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LPG MANAGEMENT SYSTEM FOR DOMESTIC APPLICATION USING INTERNET OF THINGS

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Abstract: An affordable Automated Integrated LPG (Liquefied Petroleum Gas) system for leakage sensing, automatic-manual booking, authenticated gas monitoring system and detection of gas exhausting is being explored along with the IOT application in this paper. The main aim of this paper is to prevent LPG leakage and book the cylinder automatically on sensing the weight of the cylinder which is carried out using two methods one is through the SMS and the other with the IOT. By using a gas sensor LPG leakage is detected and it notifies the consumer by automatically sending an SMS through GSM module, along with this the controller can share the same information to the user via internet and also activates the gas valve to stop the gas leakage. Along with these two more features are added in this paper, one is for booking the cylinder automatically if the cylinder weight is less than 20% of its total weight. The second one is to book the cylinder with just a click of a button which is more convenient for many users. All the sensors information is updated in the server and the same is retrieved back by the smart phone, which uses the IOT for its operation. To test and simulate the proteus software is used along with it the 3D module of the entire system is shown. The PCB designing is also done for the entire system and finally the code is written using the keil-c software.

Keywords: LPG, gas leakage sensing and prevention, gas cylinder monitoring, GSM module, buzzer and relay.

I. Introduction

Liquefied fossil oil Gas (LPG), additionally referred to as merely fuel or gas, are ignitable mixtures of hydrocarbon gases used as fuel in cooking appliances, heating equipment and vehicles. LPG is prepared by processing petroleum and is entirely derived from fossil fuel sources that is extracted from natural gas streams as they emerge from the bottom. LPG was 1st created by Dr. director Snelling. it's spoken as machine gas, once employed in vehicles. This gas is additionally used as associate degree aerosol propellant and a refrigerant which are replaced by chlorofluorocarbons in order to reduce the harm to the ozonosphere [1]. The first generation of cylinders were introduced between 1870-1880, to store liquid CO2 for industrial gas businesses. They were long steel tubes without handles and hard to handle. Later, the second generation was introduced to bridge some gaps within the 1st one. They were additionally made of steel, but with handle, shorter but wider and the form has been refined. This generation of cylinder were most popularly called "traditional" cylinder. Third generation cylinders improved upon sort of II, used plastic for coating the metal exterior permitting the outside to be customised. However, these cylinders still have identical drawbacks as generation I and generation II. The IV generation cylinders are the latest on the market. They were developed with some standard technology and represent a true advance in technology, that otherwise has effectively remained unchanged over seventy-five years. the most disadvantage related to the usage of LPG is to do with the safety and storage. To store LPG, we require very sturdy tanks and cylinders. The gas must be kept pressurized to accommodate it in 274 times lesser space. This has perceived to occur many damages. Hence the requirement of efficient system to measure and display the level of LPG is inevitable, which may be used for domestic and commercial purposes. Here we intend to use a microcontroller based system where a gas switch sensor, MQ4 is used to sense any leakage of gas. Whereas the unit is incorporated with the buzzer, to produce sound or give a visual indication of the gas leakage which is of low cost. If the gas leakage is sensed, message to the consumer using the cellular network called GSM is automatically sent. As soon as the gas weight is reduced below 13 kg, cylinder will be automatically booked by sending a text message to the dealer. Also, when the cylinder weights less than or equal to 0.5kg, it informs the consumer to refill the cylinder by sending a message. If the module is switched off, then the gas sensor needs minimum 30 seconds to work properly. So, care to be taken while using these types of sensors in this system.

II. Literature Survey

An efficient, automatic Liquefied Petroleum Gas (LPG) booking, leakage detection and real time gas observation system is projected in this paper. In this system, the LPG leakage is detected through the detector and data is sent to the user by Short Message Service (SMS) and at the same time alerts the client using a GSM module, whereas activating thealarm and fan [2]. The advantage of the system is that it incessantly monitors the

