

LPG Gas Monitoring System Using Arduino

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Abstract - In the modern society, Liquefied Petroleum Gas (LPG) has been widely used as a cooking fuel in homes, hotels, and industries. However, in many cases, LPG leakage poses a serious threat to the users and the society. There are several ways to avoid the damage because of the gas leakage but the best way is to place a gas leakage detector nearby the source. Apart from the safety issue, people also find it difficult to identify the amount of gas remaining in the cylinder which causes inconvenience in their work. Therefore, this project proposes a flexible and reliable way of detecting the leakage of LPG, monitoring the amount of LPG available in the cylinder and provides the ability to book a cylinder by automatically sending the booking request via SMS to the distributor as required. This system is also capable of sending an alert SMS notification along with a buzzer to users to notify about the leakage to avoid major accidents. The advantage of this proposed system over the existing ones is that it continuously monitors the gas level and also offers quick response to the events and accurate detection of leakage.

Index Terms - IOTLPG, Gas sensor, Weight sensor, GSM module, Wireless sensor network, Arduino

INTRODUCTION

Gas leakage is a serious problem and nowadays it is observed in many places like residences, industries, and vehicles like Compressed Natural Gas (CNG), buses, cars, etc. It is noticed that due to gas leakage, dangerous accidents occur. The Liquefied petroleum gas (LPG), or propane, is a flammable mixture of hydrocarbon gases used as fuel in many applications like homes, hostels, industries, automobiles, and vehicles because of its desirable properties which include high calorific value, less smoke, less soot, and meager harm to the environment. Liquid petroleum gas (LPG) is highly inflammable and can burn even at some distance from the source of leakage. This energy source is primarily composed of propane and butane which are highly flammable chemical compounds.

These gases can catch fire easily. In homes, LPG is used mainly for cooking purposes. When a leak occurs, the leaked gases may lead to an explosion. Gas leakage leads to various accidents resulting in both material loss and human injuries. Home fires have been occurring frequently and the threat to human lives and properties has been growing in recent years. The risks of explosion, fire, suffocation is based on their physical properties such toxicity, flammability, etc. The number of deaths due to the explosion of gas cylinders has been increasing in recent years. The Bhopal gas tragedy is an example of accidents due to gas leakage.

The reason for such explosions is due to substandard cylinders, old valves, no regular checking of gas cylinders, worn out regulators and a lack of awareness of handling gas cylinders. Therefore, the gas leakage should be detected and controlled to protect people from danger. An odorant such as ethane thiol is added to LPG, so that leaks can be detected easily by most people. However, some people who have a reduced sense of smell may not be able to rely upon this inherent safety mechanism. A gas leakage detector becomes vital and helps to protect people from the dangers of gas leakage. The objective of the proposed system is to continuously measure the weight of the cylinder and as soon as it reaches the minimum threshold it will automatically sends an SMS alert to the user as well as Authorized LPG agent so that they can act accordingly. This system also designed to detect LPG gases such as propane and butane. The allowed level for butane is 600ppm above which it is considered to be of high level and poses a danger. The threshold level of weight of the cylinder is used for automatic cylinder booking. The main aim of this project is to monitor for liquid petroleum gas (LPG) leakage to avoid major fire accidents and also facilitating safety precautions where security has been an important issue and automatic cylinder booking without human intervention. The system detects the

leakage of the LPG using gas sensor and alerts the consumer about the gas leakage by sending SMS. The system measures the weight of cylinder by using weight sensor and display corresponding weight in LPG display. The proposed system uses the GSM Modem to alert the person about the gas leakage via SMS and status of automatic cylinder booking.

Amount of gas is known by measuring the weight of gas cylinder. To measure the weight, Load cell a weight sensor is used. It continuously measures the weight of the cylinder and displays on an IOT platform, ubidots. A threshold level is set before the gas is completely consumed. And if the weight of the gas cylinder is less than the threshold, it is indicated using an indicator in ubidots and an email is also sent to the gas agency and the cylinder is booked automatically. MQ2 gas sensor is used to sense the gas leakage. MQ2 sensor module can detect LPG, smoke, alcohol, hydrogen gas etc. In this project it continuously measures the concentration of gases and the concentration is displayed on ubidots. whenever there is LPG gas leakage, concentration increases, and the increase is displayed on ubidots. And if the increased concentration is more than a specified level it is dangerous, so an indicator is used to indicate this, and an alert message is sent to the user.

