

LPG Gas Leakage Detection and Prevention System

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Abstract— Gas leakage has been a major concern in recent times. Though its usage has been extended in various industries, a small unattended leakage can lead to catastrophic damage. The objective of this project is to present the design of a cost effective automatic alarming system, which can detect and prevent liquefied petroleum gas leakage in various premises. This system alerts the user by sending him an SMS and alerting the neighbors by buzzer alarm after the gas leaks above setpoint1. The stepper motor is used to close the gas pipe valves. To reduce risks to human life, main power supply is cut off, if the gas leakage goes above setpoint2. This device ensures safety and prevents suffocation and explosion due to gas leakage. This project is implemented using ARM 7 processor and simulated using keil software.

Keywords—LPG Detection, gas leakage, gas sensor, ARM7 LPC2148, Relay, Stepper motor, Buzzer.

I. INTRODUCTION

Gas leak detection is a process of identifying hazardous gases in the surrounding environment by the use of sensors, thereby paving a way to prevent further repercussions. Liquefied Petroleum Gas, is commonly known as LPG. It is used in many applications in the industrial sector namely in space and process-heating, powering industrial ovens, production of food, kilns, furnaces, production of packing material as well as in powering forklift trucks in warehouses. LPG also finds its usage primarily in domestic sector as a fuel for cooking, lighting and refrigeration. LPG is a flammable hydrocarbon which is composed of propane, butane, isobutane and mixtures of these gases. It has high calorific value, which produces less smoke, less soot, and does not cause much environmental damage. Having these desirable properties, leakage of this gas is very dangerous and increases the risks to fire explosion. This leads to both financial and human loss. The number of reports of death due to gas leak explosions has increased in recent years. The reason for such explosions is the lack of substandard cylinders, old valves, worn out regulators and lack of awareness using gas cylinders add to the risks. A solution to this problem is a gas leak detector device. In this paper, we propose a system that not only detects gas leak but also takes precautionary measure to prevent it.

In the proposed system, we employ a gas sensor to keep a check on the concentration of LPG in the surrounding premise. The user and his neighbors are audibly notified about the leakage by buzzer and a warning message is sent to the user. To reduce risk to human life, a stepper motor is used to close the gas valves and the relay turns off the main

power supply. As a visual indication to the user, a 16X2 LCD display warns the user regarding the leakage. The sensor data is drawn on to an a mobile application which is can be useful to monitor the gas concentration particularly in the industries.

II. LITERATURE SURVEY

A.Mahalingam et.al.[1]proposed a gas leak detector that meets the UK occupational and health standards. Meenakshi Vidya et.al.[2] proposed a leakage detection and real time gas monitoring system where leakage is detected and controlled by means of exhaust fan. The level of LPG in cylinder is also continuously monitored. K. Padmapriya et.al.[3] proposed the design of wireless LPG monitoring system in which the user is alerted about the gas leakage through SMS and the power supply is turned off. Selvapriya et.al.[4] proposed the system in which the leakage is detected by the gas sensor and produce the results in the audio and visual forms. L.K.Hema et.al.[5] proposed the smart sensor technology. In this, a flexible reliable smart gas detection system is developed and again the leakage is detected and controlled by using a exhaust fan. B. D. Jolhe et.al. [6] proposed the system in which two sensors are used for detecting the gas leakage and for monitoring the level of gas in the cylinder respectively. Ashish Shrivastava [7] et.al...proposed the system in which two types of gases namely LPG and CNG are detected for home safety as well for vehicles. R.Padmapriya [8] et.al... proposed the system which ARM7 processor and simulates using keil software to alert the user by sending SMS. V.Ramya [9] et.al... proposed the system that uses two different sensors for detecting the

leakage and requires resetting manually after every situation. M.B.Frish [10] et.al...proposed the system that uses trace sensing technology and also detects the leakage.

III. HARDWARE IMPLEMENTATION

The proposed system is mainly grouped into three phases as input phase, process phase and output phase. It mainly consists of MQ6 gas sensor, LPC2148 ARM7 microcontroller, GSM module, buzzer, relay and stepper motor.