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amount of the LPG present within the cylinder using weight sensor and automatically books for a new cylinder if the cylinder weight is less than 20% of its total weight using a GSM module. The system detects the leakage of the LPG and alerts users regarding the leak and as an emergency steps are taken by the system to switch on the Gas Valve and to block the gas leakage. With this an add on feature of the system is that the approximate consumption is indicated in terms of the total weight. The proposed system makes use of GSM module to alert the user regarding the gas leakage via SMS. Whenever the system detects the rise in the concentration of the LPG it right away alerts by activating an alarm and at the same time sending message to the desired mobile phones. It also sends the same information to the user via the Wi-Fi module which stores the information in the cloud parallely cautions the user to take action. The fan is switched along with this an LPG safe solenoid valve fitted to the cylinder is switches on to stop the gas from leaking out and avoiding additional discharge [3]. The device ensures safety and prevents suffocation and explosion due to gas leakage. The former systems cannot react in time, even cannot get knowledge from an accident and locate accurately. This technique offers real time detective of potential risk area, collect the info of leak accident and find leakage point. It conjointly has protection electronic equipment consists of fan and a liquefied petroleum gas safe solenoid valve. The hazardous gasses like liquefied petroleum gas and propane were detected and showed each second in on LCD display.

If these gasses exceed normal level, then alarm is generated right away. Here we tend to use MQ-4 gas sensor used to sense toxic gas and has high sensitivity to LPG and response to natural gas. This work modifies the present safety model installed in industries. It offers fast reaction time and accurate detection. Safety plays a significant role in today's world and it's necessary that sensible safety systems are to be enforced in places of education and work. This work modifies the present safety model put in industries and this technique even be employed in homes and offices. the most objective of the work is design in microcontroller based nephrotoxic gas detection and alerting system. The advantage of this automated detection and alerting system over the manual technique is that it offers fast response time and correct detection of an emergency and successively leading quicker diffusion of the critical situation.

The aim of this project is to monitor for liquid petroleum gas (LPG) leakage to avoid fire accidents providing house safety wherever security has been an issue. The system detects the leakage of the LPG gas and senses the gas. Then it alerts user regarding the gas leakage by alert SMS. The proposed system uses the GSM to alert the person regarding the gas leakage via SMS [4]. Once the system detects the LPG concentration within the air exceeds the certain level then it straightaway alerts user by sending SMS to specified mobile and alert the individuals present at home by activating the alarm which incorporates the LED, Buzzer at the same time and show the message on LCD display and required is taken by activating the fan to decrease the gas concentration within the air. Gas discharge may be a major concern with residential, industrial premises and gas powered transportation vehicles. one among the preventive measures to avoid the danger related to gas leakage is to put in a gas leakage detector at vulnerable locations. conditions and activates a high-pitched alarm just in case of emergency things to safeguard the users.

III. Proposed Methodology

This paper deals with the advance and innovative idea for LPG leakage sensing, prevention and automatic-manual booking for refill. In advance, the system provides the automatic controlling of LPG regulator also if leakage is detected the system will automatically turn off the main switch of power supply. The three actions are updates frequently in the server so that the user if he is not in the coverage area he can see the stats of the sensors in the cloud which is connected to the module always. Adding this IOT technique in this system it improves the safety standards. Sensors status is updated in the cloud server by the microcontroller via a Wi-Fi module, which improves for convenient for the user to interact with the module. Hence it helps to avoid the explosion and blast. The block diagram comprises of following parts shown in figure below.

1) Microcontroller:

An economical and quick response controller is required to incessantly sense the LPG gas and its level (weight) sensor's output. Also, a quick reply is desired once leak is found. Together with this a system should possess capability to store some info which may be used for any process [5]. The AT89C51 is a low-power, superior CMOS 8-bit microcomputer with 4 Kbytes of Flash Programmable and erasable read only Memory (PEROM) that is employed this method. Its price effective makes the entire system much cheaper than the systems that are available within the market now a day.

The device is manufactured by Atmel's high density non-volatile memory technology it is compatible with the industry standard MCS-51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a traditional non-volatile memory coder. The Atmel AT89C51 is a powerful microcomputer that provides extremely versatile and effective solution to several embedded management applications. The AT89C51 provides the subsequent standard features: 4Kbytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, a five-vector two-level

interrupt design, a full duplex port, on-chip oscillator and clock circuitry. Additionally, the AT89S52 is intended with static logic for operation down to zero frequency and supports software selectable power saving modes.