RELATED WORK

LPG gas was first introduced in 1910 by Dr. Walter Snelling. It is a mixture of commercial propane and butane. It is highly flammable and many of the accidents occur due to the leakage of LPG. Thus, there is a need to detect and prevent the gas leakage [2], [3]. Gas detectors have been used for a long time and have wide range of applications in homes, paper pulp mills, refineries, industrial plants, refineries, aircraft etc. [8]. The system proposed by Digambar Surse1 et.al [7] uses ARM7 microcontroller. It uses MQ6 gas sensor to measure the concentration of gas. When there is gas leakage, it alerts the user through alarm and through message and turns off the main power supply. Load cell is used to measure the weight of cylinder. When the weight of the cylinder is below a threshold level of 2Kg, it sends SMS to gas agency using GSM module to book new cylinder. The system presented by Abid Khan et.al [4] uses 89C51RD2 Microcontroller, LCD Display, LED, Buzzer and GSM Modem. All the devices are connected to the microcontroller. LCD

display continuously displays level of gas inside the cylinder. When the level is below a particular threshold, MS using GSM is sent to the user and gas agency to book cylinder. MQ6 gas sensor is used to detect the leakage of gas. When there is gas leakage, it activates buzzer, and a message is sent to user.

Microcontroller Based LPG Gas Leakage Detector Using GSM Module, in this system where used gas sensor, GSM module, microcontroller, if the gas concentration is increasing the gas sensors will sense the leakage of the gas and then send to the microcontroller. Then the GSM module is connected to the microcontroller which will gives the command to stop the main supply. The system is highly reliable, tamper-proof, and secure. In the long run the maintenance cost is efficient. It is highly accurate. (A.sood, B.Sonkar, A.Ranjan, Mr. A.Faisal, June-2015)

Liquefied Petroleum Gas commonly known as LPG consists of a mixture of Commercial Propane and Commercial Butane having saturated as well as unsaturated hydrocarbons. It is an odorless gas due to which Ethyl Mercaptan is added as powerful odorant so that leakage can easily be detected. LPG is commonly used in homes for heating and cooking. This energy source is primarily composed of propane and butane which are highly flammable chemical compounds. LPG was first produced in 1910 by Walter Snelling (Didpaye1, 2015) and is classified as a hazardous material because of its flammable properties and explosive potential when stored under pressure. Before the development of electronic household gas detectors in the 1980s and 90s, gas presence was detected with a chemically infused paper that changed its color when exposed to the gas (Didpaye1, 2015). Since then, many technologies and devices have been developed to detect, monitor, and alert the leakage of a wide array of gases. Hence the requirement of an efficient system to detect leakage of LPG is inevitable, which may be used for domestic and commercial purposes.

A system, that provided security issues against thieves, leakage, and fire accidents. In those cases, this system sends SMS to the emergency number provided to it. In the proposed system we have designed "LPG gas monitoring and automatic cylinder booking with alert system". This report focus on detection of economic fuels like petroleum, liquid petroleum gas, in the proposed system we have designed "LPG gas

monitoring and automatic cylinder booking with alert system”. This report focuses on detection of economic fuels like petroleum, liquid petroleum gas, and alert system”. This report focuses on detection of economic fuels like petroleum, liquid petroleum gas, alcohol etc. (H.Rawat, A.Kushwah, K.Asthana, AShivhare,2014) Liquefied petroleum gas (LPG) is a highly flammable chemical. The mixture of hydrocarbon gas (LPG) is used as fuel for burning, at home and in the industry. LPG is used as a domestic fuel, industrial, heating and so on. A heater and gas sensitive resistor are some of the internal components of the sensor used to avoid failure leading to a false alarm indication. The alarm gets triggered when a certain concentration of gas is exceeded by steam. This device is used to indicate early warning of a problem to ensure public safety. LPG and gas sensors are used in the field of safety, health, and materials. This embedded system is used to detect hazardous gas and to alert uses by sending an SMS. (A.Shiyana,Mrs.R Deepa, October,2017).

