

An Improved Gas Leakage Detection System

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Abstract - An LPG cylinder is an everyday part of our life, which is a flammable mixture of hydrocarbons. We often hear in the news about tragic mishaps due to gas leakage which endangers human life and leads to loss of commodity. This disaster is preventable, which can be avoided by using newly developed technologies. This project brings together all these technologies and builds a Gas Detection Module. It uses a gas sensor, which detects the presence of gases like methane in its surroundings. If there is an increase in gas concentration in the air it immediately alerts the respective person via a GSM module and sends an SMS. It also uses the reading from the thermocouple such that if heat is noticed then it stops the cycle that is Cooking stage is on. If no value is detected from thermocouple then it's a case of the gas leak and a servo motor attached to the valve closes the valve immediately. Also by alerting the user that the nob is closed.

Keywords - Gas Leakage, GSM Module, Servo, Potentiometer, Thermostat, NTC thermocouple

I. INTRODUCTION

The Liquefied Petroleum Gas commonly known as LPG is not a chemical substance but a product. It is a blend of combustible hydrocarbon gases, Propane (C₃H₈) and Butane (C₄H₁₀) along with smaller amounts of different hydrocarbons ranging from C₂ to C₅. It is utilized as a fuel in numerous applications like homes, lodgings, businesses and automobiles because of its alluring properties which incorporate high calorific value also delivers less smoke, produces less sediment, and do not cause much harm to the environment.

Fossil Fuel is another broadly used fuel in various places, both LPG and fossil fuel burn to produce clean vitality on a serious note these gases being heavier than air do not scatter effectively and may lead to suffocation when inhaled and when there is a gas leakage if not paid attention to it may lead to mishap, affecting people in its surroundings.

Due to the explosive nature of LPG, a number of cases have been registered[1-3]. To dodge this issue there's a requirement for a system to detect and to avoid leakage of LPG. Gas leakage detector is the method to detect combustible gas spills by constructing a prototype design with the help of sensors and microcontroller.

In this project, the notion is to create a smart solution and fix this havoc of gas leakage explosions and accidents[4, 5]. This project integrates various mechatronics sensors and the microcontroller so as to create a smart and complete module to prevent and control such incidents. The Gases like LPG as well as Methane can be detected using the MQ5 sensor. The GSM-sim800a is a module that sends the alert message to the user. The system after detection by itself closes the valve using the servo motor and preventing the accident.

The device is designed for use in homes which use Liquefied Petroleum Gas or natural gas; however, it can be used in industries and other applications involving the gas cylinders[6].

II. METHODOLOGY

The process of the system is classified into three categories. Initially with the help of gas detecting sensor detects the presence of combustible gas in the room. When it detects, it sends the signal to the microcontroller. Secondly, the microcontroller will receive the signals from the sensor, according to the signal microcontroller activates the externally connected devices such as Servo Motor, GSM Module, any other alerting devices[7-9]. Finally, the servo motor closes the main valve to prevent further leakage simultaneously GSM Module sends the alert message to the registered mobile numbers as commanded by the microcontroller. In the end, when the gas leakage been stopped by using the reset button, the whole system can be set to the initial stage[10-12].

A. Arduino

The Arduino is an open-source microcontroller board introduced by by Arduino.cc. This board controls the data of the whole system with its set of digital and analogue GPIO (General Pins for Input and Output) which can be interfaced with various equipment. This board can be powered by a USB cable or by external battery source which supplies 12 – 20 DC volt. The board can programmable using the Arduino IDE. The board is programmed such that it continuously receives the signal from the sensor as powered on. Then it checks the signal whether the gas leakage is detected. If yes then it commands the devices with respective and necessary data to the connected external equipment.

B. GSM Module

GSM Modem that is sim800a can accept any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. This modem uses to communicate through messaging. As the gas leakage is detected by the gas sensor, the microcontroller sends a command to the sim800a to send the SMS to the registered mobile number with an alert message saying "Alert... Gas is leaking !!". This module requires 12V DC supply to work and its ground need to connect with microcontroller's ground to receive the signals. Multiple messages can also be sent to user, police and fire station, etc[13].

C. MQ5 Gas Sensor

A gas sensor (Fig. 1) is a semiconductor type gas sensor which detects the presence of gas in an area. This sensor is composed of sensitive filament called Tin Dioxide(SnO₂), interacts with a gas which changes its resistance ranging from 2kΩ to 20kΩ (in 2000ppm C₃H₈). This sensor can detect the presence of LPG, Methane, Hydrogen, Coal Gas ranging from 300ppm to 10000ppm. This sensor operates in 5V±0.1 DC with up to 20kΩ load resistance. This sensor has a fast response time. This sensor has 4 pins out of which 2 pins used to fetch signals and other 2 pins are used for providing heating current. The can be fetched in two forms, one in analogue in which it sends the amount of gas present in an area in ppm and other in digital form in which it just sends whether gas is present or not.