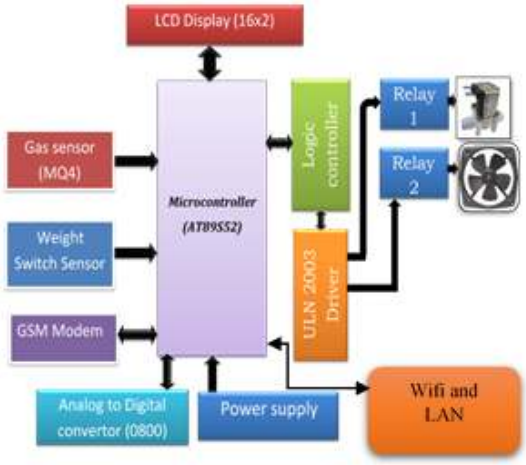

Fig. 1: Block Diagram of the System

2) Gas Sensor:

Sensitive material of MQ-4 gas device is SnO2, that with lower conductivity in clean air. The sensor is made of small AL2O3 ceramic tube, Tin dioxide (SnO2) sensitive layer, the measuring conductor and heater are mounted into a crust created by plastic and stainless-steel net. The heater provides necessary work conditions for work of sensitive parts. The enveloped MQ-4 have 6 pin, 4 of them are used to fetch signals, and alternative 2 are used for providing heating current. once the target flammable gas exists, the sensor's conduction is higher along with the gas concentration rising. We use straightforward electro circuit, convert change of conductivity to correspond output signal of gas concentration. Once the target flammable gas exists, the sensor's conduction becomes higher beside the gas concentration rising. Convert amendment of conduction to correspond sign of gas concentration. MQ-4 gas device has high sensitivity to LPG, if its concentration exceeds the limit then it activates the relay and alternately switches on buzzer and closes the valve. It is low price and suitable for various application.

3) Weight Sensor:

For booking of refill from a distributor, we should be aware in advance of quantity of gas within the cylinder, and for this purpose the level of gas present within the cylinder should be monitored unceasingly. The load cell having required weighing capacity for domestic cylinder is employed and for calibration purpose the weight device module is employed along with the load cell. L6D weight device module is enforced within the system. The load cell output drives a relay circuit which gives 2 logic pulses (for <=7 kg and <= 0.5 kg) which are further connected to microcontroller port pins to find the gas level. A leaf switch in addition is utilized in case the weight device fails to find the empty cylinder which in turn the leaf switch is closed to indicate a pulse to the microcontroller and also the action is taken as per the user requirement.

4) GSM Module:

Gas device detects the presence of gas, weight device provides the gas level in cylinder, and microcontroller can take corrective or necessary actions. The status of all these must be sent to the owner or housemates. GSM module is employed to send an SMS to the user mobile phone. Once the gas leak is detected by the gas sensor, microcontroller sends a signal to GSM module, within which one in every of the tasks is to send the text SMS. GSM module needs one SIM card. This module is capable to just accept any network SIM card. The GSM module used is SIMCOM 900 that uses SIM memory to store the amount of system owner or housemates and distributor or to whoever the messages should be forwarded. It needs very less memory to send and receive text messages and operates on simple 12 volt.

IV. Basic Concept & The Implementation Of The System

The concept is implemented using the microcontroller module which is originally designed by intel but the chips that we are using were manufactured by the Atmel Corp. Although any other microcontroller could be used without any major change. The only direct impact will be only in the software or the assembly code written for the microcontroller. From figure 1, as soon as the gas sensor detects the gas leakage the microcontroller closed the valve to stop the gas leakage. Further if in case the valve fails to do this a exhaust fan come in to picture to remove the gas molecules present in the surround air. The weight sensor is used to detect the how much gas is present and if reaches a threshold value like low gas level then it triggers the microcontroller to book a gas refill and also intimated the user with the help of GSM Modem. The Gas booking system is an add on to the system with a push of a button to book a refill. The same information is displayed on the LCD screen and the same information is sent to the use with the help of SMS method. In the first implementation, a push button is used to generate the logic level and the respective output is noted. A 16x2 LCD is used and a small message is displayed in the 1st implementation. Further the required message is changed and this is invoked when a sensor detects the GAS molecules in the surround air. Furthermore, the weight sensor is used to detect the weight of the cylinder and if the weight of the cylinder is less than the threshold value, the microcontroller is triggered by this sensor. Here we are achieving three types of information and two are from the sensors and one from the user interface.

