

LPG Leakage Detection and Autorefilling Using Arduino

T Alex Stanley Raja, R Senthil Kumar, A Nandhakumar, K V Santhosh Kumar

Abstract--- *The probability of an LPG accident is same as that of an nuclear accident (i.e) one in one million. While a nuclear facility is monitored with a number of sensors and controllers, the same cannot be said to LPG. Leakage of gas creating fatal fire accidents have become a serious problems in households where LPG is to be used. Gas leakage in the system leads to the various types of accidents that may result in financial loss and also to human injury. In our opinion a tragedy is a tragedy be it a personal or a public one. The purpose of this project is to build a foolproof system that will detect, curb and report a LPG gas leakage. It will also facilitate the auto booking by measuring the weight of the cylinder. The above mentioned is easily achieved by the use of modern day state of the art microcontroller and sensors.*

Keywords - Gas sensor, Temperature sensor, Load cell, GSM, Arduino.

I. INTRODUCTION

Liquified Petroleum Gas was first discovered in 1910 by the scientist Dr. Walter Snelling which is a combination of commercial grade gases like propane and the other butane which are having saturated and also the unsaturated hydrocarbons. Due to the usefulness of LPG, it is widely employed for many purposes as industrial and domestic fuel, auto gas, heating, lighting etc. The wide demand in market for the LPG is also growing day by day [1]. But when LPG is leaked it may lead to serious fire accidents. Also the number of casualties' due to such incidents are also on the rise in the recent years. Therefore there is purpose for a system to find and also prevent the leakage of LPG. But before the invention of electronic gas detectors for households in 1980s, it was detected by a chemical dipped paper which will change its color in the presence of those gases. But after many inventions have been discovered to find, monitor and alert the spillage of the dangerous gases [2]. Also in recent days, booking a LPG gas cylinder is done by simply sending a text message. LPG companies have recently launched some customer friendly approaches like

IVRS method for the people [3]. Therefore a reliable system to detect and also display the leakage of any of the gases is very important for household purposes. In this paper, a microprocessor based system with a gas sensor MQ6 is proposed to detect the leakage of the dangerous gases. The system is implemented with a LCD display to indicate the leakage [4]. Gas sensor used in this system has a very good sensitivity and also has good response time at a low price. If any leakage is sensed, a SMS will be sent automatically to the corresponding persons or family member using GSM. The system has an added function to measure the weight of the LPG cylinder and displayed on the LCD display [5]. If the quantity of the gas cylinder is less or equal to 10kg, it will automatically book the LPG cylinder by sending an SMS to the dealer. Also when the weight of the LPG cylinder comes down to 0.5 Kg, it alerts the persons in the house by SMS to change the cylinder.

II. PROPOSED SSYSTEM

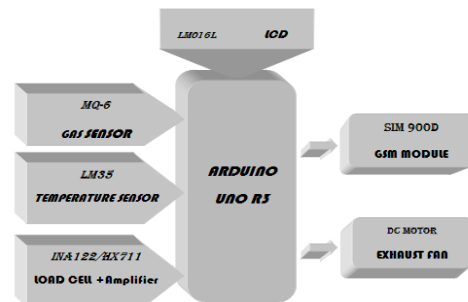


Fig.1. Block Diagram of system

The most widely used and documented processor in the arduino family is the Arduino UNO. It is a microcontroller based board which is based on the features of ATmega328. Arduino UNO has 14 digital I/O pins (out of which 6 is used for PWM), 6 analog i/p, a crystal oscillator with 16 MHz frequency, USB connector, power port, ICSP head and a master reset port [6]. It has all the features to operate and support the microcontroller; It can be connected to a PC with a USB port and powered with a Adapter with DC input or a battery to power. The selection of UNO is a great for first time arduino users since the system is cheap and can be setup easily and very reliable. Even if the board is damaged, ATmega 328p microcontroller can be changed since the UNO with DIP can be surface mounted [7], which is a greatest advantage of UNO. The meaning of "UNO" is one in Italian and it has been named to indicate the release of the software Arduino IDE 1.0

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MQ-6 gas sensor modules are used in gas leakage detecting equipments in family and industry, are suitable for detecting of LPG, iso-butane, propane, LNG, avoid the noise of alcohol and cooking fumes and cigarette smoke. This is a simple-to-use liquefied petroleum gas (LPG) sensor detects the concentrations of LPG, iso-butane, and propane in the air and outputs its reading as an analog voltage.