The Microcontroller that is utilized for the project is Arduino Uno R3. R3 is the 3rd and latest revision of Arduino Uno. The Arduino Uno is a microcontroller board that is based on ATmega328. The ATmega328 is a single microchip controller that has 32 Kbytes (with 0.5 Kbyte which is occupied through the boot loader). Moreover, it comprises of SRAM and EEPROM that can be written and read with the EEPROM library, I/O pins, AVR microcontroller chip, a power jack, a USB connection, ICSP (In-Circuit System Programming header), and the reset button. Simply, it is connected to a computer via USB cable. The Clock speed of the Arduino is 16 MHz; thus, it performs a specific task quicker than other processors or controllers. AVR chip is continuously clocking on 16 MHz regardless to what a code is performing, it never halts; thus, its current’s consumption is essentially independent from the code that is executed. (Dr. Bayan M. Sabbar, A I. Ali June-2016).

Nowadays, the state Kerala is facing an electricity shortage crisis. So, the conservation of energy is inevitable. According to the discussion with the KSEB officials of Pallom and Kaduthuruthy subdivisions, they arise the problem of power theft on distribution lines. Illegal power usage in customers, namely electricity theft is classified as a non-technical loss of power distribution systems. There is no method to find the power theft in the present system. About 2.8 crores

of revenue is wasting every year due to power theft. (Newspaper report “power theft cases on the rise”, The Hindu news on 24 May 2016)

Based on these survey results, the proposed method is trying to optimize the problems faced by the consumers and KSEB officials. This paper proposed a method to automate the billing process, better energy management and power theft on distribution lines. This system enables KSEB to collect the billing and theft detection data without utilizing manpower. When the energy consumption exceeds the threshold value the heavy loads will be automatically disconnected. The paper is concerned with the automation of the electric billing system. The electricity bill sends to KSEB office through GSM module. An LCD display is connected with microcontroller to show the consumed units and cost. Bill records are digitized. When the energy consumption is more than the threshold value the heavy loads in the home circuit will automatically tripped off using relays. This method provides an indication system to aware the user about the over energy consumption than the threshold value and sends a SMS to consumers.

METHODOLOGY

In this paper we introduced a system which is capable of detecting the gas leakage in a specific area. The additional advantages of the proposed system are:

- It is a wireless sensor network-based system which executes all its operations in real time environment.
- It uses weight sensor to continuously record the LPG level in the cylinder.
- It will automatically book the cylinder by sending the booking request when the level of LPG in the cylinder crossed the minimum level.

The system comprises of the following units as shown in the diagram below. It comprises of arduino uno, gas sensor (MQ4), load cell, GSM unit, Wi-Fi unit, buzzer and LCD display unit. These project gives alert message by buzzing the buzzer and trough SMS to the house holders. We also provide automatic doors and windows opening, so that the compressed gas can spread into air freely. Hence a fire accident does not occur.

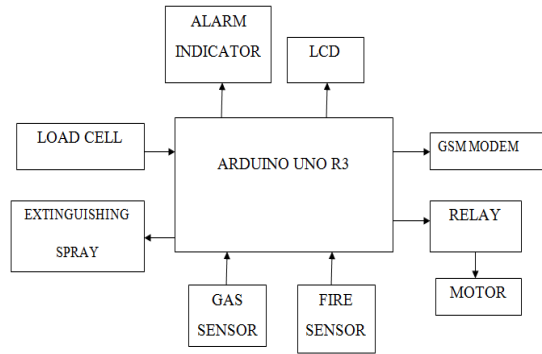


Fig 1: Block Diagram

Hardware Requirements

- Arduino Uno R3
- Load Cell
- Sim 800c Gsm Modem
- Mq7 Gas Sensor
- Relay
- Motor
- Buzzer
- Fire Sensor
- Spray Mechanism
- Power Supply Unit
- 16*2 Lcd

Software Requirement

- ARDUINO IDE
- Embedded C

HARDWARE IMPLEMENTATION

Arduino UNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by arduino. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under Common Creative Attribution Share-Alike 2.5 license and is available on the arduino website. Layout and production files for some versions

of the hardware are also available. "UNO" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The UNO board and version 1.0 of arduino Software (IDE) were the reference versions of arduino, now evolved to newer releases. The UNO board is the first in a series of USB arduino boards, and the reference model for the arduino platform. The ATmega328P on the arduino UNO comes preprogrammed with a boot loader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The UNO also differs from all preceding boards in that it does not use the FTDI USB-to serial driver chip. Instead, it uses the Atmega16U (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