(i) **Case 1**: In the first case the MQ-4 sensor is used to detect the LPG gas density in the surrounded area. As soon as the density of air and gas ratio changes the MQ-4 detects and triggers the microcontroller for further functions.The microcontroller first shuts off the gas by activating the electromagnetic valve which stops the gas escaping from the cylinder. The same information is displayed on to the LCD screen and sends an SMS to the user who is not in reach and has an audible information to the user. The valve is active until the user resets the microcontroller. This is an advantage in this module. If the valve is not working for some reason in near feature the microcontroller detects this event and sends the signal to logic controller and to the relay driver by which in turn activates the exhaust fan to remove the gas from the surrounding. The relay used here is a solid-state device which will never produces sparks which is seen in a normal mechanical relay. This is the safest way to get rid of the gas molecules from the air.

(ii) **Case-2**: In the second case the weight sensor is used to detect the weight of the gas cylinder according to the weight microcontroller takes the decision. The microcontroller detects the weight with a present value for the cylinder from low, medium to high. If the cylinder weight is reducing drastically the weight sensor detects this and send the information to the microcontroller. The microcontroller then send the gas exhausting information to the user via GSM modem and displays the same information on to the LCD screen along with this it pre-books the cylinder and the booking information is updated to the user.

(iii) **Case-3**: In the third case the user has an interface to book the gas cylinder as a pre-booking option. The user needs to just press the cylinder book option which is a push button switch. By doing this the microcontroller sends the information to the gas agency to book a refill for the user. Here we have an option where the GSM can call the agency to book a refill or by just sending the information through SMS for a refill. By adding this feature in the near future this option will add on an advantage to the system where no need to again change the code or the entire system for upgrading.

V. Expected Results

There are three conditions to be considered in the implementation of this system.

(i) In the first case the gas sensor detects the gas leakage and gas valve is activated to stop the gas leakage. The figure 2a, b shows the flow diagram of gas detection based on the threshold of the sensor during the gas leakage. Initially all the ports are initialized then the sensor is initiated to sense the gas leakage, as soon the gas is detected the valve is closed to stop the leakage of the gas in the surround area. In figure 2b, as soon as the gas sensor detects the gas leakage, the port 2 bit P1.0 becomes

low indicating the presence of gas as seen from the above figure. The low triggers the microcontroller to take necessary actions to stop the gas leakage.

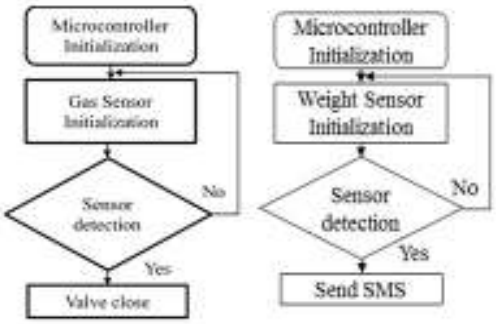

Fig. 2a: Flow diagram for the Gas leakage detection and gas estimation.

Fig. 2b: Flow diagram for the Gas leakage detection Simulation.

In figure 2c, as soon as the gas sensor detects the gas leakage, the port 2 bit P1.0 becomes low indicating the presence of gas as seen from the above figures. The low triggers the microcontroller to take necessary actions to stop the gas leakage. The other port bits of P1 are in same condition until it is triggered by the specific sensor. Each of the conditions are created as a function which are called whenever the event occurs, this method allows the microcontroller to work less compared to other type of programming method.

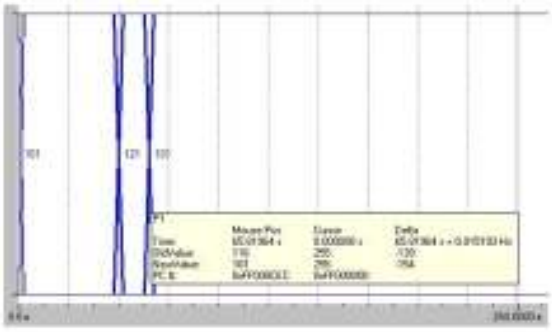

Fig.2c:Flow diagram for the Gas leakage detection trigger pulse.

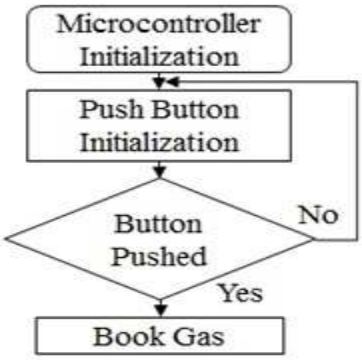

Fig. 3a: Flow Diagram of Weight Detection.

