LPG Gas Monitoring System based on Arduino & Automatic Cylinder booking with Alert System & Leakage Reduced

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Abstract: LPG (Liquefied Petroleum Gas or Liquid) is one of the most important commodities in our house hold items. This LPG contains flammable hydrocarbon gases including propane, butane and mixture of these gases. There are approximately 30crore LPG users in which mostly 40% of the population. In our country it is not possible to supply LPG through pipes to each and every home as the production of LPG is very low. Hence the supply is done with the help of cylinders. Whenever we observe the LPG gas cylinder is empty, we give request for a new cylinder by using IVRS (Interactive Voice Response System), SMS (Short Message Service) or Mobile applications. There is a delay in providing the gas cylinder. The main reason behind this is a delay in informing to the gas provider at the last moment when the gas is empty. Most of the illiterate people can't even complete the booking and also most of the times these land line phones are either busy due to congested calls or phones not working due to some technical issues. Another problem is that most of the times people book the refill with a prediction that the cylinder is going to be empty and hand over the old cylinder to the delivery men without knowing the exact quantity.

This paper proposes a system that will make entire LPG cylinder booking procedure automated without human intervention. This system continuously measures the weight of the cylinder and once it reaches minimum threshold it will automatically sends message to the authorized LPG Agent so that they can deliver the LPG cylinder in time. Along with the Automated cylinder booking we also designed feature related to the safety of the user in which it continuously monitor the leakage of LPG gas and alerts the user regarding leakage to avoid major accidents which costs human lives mostly.

Keywords: *Arduino Mega, Temperature sensor, GSM Modem, Gas Sensor, Load Cell.*

I. Introduction

There are approximately 30crore LPG users in the country in which mostly 40% of the population. The Several standards have been implemented for the gas leakage detection system. The existing systems provides an alarm system which is mainly meant to detect an Gas leakage in the house and commercial premises

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 measure 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.

When the system identifies that LPG concentration in the air reaches the specified level then it alert the consumer by sending SMS to registered mobile phone and alert the people at home by activating the alarm which includes Buzzer simultaneously and also display the same message on LCD to take the necessary action and switch on the exhaust fan or opening windows to decrease the gas concentration in the air.

II. Literature Survey

In the year 2011, A. MAHALINGAM, R. T. NAAYAGI,1, N. E. MASTORAKIS, "Design and

Implementation of an Economic Gas Leakage Detector", This project developed system to detect the gas leakage and providing immediate alarm or intimation to the user.

Later in 2013, few people developed the design proposed for home safety. This system detects the leakage of the LPG and alerts the consumer about the leak by buzzer. This project was developed using microcontroller ARM version 7 processor and simulated using Keil software.

In the year 2014, Hitendra Rawat, Ashish Kushwah, Khyati Asthana, Akanksha Shivhare, designed a system, They provided security issues against thieves, leakage and fire accidents. In those cases their 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". These report focus on detection of economic fuels like petroleum, liquid petroleum gas, alcohol..etc., and alert the surrounding people about the leakage through SMS. It also sense surrounding temperature, so that no fire accidents occurs.

The one more important feature is automatic cylinder booking by noticing the current expenditure of LPG gas in our daily life. These projects alert the user by sending message to mobile through SMS in three conditions.

They are

• When LPG gas weight reaches to maximum threshold value.

• When the LPG gas exceed its peak value.

• When the temperature exceed more than room temperature.

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 in to air freely. Hence a fire accident does not occur.

III. Design and Implementation

This proposed method consists of gas leakage detection system, weight measurement module, microcontroller, GSM module and alert system.
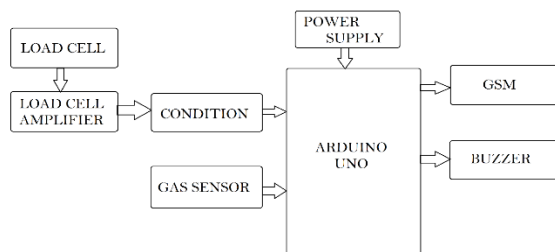

Fig 1: Block Diagram of Proposed System

The main basic Arduino Uno is widely used open source micro controller board based on the microchip ATmega 328P microcontroller and developed by arduni.c.c. The board is equipped with sets of digital and analog input and output (I/O) pis that may be interfaced to various expansion boards and other circuits. The board features 14 digital pins and 6 analog pins. It Programmable with arduino IDE(Integrated Development Environment). It requires the power supply ranging from 7-12 volts which can be build by using different

components like step down transformer, rectifier, filter and regulator which are readily available as adapters these days. Supply can be either from an ac to dc adapter or battery. The board can operate on at 7-12 volts. If voltage<7V then board becomes unstable. If voltage>12V then board get damaged.