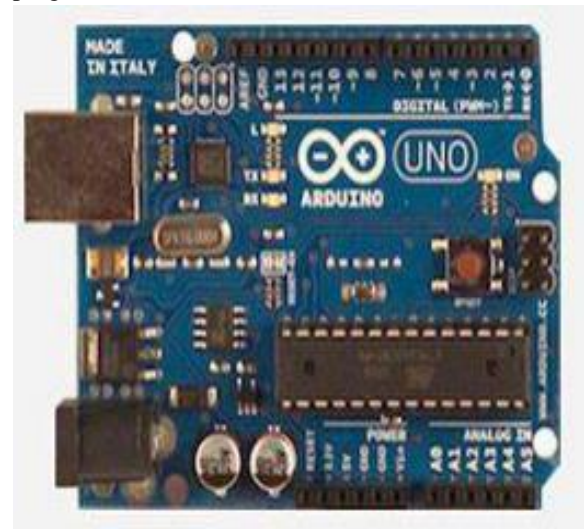


Fig -2: Arduino Board

LCD

Liquid Crystal Display (LCD) is used to display the output to the user in the form of GUI (Graphic User Interface) and a mono chromatic display. LCD used in this project is JHD162A series. There are 16 pins in all. They are numbered from left to right 1 to 16 (if you are reading from the backside). Generating custom characters on LCD is not very hard. It requires the knowledge about custom generated random-access memory (CG-RAM) of LCD and the LCD chip controller. Most LCDs contain Hitachi HD4478 controller. CG-RAM is the main component in making custom characters. It stores the custom characters once declared in the code. CG-RAM size is 64 byte providing the option of creating eight characters at a time. Each character is eight byte in size.

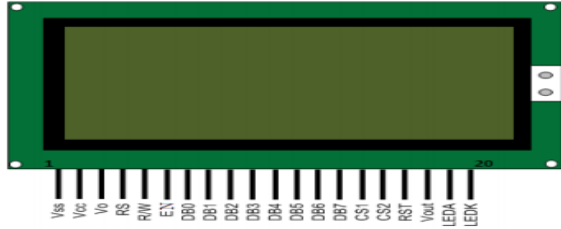


Fig 3: LCD

GSM Module

An energy meter is a device that measures the amount of electrical energy supplied to or produced by a home or building. The most commonly used energy meter is kilowatt hour meter. Instantaneous power is calculated by taking the product of the instantaneous current and voltage. This instantaneous power is then integrated against time to give energy used by the consumers. The meters are classified into two basic categories, electromechanical and electronic. The energy consumption is calculated by using the output pulses of energy meter. The load is said to consume 1 unit of electricity when the internal counter of microcontroller counts up to 3200 pulses GSM engine works on frequencies 850MHz, 900MHz, 1800MHz and 1900MHz. It is very compact in size and easy to use. It is designed with RS232 level converter circuitry, which allows you to directly interface PC serial port. The baud rate can be configurable from 9600-115200 through AT command. Using this modem, you will be able to send and receive SMS and also connect to internet via GPRS through simple AT commands.



Fig-4: GSM

Load Cell

Load cell is a weight sensor that is used to measure weights. It transforms pressure or force to electrical output and the electrical output is directly proportional to the force applied. Different types of load cells are available like strain gauge, hydraulic load cells. Number equations consecutively. In this project strain

gauge load cell is used. It consists of four strain gauges connected in Wheatstone bridge form. It works on the principle of strain gauge. When force is applied on the gauge, it becomes tensile or compressed resulting in change in length of the wire of the strain gauge. Since wire resistance is inversely proportional to the length, the electrical resistance of the gauge changes. This change in resistance is proportional to the force applied on gauge. The electrical signal output available from the load cell is typically in the order of mv. So HX711 is used to amplify the small electrical voltage. HX711 has two analog input channels A and B. When a 5v supply is connected to AVDD of HX711, channel A can be programmed with a gain of 128 or 64 and channel B with a gain of 32. The wires coming from the load cell are connected to E+, E-, A, A+ and the amplified output is taken from the serial data of the HX711 and given to the microcontroller.

Gas Sensor

MQ2 gas sensor module is used for the detection of gas leakage. It can detect gases like LPG, smoke, alcohol, hydrogen. Using analog pin of the sensor module, the concentration of the gas can be measured in ppm. Operating voltage is 5v and can be used as analog or digital sensor. Sensitivity can be adjusted by the potentiometer and has a Preheat duration of 20secs. system implementation

This system consists of three individual modules which explain the internal functionalities of this system as follows:

- LPG leakage detection system module.
- LPG weight monitoring system module. \
- LPG cylinder booking system module.