Fig. 3b: Weight Detection trigger pulse

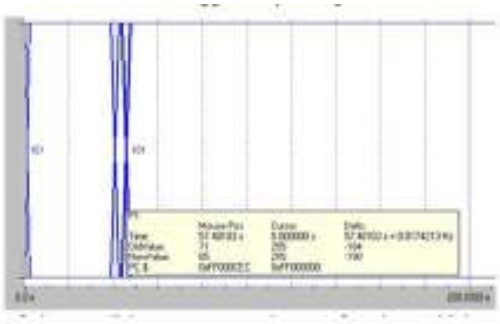

Fig. 3c: Trigger pulse for Weight Detection of cylinder

In figure 3a, the trigger pulse from the port P1, bit P1.0 shows the actual triggering value for a particular event which we have considered that as a gas leakage pulse from the sensor.

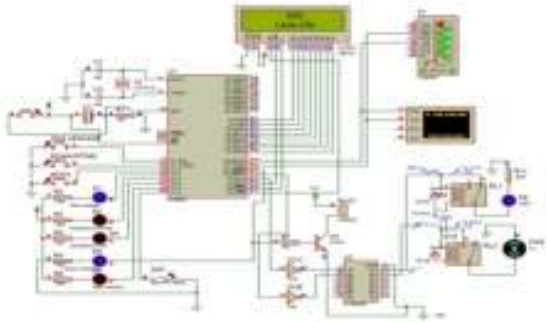

Fig 4a: Simulation Circuit diagram for the Gas leakage detection using proteus design tool.

The figure 3b shows the flow diagram of weight detection based on the threshold of the sensor. Initially all the ports are initialized then the sensor is initiated to sense the weight of the cylinder, as soon the gas is detected the change in weight with respective to the predefined value which is always around 20% of the cylinder gas volume. As soon as it reaches to the predefined value the microcontroller will book for a new cylinder using GSM modem and sends the same information to user.

In figure 4b, as soon as the weight sensor detects the gas cylinder weight which is less than the threshold value which is less than the 20% of the total gas volume of the cylinder, the port 2 bit P1.1 becomes low indicating the gas cylinder weight as seen from the above figure. The low triggers the microcontroller to take necessary actions to book for a new cylinder. The other port bits of P1 are in same condition until it is triggered by the specific sensor. Each of the conditions are created as a function which are called whenever the event occurs.

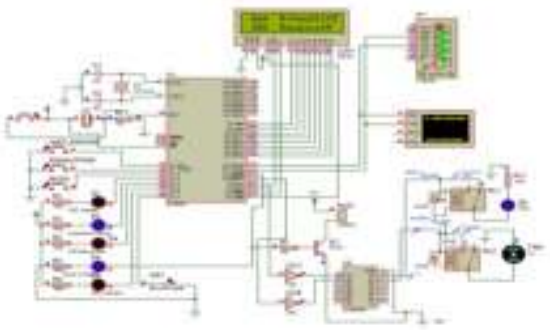

Fig 4b: Simulation Circuit diagram for the weight detection of cylinder using proteus design tool.

(ii) In the second case the weight of the cylinder is determined by the sensor and the information is sent to the controller, the controller makes some math work and estimated the weight of the cylinder.

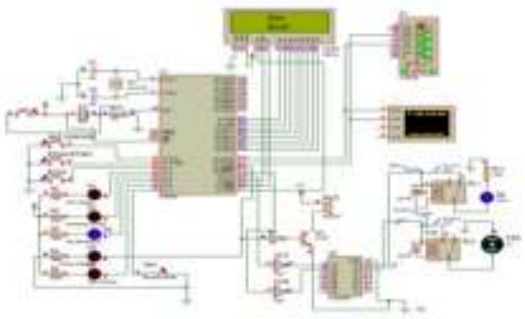

Fig 4c: Simulation Circuit diagram for booking the gas cylinder using proteus design tool.

(iii) In the third case the push button is used as an input to the microcontroller to book the cylinder. Initially the Port P1 bit P1.2 is made to high in the normal condition, as soon the user presses the button it makes the bit to zero. As soon as it goes to zero the microcontroller takes the necessary step to book the new cylinder via GSM modem through SMS.