The Main platform we are using to build the project is Arduino Uno which provides us the flexibility to write the code effectively in convenient way and also it will provides us features like Inexpensive, Cross platform, Simpler and clear programming environment, Open source and extensible software, Easy for beginners, The Arduino uno is a microcontroller board based on the ATmega328P .It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC to-DC adapter or battery to get started. With the above features it force us to use in our project design.

The other main component we are using in our project is use of Load cell. A load cell is a transducer that is used to convert a force into electrical signal, which is used to measure of a LPG gas cylinder weight so that we can expect and alert the user with in how many days the cylinder is about to empty. There are different Load cells available in the market with different weight measurement capabilities.

The Gas Sensor is also one of the components used to detect the leakage of the LPG Gas (Methane & Propane) which converts one form of the signal into other form. There are different type of sensors available in the market we make use of few of them in our project such as Methane (MQ4) Sensor and Temperature Sensor (LM35).The MQ4 is used in gas leakage detecting equipments are suitable for detecting of CH_4,Natural gas and to avoid the noise of alcohol and cooking fumes and cigarette smoke. The MQ-4 can detect natural gas concentrations from 200 to 10000ppm.High sensitivity to CH_4, Natural gas. MQ 4 has Fast response, Stable and long life. The LM35 series is a precision IC temperature devices with an output voltage linearly- proportional to the Centigrade temperature.

LCD (Liquid Crystal Display) is used to show the output of the results of Different sensor values and various results to show of size about 32 ASCII character in 2 lines commonly used one is 16x2 LCD modules.

We are using GSM Modem to alert the user by sending SMS(Short Message Service) about Gas Leakage and LPG Gas Completion Status.GSM (Global System for Mobile communication) is a digital mobile telephony system that is widely used in England and different parts of the world. GSM uses of time division multiple access (TDMA) and is the most widely used of the technologies (TDMA, GSM, and CDMA). GSM digitizes and syncs data, then sends it to a channel with two other streams of user data, each in its own time slot. It operates at either the 800 MHz or 1800 MHz frequency band.

1. Gas sensor:

A gas sensor is a device which detects the presence of gas in the area. This sensor interacts with a gas to measure its concentration. Each gas has a unique breakdown voltage i.e the electric field at which it is ionized. Sensor identifies gases

by measuring these voltages. The concentration of the gas can be determined by measuring the current discharge in the device. The gas sensor detects the presence of various gases such as hydrogen, carbon monoxide, methane and LPG ranging from 100ppm to 3000ppm. The detecting concentration of the device is 200-10000ppm. It gives both analog and digital output. The supply voltage for the gas sensor is 5V

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Fig 2: Gas Sensor

2. *Piezoelectric buzzer*

Buzzer is an audio signaling device. The typical uses of buzzers are for alarms, timers and confirmation of user input such as a mouse click or keystroke. The project used an electronic type of buzzer which is a piezoelectric element that driven by an micro-controller signals. Peizo buzzer is based on the inverse principle of peizo electricity discover in 1880 by Jacques and Pierre Curie. It is the phenomenon of generating electricity when mechanical pressure is applied to the certain materials and the vice versa . such materials called Piezoelectric materials. When an alternating electric field subjected to the material they stretch or compress accordance with the frequency of the signal thereby producing sound

Fig 3: Piezoelectric buzzer

3. *Load cell amplifier*

The load cell amplifier is a small break out board for the HX711 IC that allows you to easily read load cells to measure weight. The HX711 uses a two wire interface (clock and data) for communication. Load cells use a four wire wheat stone bridge configuration to connect to the HX711. These are commonly colored RED, BLACK, WHITE, GREEN and YELLOW. Each color corresponds to the conventional color coding of load cells. By connecting the amplifier to your arduino you will be able to read the changes in the resistance of the load cell, and with some calibration you will be able to get very accurate weight measurements.