IC LM35 is a new sensor used for the detection of accurate temperature. Linear is also the how well over the required range of the temperature with the sensor output that is consist changes. Unlike the other thermistor, linear for the precision IC where the sensors are not good of 0.5°C accurate with a wide temp range. The output of the sensor is fund to be linear to the temperature measured in centigrade. LM35 sensors are very precise ICs with the temperature detection in centigrade temperature is proportional to the output voltage. LM35 sensors have an advantage on the sensors having linear property which have been calibrated in Kelvin, since there is no requirement to minus the voltage which is constant voltage from the output to be convenient in the scaling in celesius. The sensor used here is not in use of calibration in the external side for trimming to give the typical reading the accuracy of $\pm 1/4^\circ\text{C}$ for the temperature at room settings and $\pm 3/4^\circ\text{C}$ in and over to the -55°C to 150°C range of temperature. The system cost is made very low by trimming assured and the calibration is done at level of the water. LM35 is a sensor that has impedance is low, oput is linear, calibration which is precise and inherent that makes the combining the read and circuit control to ease [8]. The sensor must be used power supply single or any other power source that is AC. Since the system gets only 60 μA from the mains, the heating is very low, much lower than 0.1°C in air. LM35 is used to operate in the range of -55° to $+150^\circ\text{C}$ in temperature while the LM35C is used in the range of -40° to $+110^\circ\text{C}$ temperature range (with a improved accuracy of -10°C). It is also common to TO-92 temperature sensor. It is written in the equation as,

$$\text{Temp} = (5.0 * \text{analogRead}(\text{tempPin}) * 100.0) / 1024$$

This equation will not give high resolution since the LM35 produces the voltage in the range of 0 to +1V. Analog to Digital converter uses the 5V in the high value. It wastes the 80% of the range of the values. If the aRef value is changed to 1.1V, the high resolution is almost possible. The equation of the original thing is achieved by reading taken and finding the range percentage and multiplying the value of the range itself (aRef with 5000 mV), and divide by ten (10 mV per deg Celcius).

For booking the cylinder from the distributor, there must be awareness in the gas amount of the advance in the cylinder. The gas that is available in the cylinder must be viewed all the time for the purpose. For the domestic cylinder, the load cell that is required with the weight capacity and the calibration purpose, the weight sensor module can be used in load cell, HX711 is the sensor module. The weight of the gas cylinder is done by using the load cell so the user can be expected and alerted. It is a passive transducer or sensor which converts applied force into electrical signals. They are also referred to as "Load transducers". In order to avoid erroneous results the load cell must be calibrated, this is incorporated in the projects

programming as a function called the set.scale().It also requires scale ratio which is the ratio of unknown weight to known weight into conversion factor.

HX 711 is a precision 24-bit analog to digital converter (ADC) specially designed for Weigh scales and industrial control applications to interface directly with a bridge sensor. It consists of a 2 wire interface (Clock & Data) for the purpose of communication. This load cell will use a 4 wire type of Wheatstone bridge on the configuration for the purpose of connecting to HX711. The commonly used colors are red, black, white, gray and yellow. All of the colors will correspond with the normal color coding of the cells load in the manner as Red for input, black for ground, white for signal, green for minus and yellow for shield.

GSM Modem can be used to send the SMS about the rise in temperature and the completion status of the LPG gas to the consumer. GSM (Global System for Mobile communication) is a new system in digital mobile telephony which is widely used in all countries including India. GSM make use of the time division multiple access (TDMA) and is the most widely used of the technologies among the following (TDMA, GSM, and CDMA). DC fan is used to exhaust the leaked gases as sensed by the gas sensor. Hence, it is also called as exhaust fan. For this pupose, we are using a Hobby motor or toy motor 5V DC motor as an exhaust fan. Thus, it does not require a drive as the arduino board delivers 5V as output.

LCD (Liquid Crystal Display) screen that is a display module in electronic that is used in wide range of applications. LCD display of 16x2 is very basic module and is most widely used in all devices and circuits. The given modules are used over 7 segments and other multi segment LEDs. The major reasons for these are: LCDs are less cost, can be easily programmable and have no limitation of displaying special & even custom characters (unlike in seven segments), animations. LCD.h is the header file that can be included to interface the LCD to the arduino.

III. WORKING

The important sensors used are temperature sensor, gas sensor and the load cell. During the startup the arduino checks the temperature sensor for any fire accidents. If there is indeed fire, then the fire brigade is intimated.

