed quickly and prevent loss of property and life. The project uses a combination of microcontrollers, sensors and telecommunication networks to achieve this.

II. LITERATURE SURVEY

A. Existing Works

1. "Design and Implementation of an Economic Gas Leakage Detector" [1] written by A. Mahalingam et al., discusses the implementation of a gas leakage system using a USB powered microcontroller and sensor to alert users of gas leakage. While this system is cost-effective, it does not provide a method to interact with the user who is not present on site of the leakage.
2. "A security alert system using GSM for gas leakage" [2] written by S. Rajitha et al., proposes a system using a 32-bit ARM microcontroller LPC2148 and MQ5 gas sensor along with a GSM module for the leakage detection and for informing users of the leakage. While comprehensive, this method is not cost effective because of the high cost of the microcontroller.
3. "A wireless home safety gas leakage detection system" [3] by L. Fraiwan et al., outlines a system that makes use of gas sensors and RF transmitter/ receiver pairs to detect leakage and to inform users. Like the first paper mentioned above, the system fails to inform the user if not present at the scene of detection.
4. "A survey on gas leak detection and localization techniques" [4] by P. Murvay et al., discusses the various state-of-the-art gas detection techniques available in the industry today.
5. "Development of wireless sensor network system for LPG gas leakage detection system" [5] by T. Mujawar et al., discusses a system that makes us of the MQ2 gas sensor and a GSM shield along with an Arduino microcontroller to detect the leakage and also uses a GUI based on LabVIEW but the final product is not cost effective for end users.

B. Gaps Identified

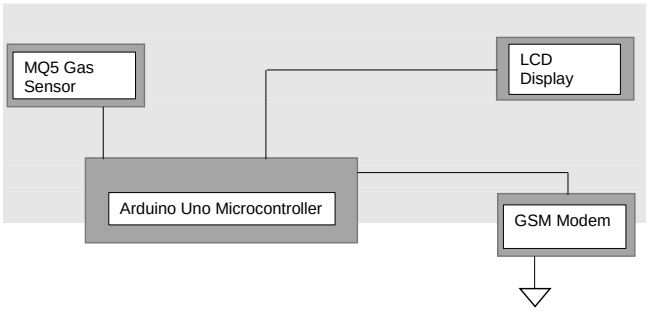
As seen by the above summaries, we see that most existing systems implement one thing or another but leave out the rest. What we present is a combination of the above by combining the advantages of the above systems while minimizing the disadvantages. Our system is cost effective, thorough and modular which makes it the best available product for the end user.

III. OVERVIEW

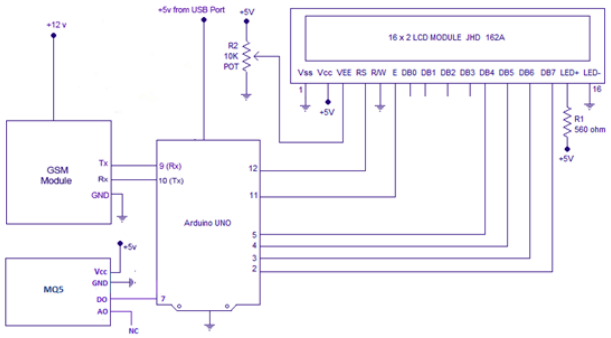
The system we have implemented is as follows – a microcontroller to control the working of the entire system. A readily available gas detection sensor to perform the sensing. A modem to send messages to the user of the leak status and an LCD display on the unit to display current status if the user should seek it.

We have an Arduino Uno microcontroller connected to an MQ5 gas sensor. The gas sensor uses a tin dioxide filament whose resistance decreases with increase in the concentration of LPG. We have a SIM900A GSM Modem that is connected to the serial communication ports of the Arduino. It is a UART modem. There is also a LCD display hooked up to the Arduino that displays current status information. The microcontroller was programmed using a laptop and the executable was burned on to the ROM of the microcontroller. The system is designed to work in standalone mode and can automatically reset itself.

A. System Model



B. Circuit Diagram



IV. System Design

In this section, we will see how the system has been designed. The price of the components, the requirements, the performance and its usability.

A. Functional Requirements

- Assumptions & Dependencies

We assume that the user has knowledge of operating a phone and nothing else. The project is dependent on the availability of a SIM card and a good mobile signal strength to send messages in a timely manner.