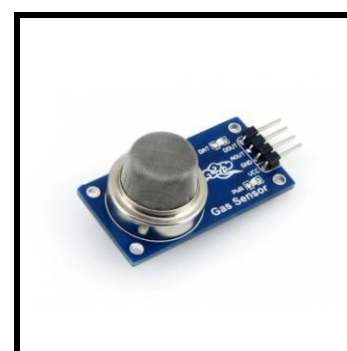


Fig.1 a) MQ-5 Gas Sensor

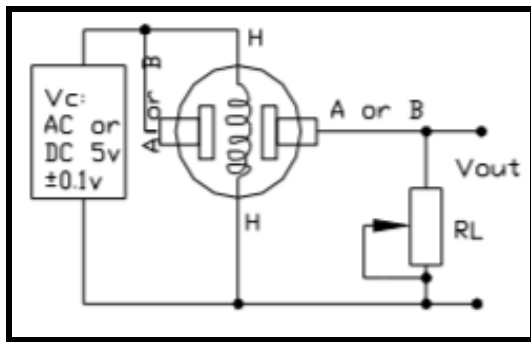


Fig.1 b) Gas Sensor Circuit

This sensor has a different resistance value in different concentration. For example, if we calibrate the MQ-6 gas sensor to the 1000ppm of propane concentration in air, then the resistance value would be approximately 20kΩ. The change in the resistance value with respect to the concentration as shown in Fig.2.

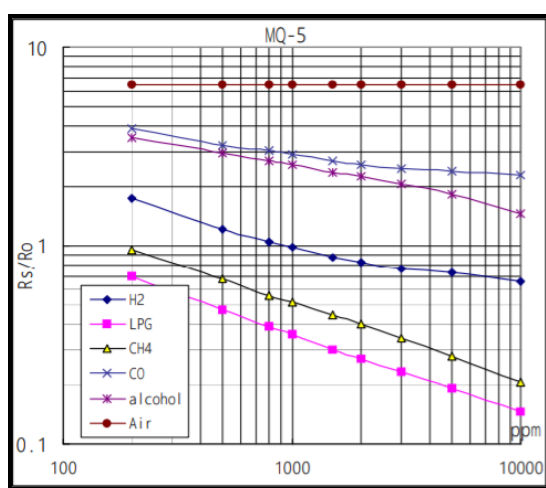


Fig.2 Sensitivity characteristics of gas sensor

D. Servo Motor

The servo motor is a rotary actuator or a motor that allows for precise control in term of the angular position. This motor works on the PWM principle, which means its angle of rotation is defined by the duration of the pulse applied to its pin. This motor is made up of DC motor which is governed by a variable resistor (potentiometer) with some gears. The system uses SG90 servo motor which has 3.0V to 7.2V operating voltage with 1.2 kg-cm torque. The main purpose of the servo motor is to close the main supply of gas to prevent further leaking. The motor is linked with the main switch such a way that if the motor rotates 90° then it immediately closes the main valve.

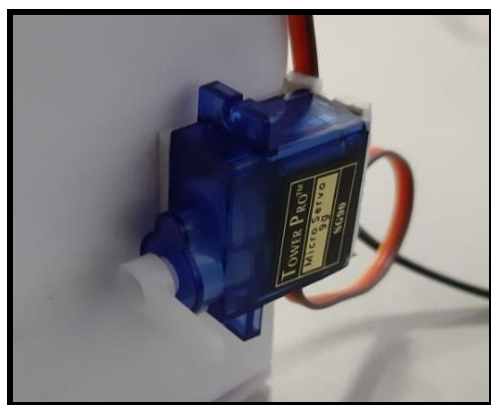


Fig.3 Servo Motor as Main Valve

E. Thermostat Controller

In the case of cooking, a gas sensor detects the unburnt gases in the flame and sends a positive signal for the presence of a gas to the microcontroller which will close the supply of gas line. In order to prevent this trouble, the thermostat controller is used in such a way that it detects the temperature of the stove by using a thermocouple. When the temperature reading is higher than 200°C, it will trigger the relay to an on state which is used as a signal to the microcontroller so that it will not close the valve in case. If temperature increment is not observed then the thermostat controller sets the relay to an off state.

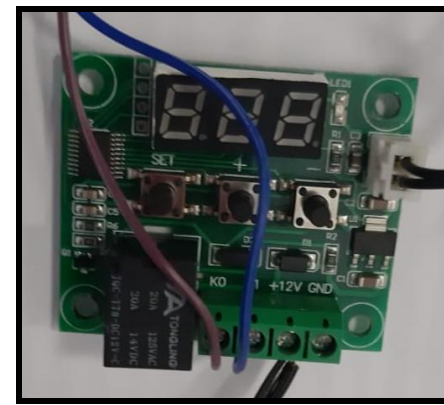


Fig.4 Thermostat Controller

W1209 (Fig.4) is a thermostat controller to control power the electrical device based on the temperature sensed included NTC temperature sensor. 3 switches allow for configuring various parameter to on & off trigger temperature. The current temperature is displayed in degrees in centigrade on its display. The on-board relay can switch up to a maximum 14V DC at 10A. It performs cold-junction compensation and digitizes the signal from a type-K thermocouple.

