LPG Detection, Measurement and Booking System

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Abstract: **In this paper we present how to detect the leakage using a gas sensor and book a new cylinder automatically by sending a message to agency. The gas sensor MQ-6 is very sensitive to methane and propane which are main constituents of LPG. A load cell is used to measure the weight of cylinder continuously. The weight of cylinder is displayed continuously and some 4-5 MQ-6 sensors will be placed in different place of room, output of sensor will become high when there is LPG leakage is present. When the sensor output is high buzzer will be switched on and a message will be sent to customer and nearest gas agency via GSM. When the weight of cylinder equal to threshold value a message will be sent to agency to book new cylinder. The same system is implemented using LabVIEW, and a statistical analysis of gas sensor and load cell is done.**

Keywords: MQ-6 gas sensor, Load Cell, Microcontroller (MCU), GSM, LabVIEW

I. INTRODUCTION

Safety and security is most important for anything which we have in our daily life, especially in the home to prevent the explosion of gases. Now-a-days the explosion of domestic LPG is increasing, LPG scam is also increasing parallel with it. To avoid the frequently checking the gas manually and scam, the quantity of gas in cylinder is continuously monitored using a weight sensor Load cell. As soon as level reaches a threshold value1 a message is sent to user and to agency to book a new cylinder by sending the user name, user id. Now-a-days the booking of cylinder through a voice response. Hence the requirement of an efficient system to measure and display the level of LPG is accurately. Here we intend to propose a microcontroller based system where a gas sensor, MQ6 is used to detect dangerous gas leaks. This unit is incorporated into an alarm unit, to sound an alarm or give a visual indication of the LPG leakage. The sensor has well Sensitivity combined with a quick response time. If leakage is detected, message to the authorized person or family member using cellular network called GSM is sent automatically, also it switch on the exhaust fan which make the gas to go out. It also provides a feature to measure weight of LPG cylinder with its value on LCD display. A gas quantity of less or equal threshold value1 value books the cylinder automatically by sending text message to a dealer. Also when cylinder weighs less than or equal to threshold value2, it informs the family members by sending a message to refill the cylinder.In addition to that detecting the leakage in pipeline is done by moving a rack and pin arrangement which has two sensor attached to it.

II. SYSTEM OVERVIEW

The system block diagram comprises of parts as shown in figure 1. It consists of microcontroller (ATMega128), Gas sensor (MQ-6), Weight sensor (Load Cell), GSM module (SIMCOM 300), displays (LCDs), DC motor, Exhaust fan.

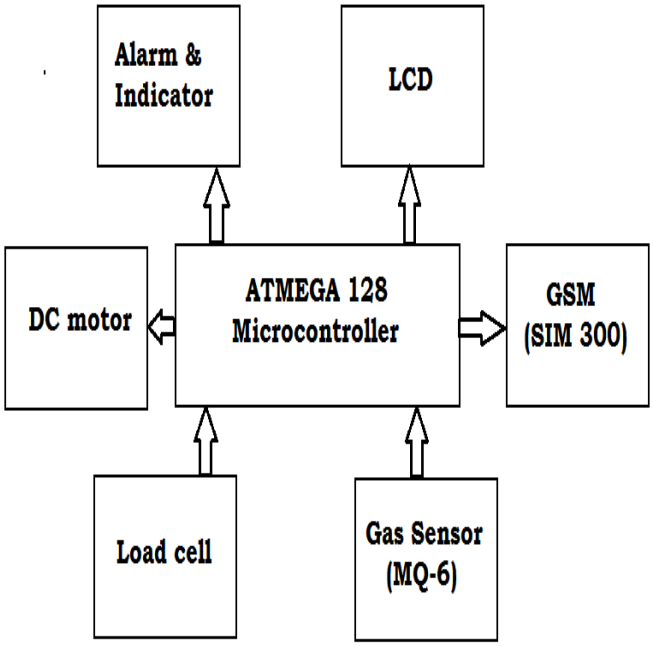

Figure.1 System Block Diagram.

A. Microcontroller

An efficient and fast working controller is needed to continuously sense the LPG gas and its level (weight) sensor's output. Also a fast reply is desired when leakage is found. Along with this a system must possess capacity to store some information which can be used for further processing. Above operations require a very fast, single cycle execution rate microcontroller like ATMega128. As shown in above figure 1, the microcontroller is at the centre of the system.

The LCD module connected to port C of ATMega128 in 8-bit mode is used to display the required messages. GSM module using AT commands connected to Rx and Tx pins of port D of ATMega128 are used to receive and transmit messages to desired family members and distributor. The weight sensor (load cell) module output taken from relay circuit is connected to pins of port A which is used to monitor gas level continuously.