- Domain Requirements

The domain this project deals with includes microcontrollers, sensors, cellular technology and automation. However, the working of this project can be explained to anyone without much of domain knowledge too.

- User Requirements

The user must know how to operate a phone. He/she must have a spare SIM card to send messages from and good cellular signal reception at the site of deployment. Additionally, a decent electricity supply is preferred.

B. Non-functional Requirements

- Efficiency

The product is efficient in the sense of time and space. It runs fast machine level code on a microcontroller and is able to detect and inform the user about the leakage in real-time. It is also very compact and easy to deploy.

- Reliability

The product is robust and able to reset itself after a leakage event and continue monitoring the environment. It is designed in such a way that once the system has been deployed it need not be maintained.

- Portability

The system is compact and can be set up very easily. It has good portability.

- Usability

The system has been designed keeping the layman in mind. It does not need any domain knowledge to operate and can be easily used by most adults.

C. Figures and Tables

- Hardware Requirements

The components required and their costs are listed below-

Name	***Component Serial Number***	***Cost (in Indian Rupees)***
Arduino	Arduino Uno	350
Gas Sensor	MQ5	150
GSM Module	SIM900A	1000
LCD Display	HD44780	120
Total Cost		Rs. 1620

- Software Requirements

There is no special software required to run the project except the availability of a phone that can receive messages.
To code the program for running the microcontroller logic we require any computer with-
Windows/ GNU-Linux/ MacOS,
Arduino IDE

V. Results

A. Sample Test Case

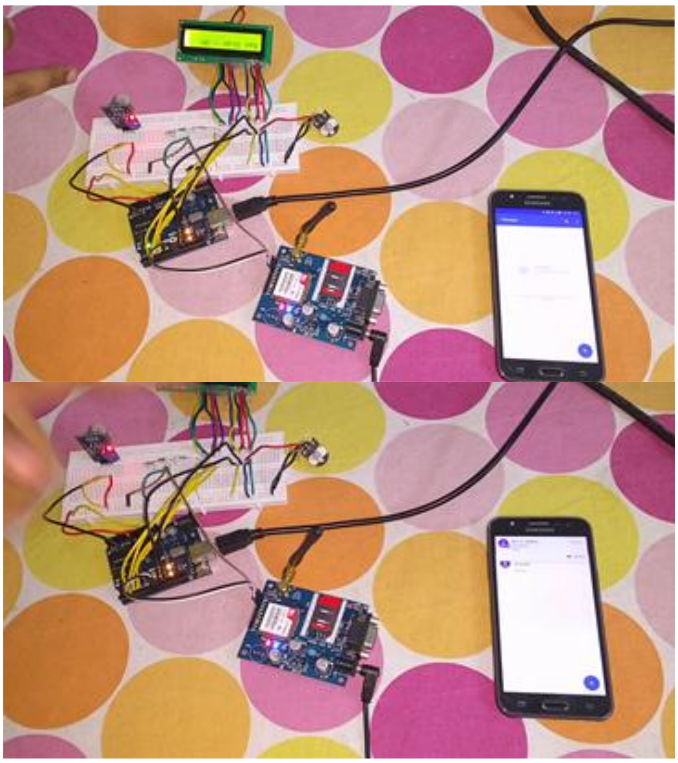


Fig- 1,2 The initial state of the system and the system after receiving the SMS from the GSM modem.

B. Summary of results

From the above test cases we deduce the working of the hardware prototype of the system we have presented. When there is a spike in the LPG levels in the environment the gas sensor sends a digital output to the Arduino board. The Arduino board interprets this signal and accordingly changes the text on the LCD to a warning and asks the GSM modem to send an SMS to a pre-registered mobile number. After this, the system resets itself having done its job and waits for user intervention to get rid of the gas leak.

VI. Conclusion

The system has demonstrated that it has the properties that is required of it, namely- cost-effectiveness, reliability, feature completeness and modularity. However, no system is without its limitations. Ours is no exception. For one, the current system lacks customization. The SMS can be sent only to a single pre-determined number. Also, if the system gets damaged, it cannot be repaired by the user but someone with domain knowledge. We seek to rectify these two major pitfalls in the future.

References

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