III. RESULT

Gas leakage is an event that causes a lot of life thus coming up with the simple solution, a thought to collaborate a complete module right form detection to stop the action. The data flow of the process is in the following manner. This system has been tested by taking a small amount of LPG gas near to the sensor, the MQ-5 sensor detects the LPG and sent digital value (HIGH) to the microcontroller when gas detected. Simultaneously, thermostat sent the signal (LOW) when the temperature is lower. After that microcontroller sent the active signal to its connected devices. As a result, GSM module sent an alert message to registered mobile numbers and also shutdowns the main valve using the servo motors. If at times servo fails to close up the valve then the message will continue to pop up the user and alert continuously. Further, an extension can be done in this project such that after a certain number an alert can be sent to the fire station and police too[14-16].

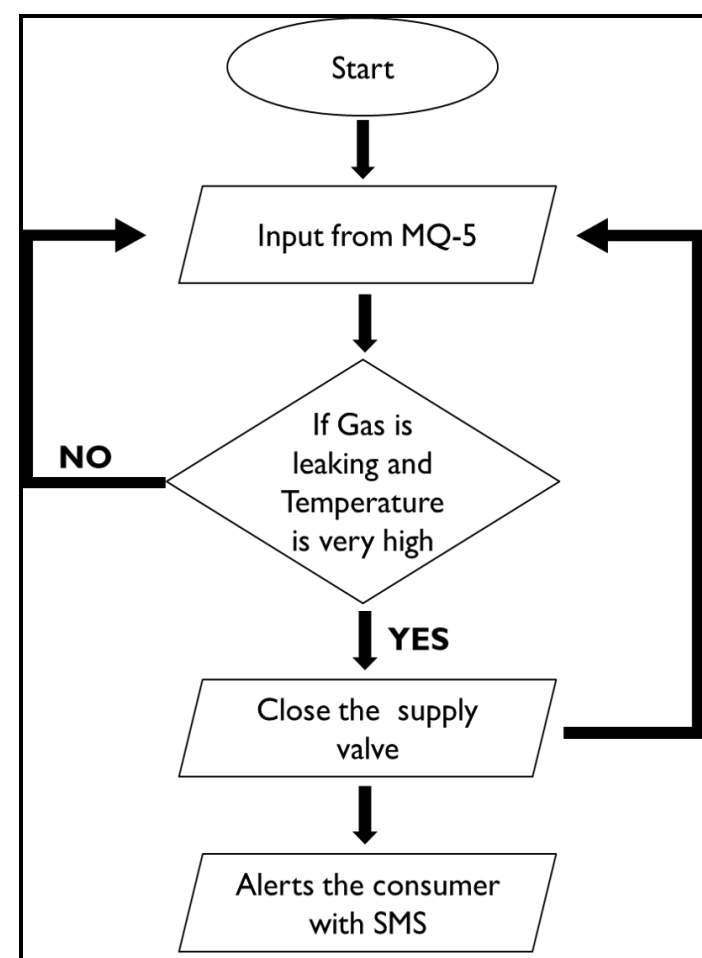


Fig.5 Data Flow of system

This system integrates a set of required devices and serves as a complete solution so as to aid the problem and fix it, thus saving many lives and destruction.

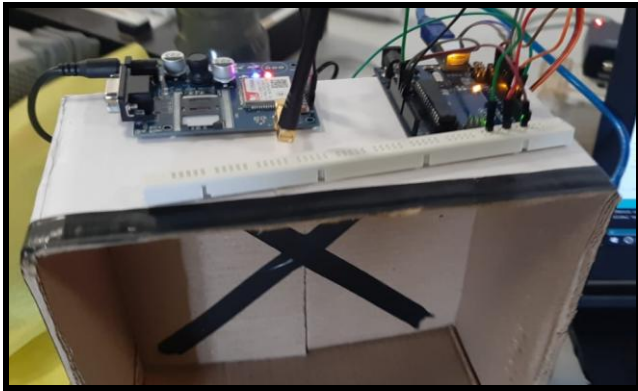


Fig.6 a) System Prototype from top view



Fig.6 b) System Prototype from front view

IV. CONCLUSION

Gas leakage became a concern after the impact of harmful gases on human wellbeing were found. Before modern times when there were no cutting-edge electronic sensors, people relied on less precise methods which included the detection of gas leakage by the human sense i.e. nose. Due to the advent of modernization which includes high-end technology and modern electronic sensors we were able to find a solution to gas leakage by constructing a gas detection sensor, which has helped save many lives. This can be further extended to detect the leakage in the whole pipeline instead of checking only at the outlet by using further advanced techniques[17].

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