Red (excitation+ or VCC)

Black (excitation- or GND)

White (amplifier+, signal+ or output+)
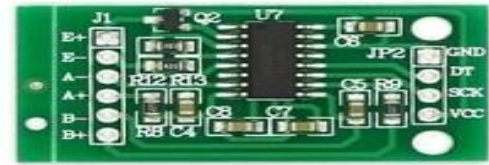
Green (A-, S- or O-)

Yellow (shield)

Fig 4: *Load cell amplifier*

4. LCD Display

LCD stands for Liquid Crystal Display.. They have become very common with industry by clearly replacing the use of Cathode Ray Tubes (CRT). CRT consumes more power than LCD and also bigger and heavier. We all know about LCD"s, but no one knows the exact working of it. LCD is finding wide spread use replacing LEDs (seven segments or other multi segment LEDs) due to the following reasons:

- The declining prices of LCDs.

- The ability to display numbers, characters and graphics related data. This is in contrast to LEDs, which are limited to numbers and a few characters.

- Incorporation of a controller into the LCD, thereby making the CPU to keep displaying the data.

- Ease to program for characters, strings and graphics related data.

These are specialized for being used with the microcontrollers, which makes that they cannot be activated by standard IC circuits. They are used for writing different messages on a miniature LCD.

5. *Load cell*

As per dictionary, a load cell is described as a "weight measurement device necessary for electronic scales that display weights in digits." However, load cell is not restricted to weight measurement in electronic scales.

Load cell is a passive transducer or sensor which converts applied force into electrical signals. They are also referred to as "Load transducers".

Fig 5: Load Cell Load cells use different operating

principles, viz.,

- Load Cells based on fluid pressure

- Load Cells based on elasticity

- Load Cells based on magnetostriction effect or piezoelectric effect

However, the only load cells which are prevalent are the load cells based on strain gages. Hence, the term „load cell‟ means „strain gage-based load cells‟. The reason behind the wide adoption of strain gage-based load cells is their characteristics

- Highly precise and linear measurements

- Little influence due to temperature changes.

- Small size compared with other types of load cells.

- Long operating life due to lack of moving parts or any parts that generate friction.

- Ease in production due to small number of components.

- Excellent fatigue characteristics

Strain-gauge load cells convert the load acting on them into electrical signals. The measuring is done with very small resistor patterns called strain gauges - effectively small, flexible circuit boards. The gauges are bonded onto a beam or structural member that deforms when weight is applied, in turn deforming the strain- gauge. As the strain gauge is deformed, it's electrical resistance changes in proportion to the load. The change to the circuit caused by force is much smaller than the changes caused by variation in temperature. Higher quality load cells cancel out the effects of temperature using two techniques. By matching the expansion rate of the strain gauge to the expansion rate of the metal it's mounted on, undue strain on the gauges can be avoided as the load cell warms up and cools down. The most important method of temperature compensation involves using multiple strain gauges, which all respond to the change in temperature with the same change in resistance. Some load cell designs use gauges which are never subjected to any force, but only serve to counterbalance the temperature effects on the gauges that measuring force. Most designs use 4 strain gauges, some in compression, and some under tension, which maximizes the sensitivity of the load cell, and automatically cancels the effect of temperature. It is often easy to measure the parameters like length, displacement, weight etc that can be felt easily by some senses. However, it is very difficult to measure the dimensions like force, stress and strain that cannot be really sensed directly by any instrument. For such cases special devices called strain gauges are very useful. There are some materials whose resistance changes when strain is applied to them or when they are stretched and this change in resistance can be measured easily. For applying the strain you need force, thus the change in resistance of the material can be calibrated to measure the applied force. Thus the devices whose resistance changes due to applied strain or applied force are called as the strain gauges.

6. Arduino UNO

In this proposed system Arduino Uno is used as a controller. Arduino is an well equipped Open-Source Prototype Platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light sensor, or a Twitter message - and turn it into an output - activating a motor, publishing anything online.

The Arduino software is easy-to-use for beginners. It will simplify the process of creating a control environment by providing the standard and flexible board that can be reusable programmed and connected to the system without any necessity of PCB design. Inexpensive, Cross-platform, Simple programming environment, Open source extensible software, Open source and extensible hardware. It is flexible enough for advanced users. It works on platforms like Mac, Windows and Linux. Arduino is a key tool to learn new things.

Fig 6: Arduino Uno R3 Board

7. GSM Module

GSM *(Global System for Mobile)* is an abbreviated form of Global System for Mobile Communication. It is used to establish a communication between a computer and a GSM system. Global Packet Radio Service (GPRS) is an extension of GSM that enables higher date transmission rate. It is basically a GSM modem (like SIM900) connected to a PCB with different types of outputs taken from the board – say TTL output (for Arduino, 8051 and other microcontrollers) and RS232 output to interface directly with a PC (Personal Computer). The board will also have pins or provisions to attach mic and speaker, to take out +5V or other values of power and ground connections.