VI. Real Time Setup

In the real-time setup, all the modules as well as the components are first rigged up using breadboard. The results are noted down and are compared with the simulation results. The microcontroller output is noted down from a CRO, the ADC values are tested by applying different analog values and the respective digital values are noted. Similarly, the Gas sensor MQ4 is tested using the nail polish remover which contains the traces of methane gas. The output is noted down, as we have seen the gas sensor needs 30 seconds' delay time for its normal operation, the time is crucial as it only detects after the coil gets heated as per the manufacturer specifications, with in that time the sensor will not give proper results. We consider all these information as highest criterial before rigging up the whole circuit. Further, LCD is used to display the information about the event as we have seen in this paper. The following modules are strictly kept at 5v from an SMPS which are as follows, LCD, GSM Modem, ADC 0808, Gas Sensor MQ4 & Microcontroller 89S52.

Table I: Voltage and Current ratings

Sl. No.	Name of Module	Voltage Rating		Current Ratings	
		Min	Max	Min	Max
1.	89S52	3V	6.6V	0.48mA	22mA
2.	ADC 0808	4.5V	6.5V	0.2mA	2.1mA
3.	ESP 8266	3.3V	3.6V	35mA	75mA
4.	MQ4	3V	5V	40mA	250mA
5.	ULN2003A	5V	50V	25mA	500mA
6.	LCD 16x2	4.5V	5V	0.25mA	25mA
7.	Solenoid Valve	12V	18V	250mA	500mA
8.	Exhaust Fan	8V	16V	0.25mA	25mA
9.	SIMCOM 900	3V	12V	125mA	210mA
10.	SMPS	5V	24V	2A	3A
11.	Relay	8V	14V	80mA	300mA

VII. Experimental Results

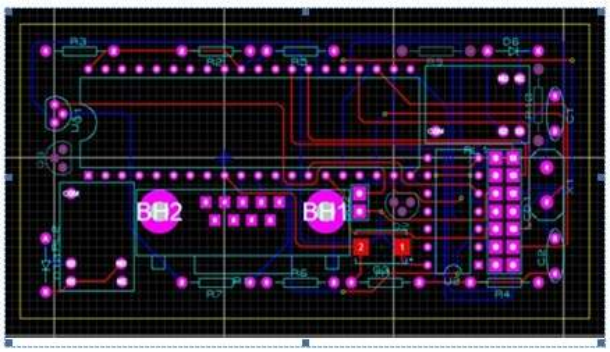

Fig. 5: PCB Layout of the entire module.

As shown in the above figure the PCB layout of the entire system excluding the GSM modem.

The table 2 shows the simulation time and real time sensor and other modules reacting time.

Table II: Simulation Vs Real Time

Sl. No.	Task	Type	Simulation Results	Real-Time Results	Difference
1.	Sensor	Gas MQ4	0.56S	1.22S	0.66S
2.		Weight /Switch	0.68S	1.36S	0.68S
3.	Display	LCD 16x2	1.12S	1.65S	0.53S
4.	Buzzer	Piezo Electric	1.2S	1.48S	0.28S
5.	Relay	12V Relay	4.2S	5.43S	1.23S

Here we can observe that as soon as the sensor detects the change in the environment it triggers the microcontroller to display as well as do the needful to stop the gas leakage. This is also seen in real time as well as in the simulation time. There is quite difference in the both which is noted down in the table 2.

VIII. Conclusion

This paper describes our proposed system for gas monitoring, leakage, automatic booking and manual booking. The main aim of the project is to reduce the deaths occurred due to the leakage of gas from the cylinder as well as negligence by the users. Here the system controls the flow of gas from the cylinder to the stove or any other devices in need for the LPG gas. As soon as the system comes to know if any gas leakage it will automatically shuts off the gas cylinder valve by using a solenoid valve, if this fails in case the controller will automatically switches on the exhaust fan to remove the gas from the surround place. The second advantage of this system is it can book for a new cylinder as soon as the cylinder weight is less than 20% of its total weight. The third advantage is it gives a convenient way for the user to manually book the cylinder by just clicking on a button. Further the entire circuit is designed and tested using proteus design tool. Along with this the code is written using keil-c software. The final module is designed, furthermore, the entire information is updated in the cloud sever where the information is gathered whenever it is necessary.

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