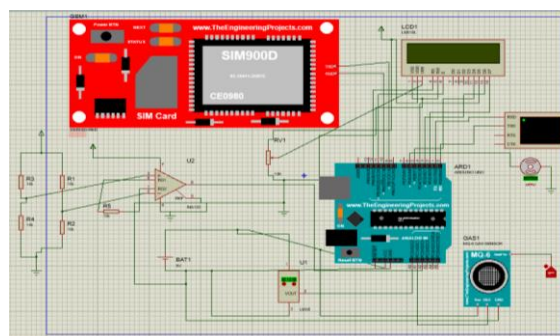


Fig.2. Circuit Diagram



This is followed by the gas sensor that detects any leakage, if there is a leak then an exhaust fan is switched on till the gas percentage falls below hazardous levels. Finally if all cases prove to be false then the load cell checks the cylinder weight to enable auto booking if the weight is 1/3 of the cylinder weight

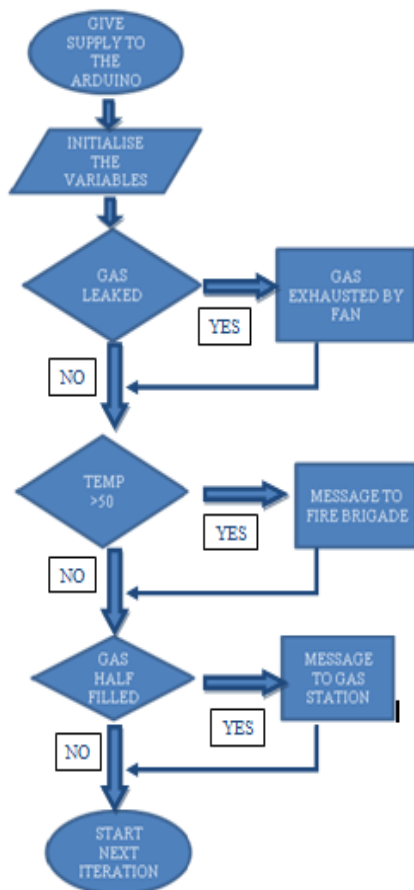


Fig.3 Flowchart of proposed system

The simulation results are checked for seven cases, They are as follows

Case 1: Load Cell: In this case the working of a load cell is demonstrated. When the weight of the cylinder is half filled it sends message to the Gas station stating that the gas is to be booked.

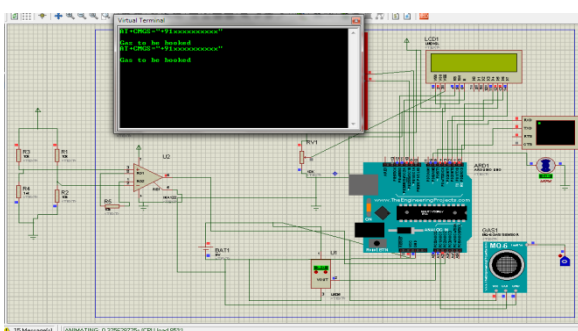


Fig.4 Simulation results for weight sensor

Case 2: Gas Sensor: In this case working of gas sensor alone is shown. When the gas sensor detects a gas, it displays to the consumer that the gas is leaking. It itself

takes the remedial measure to exhaust it using a dc fan that runs on dc.

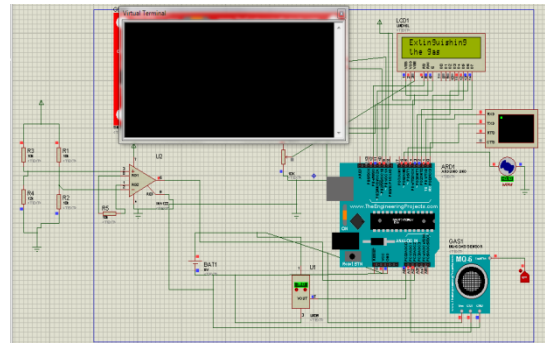


Fig.5 Simulation results for gas sensor

Case 3: Temperature Sensor: Action of temperature sensor is to constantly monitor the temperature notify the arduino if the temperature value exceeds the safe limit value fed to it. Arduino in turn sends message to the fire service stating the message emergency.