The main objective of the first module of this system is to identify the gas leakage. The MQ-4 sensor is used to sense gas to identify whether there is any leakage or not. MQ-4 gas sensor can identify the leakage of gas when the density of gas is in between 200ppm to 2000ppm. Whenever the system encounters the leakage of LPG, it sends the signal to the central part of the system and displays a message on the LCD display and sends an alert SMS to the registered no. In the Arduino there are number of pins which are used for input and output. In this system we have used pin number 7 as the input from gas sensor. As soon as, there is input on the pin-7, the CPU of the system sends the positive signal to the pin-8 to makes alarm i.e.,

buzzer will continuously ring until the microcontroller sends the negative signal to the pin-8.

The main aim of the second module is to monitor the weight of the LPG cylinder. To monitor the weight of the LPG cylinder, this system uses a weight sensor which is combination of load cell and analog to digital converter. For giving the input to the system about the weight of the cylinder, pin- A0 has been used. The load cell of this system continuously monitors the weight of the cylinder and whenever the weight of the cylinder reaches the minimum level, it sends this information to the microcontroller. Whenever the system receives an input from the pin-A0, system displays the corresponding weight of the LPG on the LCD display and sends an alert SMS to the owner to inform about the status of the LPG cylinder.

The main objective of the third module is to modernize the way of booking a cylinder. When the weight of LPG in the cylinder crosses the low level, it sends the booking request in the form of a SMS to the distributor to book a cylinder against the specific user.

RESULTS AND DISCUSSION

A system prototype has been built and all the modules of the system are working according to the desired requirement. According to our first module, when the gas sensor senses the presence of LPG in air, it detects the leakage, it displays information on LCD about the leakage of the gas and sends the SMS to user to take necessary action and activates the alarm. The proposed system also continuously measures the gas level in the cylinder, if the weight of cylinder crosses its minimum level it sends an alert SMS to the user and a booking request to the distributor. Some experiments are carried out to check the capability and efficiency of the proposed system. The followings are the examples of such experiments.

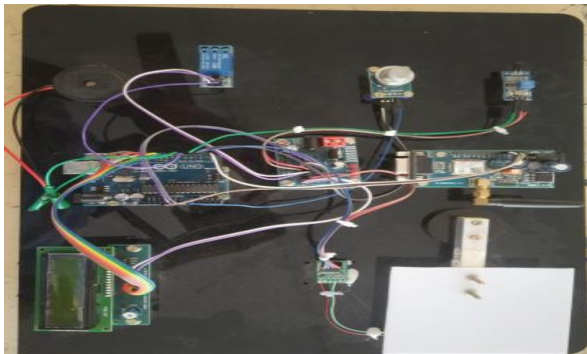


Fig 5: Experimental setup

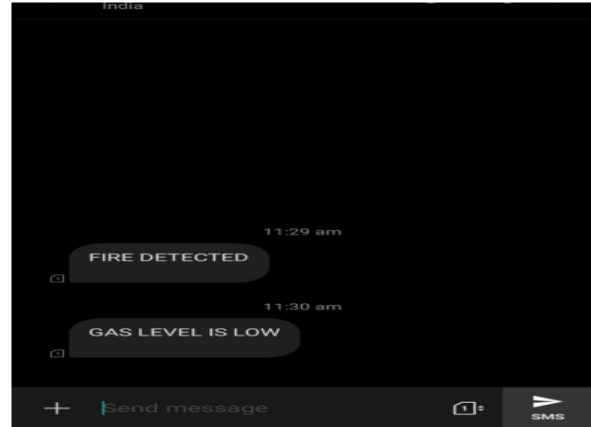


Fig 6: SMS notification on user mobile phone

The above figure shows the pictures taken from user mobile phone when the GSM module integrated in the system sends SMS to the registered mobile when gas leakage happens. Any mobile phone supporting the SMS service can be used for this execution.

CONCLUSION

In this paper we have considered different aspects of LPG leakage and weight monitoring mechanism and came up with a cost-effective and systematized procedure on the basis of WSN. The recommended system constantly calculates the concentration of LPG in the air and weight of the cylinder to achieve the intended target. This system is also capable of booking a cylinder as and when it needed. Apart from all the above functionalities it also includes different alert mechanisms such as LCD display, buzzer and SMS notification which make the system more accurate and efficient. It is an advantageous and well-organized system which can be used in home as well as in industry to prevent any calamity which may happen due to LPG leakage.

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