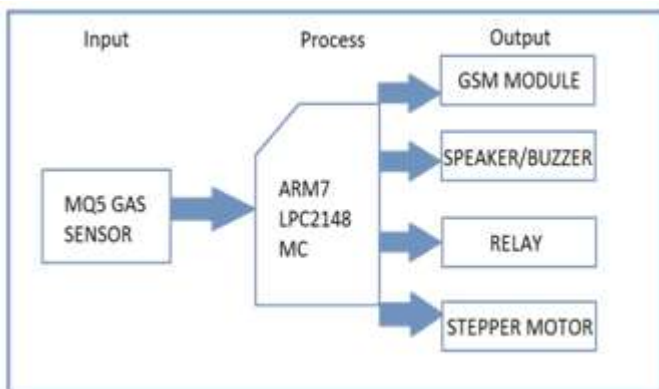
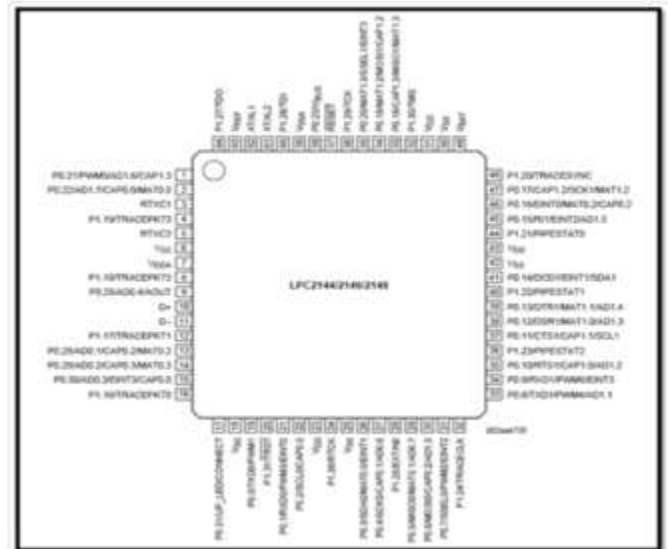


Fig.1 Block diagram of the system

This system aims at taking immediate actions to detect and also control the gas leak. Here we define two setpoints based on the concentration of the gases in the air. As soon as the gas leak is detected, a series of action takes place. When the gas leakage goes above setpoint1, the buzzer rings to alert the user about the gas leak, an SMS alert is sent to the user and also a message is displayed on the LCD display. Then a mechanical handle is provided for closing the knob of the cylinder using stepper motor. When the gas leakage goes beyond setpoint2, the relay is used to switch off the power supply to avoid the repercussions of the gas leak.

A. LPC2148 ARM7 Microcontroller

The LPC2148 microcontroller is based on 32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine microcontroller with embedded high-speed flash memory ranging from 32kB to 512kB, 16kB to 40kB of on-chip static RAM, multiple serial interfaces including two UARTs and variable data length capabilities. The microcontroller as inbuilt ADC (Analog to Digital Converter). Thus the ADC converts analog output received by the gas sensor to digital signals, process it and sends it to GSM module, buzzer, stepper motor and relay. The programmed instructions are fed into the microcontroller and burned using flash magic.



B. MQ6 Gas sensor

A gas sensor is a device that detects the presence of gases in an area, often as part of a safety system. One such gas sensor used for LPG gas leak detection is MQ6 gas sensor. It consists of a steel mesh under which sensing element in housed. Sensitive material of MQ6 gas sensor is Tin Dioxide SnO₂, which has lower conductivity in clean air. When the concentration of the combustible gases increases in the air, MQ6 senses and its conductivity is more higher along with gas concentration rising. The output of the Gas sensor is in analog form which can be converted into digital form using in built ADC (Analog to Digital Converter). Initially when there is a leak, the gas sensor detects it and gives voltage related to the amount of gas that is getting escaped. MQ6 gas sensor has high sensitivity to Iso-butane, propane, LPG and less sensitivity to smoke and alcohol. The MQ-6 can detect gas concentrations anywhere from 300ppm to 10000ppm. The sensor works with 5volt power supply. Equation (1) to calculate the resistance of sensor:

$$\text{Resistance of sensor (Rs)}: \quad R_s = (V_c / V_{RL} - 1) \times R_L \quad (1)$$

Where R_s is the sensor resistance

V_c is the supply voltage to load cell

V_{RL} is the voltage across load resistance

R_L is the load resistance.