Fig 7: GSM SIM900 Module

The baud rate can be configurable from 9600 – 115200 bps through AT (Attention) commands. This GSM TTL modem has internal TCP/IP stack to enable user to connect with internet through GPRS feature. It is suitable for SMS as well as DATA transfer application in mobile phone to mobile phone interface

IV. Results & Discussions

In Arduino Based LPG gas Monitoring & Automatic Cylinder booking with Alert System MQ-4 gas sensor, LM-35 Temperature sensor, 10 kg load cell(for prototype) as input devices and Piezoelectric buzzer, 16x2 LCD display and GSM module used as output devices.

Fig 8: LCD showing output of Temperature, gas level and weight

Actually the room temperature is 25°C, but we increased temperature of LM35 upto 53°c. Initially before gas leakage the output of gas sensor is 0 ppm, but when it sense gas the output is 267 ppm. We have placed 10kg load cell, so the maximum capacity is 10kg load. 338 is in the units of grams of weight.

Fig 9: Output showing Status of LPG cylinder

The above figure represents SMS messages in user mobile phone which is send by GSM module for different kinds of input reaction in our project. The message "GAS IS LOW RECHARGE SOON" is sent to the user when the LPG gas reaches to minimum threshold level. So the user comes to know to when to book the cylinder to avoid delay in delivering cylinder. The message "GAS IS EMPTY RECHARGE
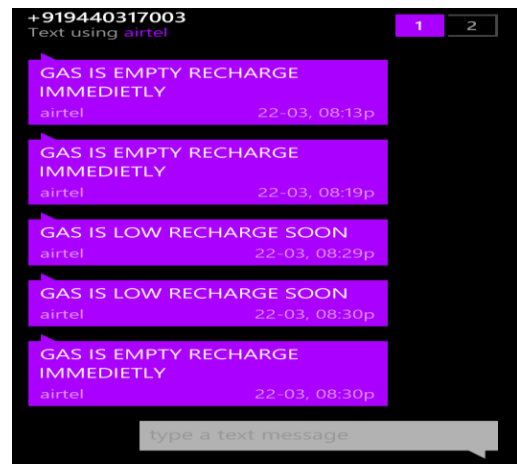
IMMEDIETLY" is sent when the weight of the gas is fully empty.

Fig 10: SMS"s sent to the user mobile
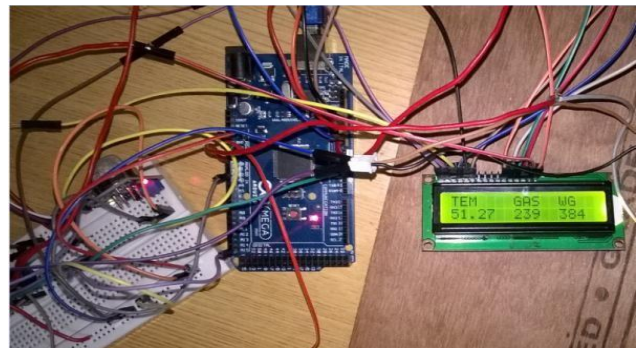

Fig 11: Initial Design of the Project

Fig 12: Final Design of the Project

V. Conclusion

As we shorted out the problems faced by LPG gas consumers so we come up with some solutions to meet the few requirements of them, as we made our system is completely automate the process of refill booking without human intervention. Our system is also reasoned to help customers to upgrade their safety norms, act in accordingly with minimum requirements on environmental issues and mostly the basic function being prevented by major disasters and protect life and property from reputed Accidents. The primary objective

of our project is to measure the gas present in the cylinder when weight of the cylinder is below the fixed load, this can be done using the weight sensors. The gas retailer gets the order for a new cylinder and the house owner (consumer) receives the message regarding the status and the secondary objective is to provide any malfunction in gas servicing system in order to prevent damage or explosion of LPG. Thus the system developed by us will somehow help the LPG Gas Consumers to lead a comfortable life.

VI. Future Scope

This monitoring system can be further enhanced by using Bluetooth in place of GSM to send the alert messages to user, which supports the another real-time application. For industrial purposes mobile robot can be developed for detecting multiple gas concentrations. Addition of load cell can also be used as pressure sensor which detects the amount of gas in the cylinder and also detects high pressure gas in cylinder pipe, displaying the alert messages via SMS and LCD displays.

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