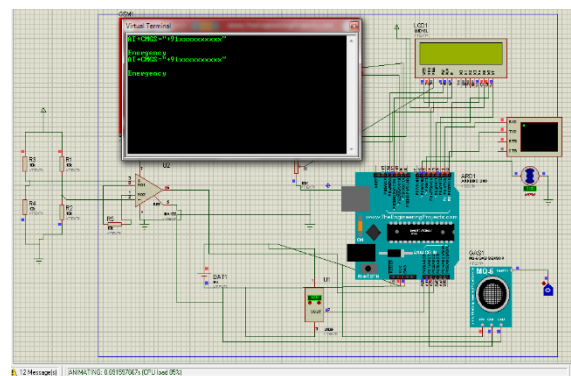


Fig.6. Simulation results for temperature sensor

Case 4: Load cell and Gas Sensor: In this case both the actions of load cell and gas sensor is explained. When the gas is detected it exhausts using a fan that is connected to arduino. For half filled weight it sends message to the Gas station for immediate booking system

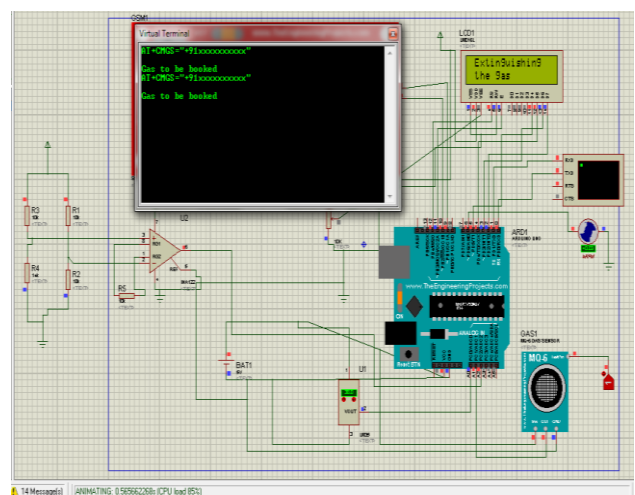


Fig.7 Simulation results for gas and weight sensor

Case 5: Gas Sensor and Temperature Sensor: Here gas sensor and temperature sensor comes to the picture together. Outcome of temperature sensor is through a message and that of a gas sensor is through alcd and a fan.

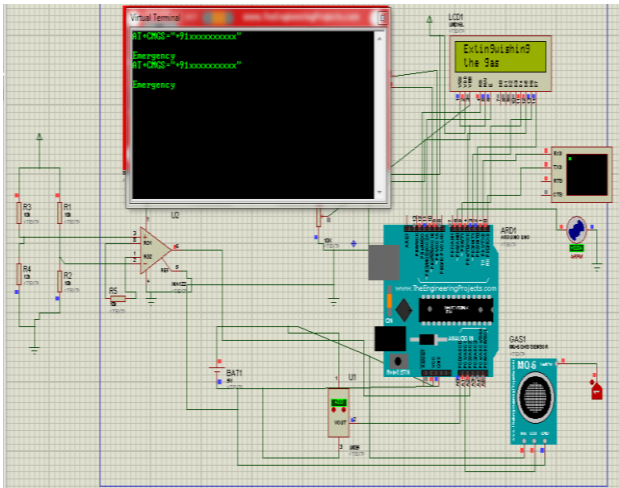


Fig.8 Simulation results for gas and temperature sensor

Case 6: Temperature Sensor and Load cell: Here the combined action of temperature sensor and load cell is explained. As the temperature exceeds the value fed, it sends message to the gas station and at the advent of half filled gas it send message to the gas booking

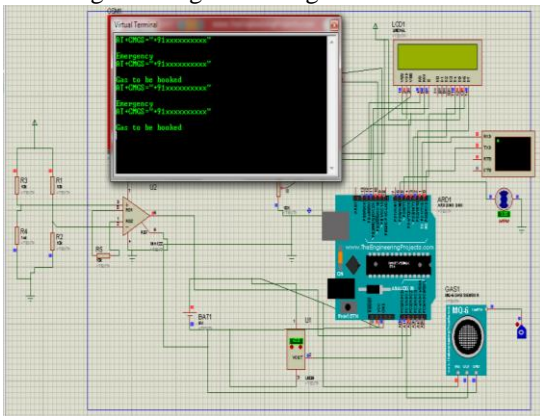


Fig.9. Simulation results for temperature and weight sensor

Case 7: Load cell and Gas Sensor and Temperature Sensor: Here all three transducers act at the same time and has outcome such as messages and fan rotations.

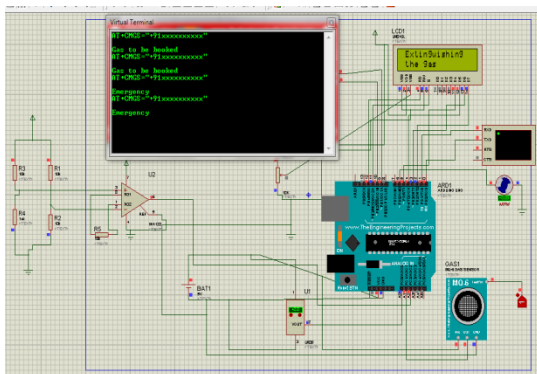


Fig 10. Simulation results for gas, weight and temperature sensor

While in simulation we can obtain numerous cases or scenarios, the same cannot be said about practical implementations owing to logical reasons.

