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Development of a LPG Monitoring and Automatic Cylinder Booking System Based on Wireless Sensor Network

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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 monitor the gas level and also offers quick response to the events and accurate detection of leakage.**

Keywords— LPG, Gas sensor, Weight sensor, GSM module, Wifi module, Wireless sensor network

I. INTRODUCTION

Liquefied Petroleum Gas (LPG) is a highly inflammable gas consisting of propane and butane [1]. Apart from these two some other elements like butylenes, propylene and other hydrocarbons are also present in small quantities [1, 2]. An additional element like ethanethiol is added as a powerful odorant, so that the odor of ethanol helps to detect the leakage [3,4]. It is very much important to detect the LPG leakage because it can lead to major damage of property and human life. There are several reasons which may cause gas leakage such as carelessness, quality of the pipe, stove and cylinder etc.

A Wireless Sensor Network (WSN) comprises of huge number of self-governing sensor nodes which are capable of observing different condition like temperature, pressure etc. The key components of WSN are a sensor node, a preprocessing unit, power supply unit and a communication unit [5]. Sensor nodes are nothing but some computing devices equipped with sensor. Each sensor node duplicates its energy while transmitting, receiving and processing information [6].

Few years back LPG leakage detection was examined by a wired network, where need of power and cost of maintenance were significantly high. To overcome the limitations of traditional system, WSN is the best choice [7]. The main aim of using WSN to develop this system is to decrease the manufacturing cost so that it can be easily accessible by all. The high power requirement of wired network can be made simpler using WSN technology [8].

In today's world along with the explosion of domestic LPG, LPG scam is also increasing parallelly. To avoid this, we must have a system which can track weight of the cylinder automatically. Quantity of gas in cylinder is frequently checked by using a weight sensor.

Here we proposed a system based on WSN which will be able to spot the gas leakage using gas sensor and keeps track of the weight of the cylinder by using load sensor. Once the leakage is detected it will instantly send SMS to registered mobile no and alert its nearby people by activating the alarm which includes buzzer and shows the gas leakage message on LCD display. Apart from the leakage detection, this system calculates the weight of the remaining gas in the cylinder and when it crosses the low level, instinctively sends SMS to the registered mobile no and displays it on LCD display to inform users. This system also books the cylinder by sending the booking request to the distributor once the amount of the gas in the cylinder crosses the minimum level.

The proposed system contains three different modules as mentioned bellow:

- LPG leakage detection module.
- Gas level monitoring module.

- Automatic cylinder booking module.

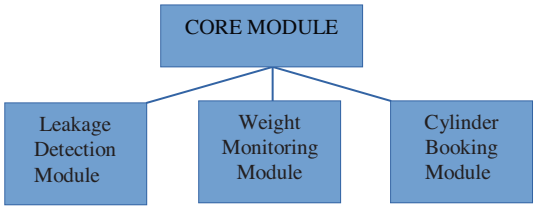

Fig. 1: Classifications of modules

- The leakage detection module is responsible for detecting leakage in the cylinder.
- The weight monitoring module is responsible for monitoring the gas level in a cylinder.
- The cylinder booking module is responsible for sending the booking request to the distributor when the gas level goes down to a certain level.

Apart from these three modules another two modules called GSM module and Wifi Module are associated with this system which are responsible for all SMS notifications and internal communications respectively[EXISTING SYSTEM

In the present day, all the gas leakage detectors simply use gas detectors to detect the LPG leakage and immediately transfer the signal to the central unit of the system for further execution. The main disadvantage of the existing system is that it is time consuming. Some of them are as follows:

- The authors proposed a system where MQ6 gas sensor along with the microcontroller is used and it is directly responsible for gas leakage detection. In addition to the detection of leakage this system also informs the users about the leakage by using different mechanisms like sending an SMS to the user when it detects gas leakage, turn on the buzzer and the exhaust fan to reduce the concentration of gas in the air [9].
- The authors proposed a system that included a way of booking the cylinder and inform the user when the level of the gas in the cylinder goes below to minimum level [10].

II. PROPOSED SYSTEM

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, wifi unit, buzzer and LCD display unit.