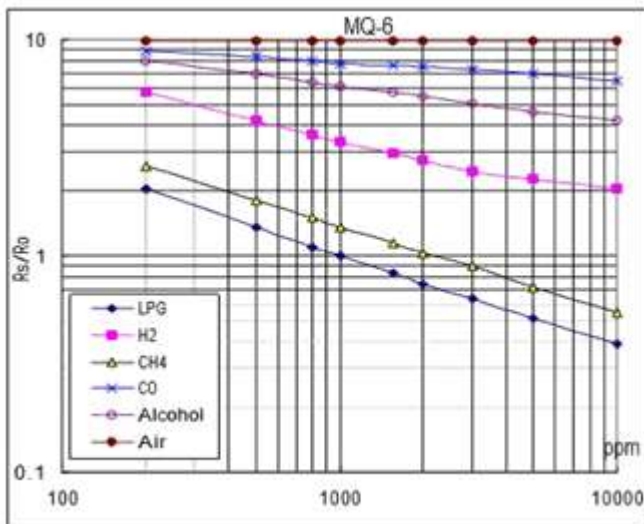


Fig.3 Sensitivity characteristics of MQ6 gas sensor

C. Buzzer

A buzzer is an electrical device that makes a buzzing noise and is used for signaling. A buzzer has a piezo disc and an oscillator inside. When the buzzer is powered, the oscillator generates a frequency around 2-4 kHz and the piezo element vibrates accordingly to produce the sound. As soon as the gas leak is detected, the buzzer automatically rings to alert the users about the gas leak.

D. GSM module

The GSM stands for Global System for Mobile Communication. It is a digital cellular technology used for transmitting mobile voice and data services. The main purpose of GSM module is to alert the user about the gas leak. The type of GSM module used in this system is GSM module SIM900A. The GSM module allows microcontroller to communicate with mobile phones through UART. It requires a SIM card just like mobile phones to activate communication with the network. Also, they have IMEI (International Mobile Equipment Identity) number similar to mobile phones for their identification.

Once the gas leakage is detected, from the inserted SIM, an SMS alert is sent to the user number. If the user phone is not reachable, the same alert message is sent to the other registered numbers there by alerting the user about the same.

E. LCD Display

A liquid-crystal display is a flat-panel display used to present textual information to the user. The type of LCD used in this system is 16X2 LCD display. The use of LCD is to display the

concentration levels of gases in the air and also to display a warning message on the display to alert the user around about the gas leak.

F. Stepper Motor

A stepper motor is an electrical motor that converts electrical signals into mechanical shaft. They move in discrete steps. They have multiple coils that are organized in groups called phases. By energizing each phase in sequence, the motor will rotate one step at a time.

When the gas leak is detected and if the leakage goes beyond setpoint1, stepper motor starts rotating at a particular angle, closing the knob of the gas cylinder thereby preventing the leakage of gas.

G. Relay

A relay is an electrically operated switch. All relays contain a sensing unit, the electric coil, which is powered by AC or DC current. When the applied current or voltage exceeds a threshold value, the coil activates the armature, which operates either to close the opened contacts or to open the closed contacts. When a power is supplied to the coil, it generates a magnetic force that actuates the switch mechanism. Relay is used in this system to cut off the main power supply when the gas leakage goes beyond setpoint2, in order to avoid fire accidents and any other major disasters.

IV. RESULT

The system was successfully implemented and tested by introducing a small amount of LPG gas near it with setpoint1 between 300ppm and 900ppm and setpoint2 being 900ppm and above. LPG leak above setpoint1 initiates audio-visual alarming, a gas leak warning message is sent to the user and the gas valves are closed with the aid of the stepper motor. Due to failure of operation of stepper motor, the concentration of LPG builds in the environment and if goes above setpoint2, a second level protection mechanism is activated using relay to cut off the power supply to the house to avoid any fire accidents.

V. CONCLUSION

This system provides a fast and cost-effective solution to prevent gas leak repercussions by reducing the risk to human life. The statistics of concentration of gas collected on to the application can be useful to recognize the faulty valves and regulators prior and do the necessary replacement. Apart from detecting the leakage, a two level prevention mechanism makes the system more reliable. The cost involved in developing the system is significantly low and is much less than the cost of gas detectors commercially available in the market.

VI. FUTURE ENHANCEMENTS

This monitoring system can be further enhanced by using Bluetooth in place of GSM to send the alert messages to user, which supports another real-time application. For

industrial sector, the data collected by the mobile application is beneficiary and used for data analytics. The integration of other sensors like temperature, pressure sensors etc. makes the system as a home automation project.

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