IV. HARDWARE IMPLEMENTATION

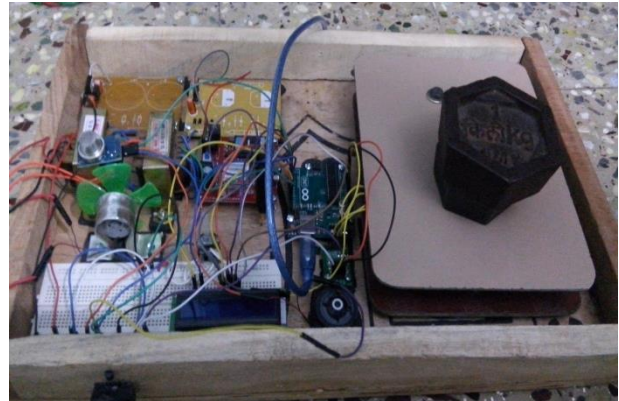


Fig 11. Project hardware

V. RESULTS

The system consists of input, output and a controller module. Input modules used are gas sensor MQ6 module, temperature sensor LM35 module and load cell module with load cell amplifier HX711. Output elements are DC motor (Exhaust fan), LCD display LM016L and GSM module SIM900. The controller used in the module is Arduino Uno R3. The controller directs the output elements based on the variations in the state of the input sensor module values.

When the gas sensor detects the presence of harmful gas, it displays to the consumer that there is a gas leakage. It automatically takes the remedial measure to exhaust the gas using a dc fan that runs on 5v DC.

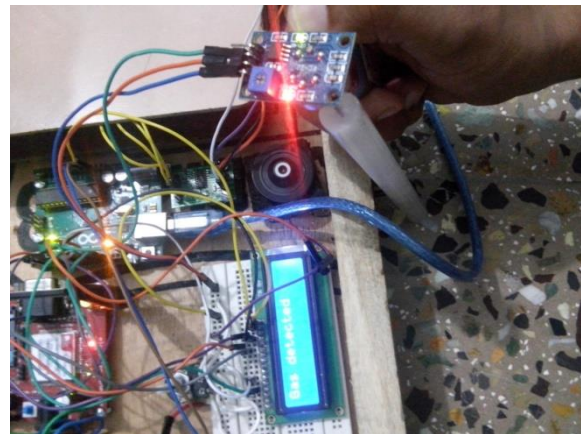


Fig 12 Test case of MQ6 gas sensor module

The action of temperature sensor is to constantly monitor the temperature and notify the processor if the temperature value exceeds the safe limit. The processor in turn sends message to the fire service stating the emergency. The cutoff temperature limit is set as 48 degree Celsius.

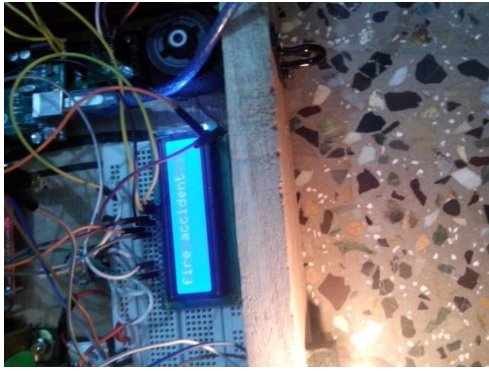


Fig 13 Test case of LM35 gas sensor module

When the weight of the gas cylinder has gone to one third weight, it sends message to the Gas Vendor stating that the gas is to be booked.



Fig 14 Test case of weight sensor module

VI. CONCLUSION

Gas leakages resulting into fatal inferno has become a serious problem in household leading to financial loss as well as human injuries. In our opinion a tragedy is a tragedy be it a personal or a public one. The first and main objective of our project is to design a system which detects gas leakage and exhaust it out as soon as detected. The second objective is to check for any fire accidents and intimate to fire brigade automatically. The third objective is to check for the filled gas in the cylinder and intimate to the user for refilling in case of less than half filled. Thus, the proposed system will be useful in upgrading the safety methods and comply with the regulatory standards that are set by the government and the environment safe to operate with the important use for the prevent of any untoward incidents by protecting the life and property from danger for leading a comfortable life.

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