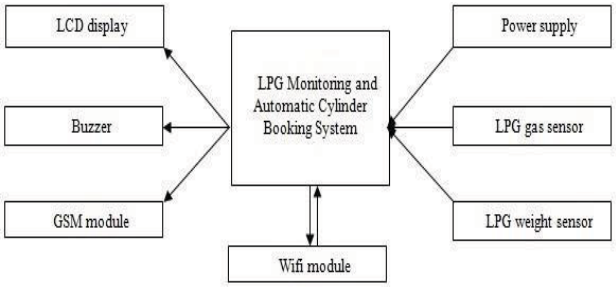

Fig. 2: Block diagram of the system

III. METHODOLOGY

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 encounter 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.

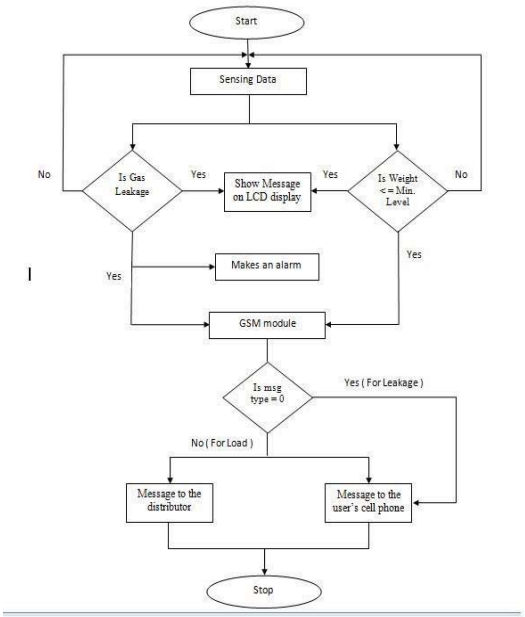

Fig. 3: Working principle of the proposed system

In this system, both gas leakage detection and weight monitoring function get the highest priority. Weight monitoring and cylinder Booking module is based on the continuously gas level monitoring functions of this module[11].

A. Algorithm for the proposed model

Input: Density of the LPG in air and weight of the cylinder.
Output: Decision whether there is a leakage or not and inform user and book a cylinder if the gas quantity crosses the minimum level.
Step1: Read the density of the LPG in the air by using the gas sensor.
Step 2: If the gas density is in between the given range the system will detect the leakage and sends the leakage signal to the central part of the system otherwise repeat the step 1.
Step 3: After getting the input, the central unit sends the signal to the respective units to inform user about the leakage and back to step 1.
Step 4: Continue the steps from 1 to 3 until it switch off
Step 5: Read the remaining gas weight of the cylinder by using gas sensor..
Step 6: Convert the analog input signal to digital one by using analog to digital converter and send it to the central unit of the system.
Step 7: Compare the resultant value with the minimum value and if the input value is less than the minimum value, it informs the user about the low gas level and simultaneously book a cylinder by sending the booking request to the distributor otherwise back to step 5.
Step 8: Continue the steps from 5 to step 7 until it switch off.
Step 9: Exit.

IV. SYSTEM IMPLEMENTATION

A circuit diagram is a graphical representation of an electrical circuit embedded with some gadgets. It highlights the actual connections between different electrical gadgets. Generally circuit diagrams are used for different purposes like designing, construction and maintenance of electrical and electronic equipment of a particular system.

The followings are the components and its specifications that are used in this system:

- **LCD Display:** There are total 16 pins on LCD display module out of which 2 pins are used to provide power to LED and two pins are used to provide power to the LCD display itself, on the LCD display module. Remaining twelve pins can be used to interface the LCD display module with Arduino Uno board.

- **Load Cell and HX711 interfaced:** Load cell is connected with HX711 calculates the weight of the cylinder and sends an analog signal to HX711 Module which amplifies the signal. It is a 24bit system, which converts the input signal to digital signal.

- **Gas Sensor:** Generally in a gas sensor [12] there are 4 pins available. Out of these four pins three pins has been connected directly to arduino board in which two pins is for power supply and one pin is for sending the sensed data to the arduino.

- **GSM Module:** There are total 10 pins available in the GSM module. Out of these ten pins we have used four pins which are directly connected to the arduino board. VCC to supply voltage, GND is for neutral, RX is for receiving data and TX is for transferring the data.

- **Wi-Fi Module:** The ESP8266 **Wifi Module** is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to any **Wifi** network. ESP8266's VCC and GND pins are directly connected to 3.3V and GND of Arduino and CH_PD is also connected with 3.3V[13-14].

- **Buzzer:** It is basically a tiny speaker that you can connect directly to an **arduino**. Out of all pins, one pin is connected to ground pin and the other one is connected to the digital pin of the arduino board.

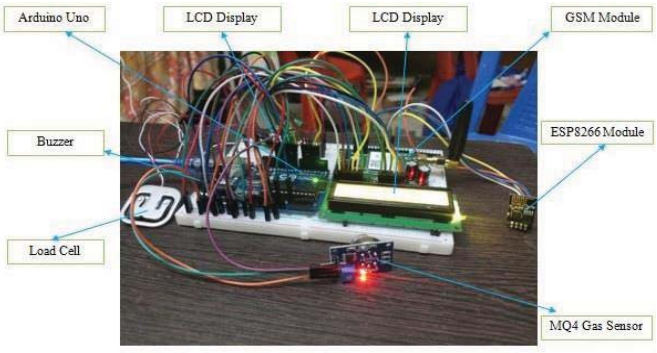

Fig. 4: Prototype of the proposed system

The final prototype has been made by comprising eight individual hardware units namely arduino uno, MQ4

gas sensor unit, GSM unit, buzzer, display unit, load cell, HX711 amplifier, ESP 8266 and wi-fi unit.

The proposed system is designed and tested in real time environment by providing the small amount of LPG near MQ4 sensor module. The MQ4 calculates the concentration value of LPG in the air and if it crosses the maximum level, it sends an alert SMS to the user and activates the buzzer to alert the user and display the gas leakage message on LCD display. Apart from the leakage detection, this system gives a fully automated approach towards the weight monitoring and cylinder booking in more accurate way.

V. RESULTS AND DISCUSSION

A system prototype has been build and all the modules of the system are working according to the desired requirement. According to our first module, when the gas sensor sense the presence of LPG in air, it detects the leakage, it display 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 its send 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:

A. Module 1

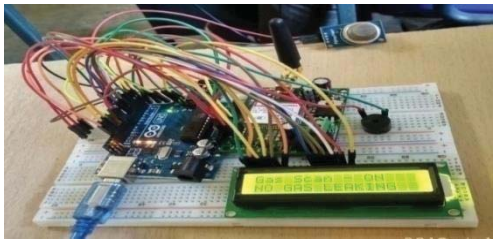

Fig. 5: Message display before gas leakage in LCD

The above figure explains the results of the module when there is no gas leakage. As soon as the system is powered on, the system continuously monitor the gas concentration in air, but as there is no leakage of gas, so the system displays a message “NO GAS LEAKING” on the LCD display.

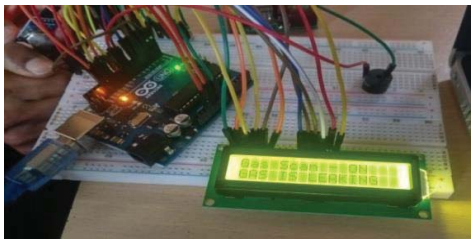

Fig. 6: Message display after gas leakage in LCD

The above two figures explains the results of the module when there is leakage of gas. As soon as there is leakage of gas, the system detects the gas leakage and displays a message “GAS IS LEAKING” on the LCD display. The system is also sending a SMS notification to the user.

Fig. 7: 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.

B. Module 2

Fig 8: Output on the LCD display before putting load on the Load Cell

The above figure shows the results of the module when there is no weight on the load cell. As soon as the system powered on, the system continuously monitors the weight of the LPG cylinder, but as there is no load on the load cell, so the system displays a message “WEIGHT MEASUREMENT 0.00KG” on the LCD display

Fig. 9: Output on the LCD display after putting load on the load cell

The above figure shows the results of the module when there is some weight on the load cell. As soon as the system powered on, the system immediately start monitoring the weight of the LPG cylinder and when there is some weight put on the load cell, the system displays a message “WEIGHT MEASUREMENT 2.12KG” on the LCD display.

C. Module 3

This module provides the automatic cylinder booking facility to the users. This module works with the help of the second module which is responsible for monitoring the weight of the cylinder. When the amount of the gas crosses the minimum level in the cylinder this module send the cylinder booking request to the distributor via SMS.

VI. CONCLUSION

In this study 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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