B. Gas Sensor

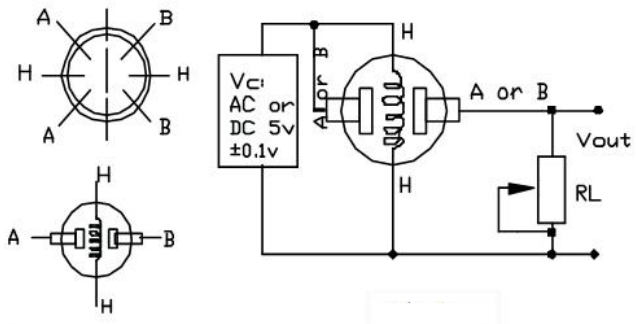

Figure.2 Transfer section of Sensor

Gas sensor is the device used for detecting the presence of gases like Carbon Monoxide, LPG, ethanol, toluene, hydrogen etc. These are used as safety measures in work places and home to avoid hazardous situations. Gas detectors are usually battery operated devices and if the gas level exceeds the pre-set level, it sends output signal to activate the circuit. Here we use MQ-6 which is sensitive to propane and butane which are constituents of LPG.

It is a 6 pin device and it requires 5V dc maximum which is derived from a power supply. There is a heating element inside the sensor which becomes hot at 5 volt and remains stand by. The sensing element has a sensing material (Usually a Semiconductor) and a heater to heat up the sensing material. The different sensing materials used are Tin Oxide, Tungsten oxide etc. depending on the type of gas to be sensed. The transfer section of sensor is shown in figure 2.

In principle, when the Tin Oxide is heated to high temperature, it adsorbs oxygen on its surface with a negative charge. Then the donor electrons from the Tin oxide crystals passes into the adsorbed oxygen leaving the positive charge in a space charge layer. This creates a surface potential which prevents electron flow. Inside the sensor, the current flows through the boundary of Tin oxide crystals. In the boundary of the crystals, the adsorbed oxygen forms a barrier to prevent the free movement of carriers. This potential barrier gives the electrical resistance to the sensor.

The output of sensor is in terms of millivolts, is amplified using LM358 which is a precision amplifier. The output of sensor is given to port F of MCU. The port F is input for ADC, the sensor output is converted into digital by internal ADC. The sensor gives only two output which is 1) without leakage, 2) with leakage.

C. Weight Sensor

To book a cylinder from a distributor (Agency), we must be aware of amount of gas in the cylinder, and for this purpose the level of gas present in the cylinder has to be monitored continuously. The load cell having required weighing capacity for domestic cylinder is used and for calibration purpose the weight sensor module isused along with the load cell.

Here we use a binocular load cell to measure the weight of cylinder. It has two ends fixed and free end. The weight i.e. cylinder is placed at free end. During a measurement, weight acts on the load cell'smetal spring element and causes elastic deformation. This strain which can either be positive or negative is converted into an electrical signal by a strain gauge installed on the spring element. The (mandatory) basic components, i.e. spring element and strain gauge are complemented with additional elements (housing, sealing elements) protecting the strain gauge elements. The strain gauge output is resistance which are connected at four arms of Wheatstone's bridge which gives a single output voltage is converted to digital and used for further analysis. The whetstones bridge gives the four output voltages i.e. excitation positive and negative and signal positive and negative. These signals are given to IC ADS1230, which gives a single Analog voltage is converted into digital by AT89c2051 which is an 8 bit processor and gives the digital 8 bit output is fed as input to atmega128 port A. The load cell circuit is as shown in the figure 3.

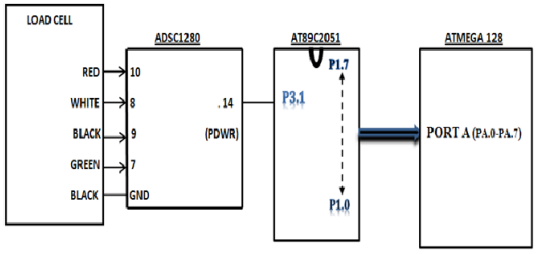

Figure 3. Load cell circuit.

The amount of gas present in the cylinder is continuously displayed on LCD. If the amount of gas in cylinder reaches to a threshold value1 a SMS is sent to user and distributor to book a new cylinder.

D. GSM Module

Gas sensor detects the presence of gas, weight sensor gives the gas level in cylinder, and microcontroller will take corrective or necessary actions. The status of all these happening has to be conveyed to the owner of system or housemates.

The technology making it very easy to send and receive messages using GSM module works on simple AT commands which can be implemented by interfacing it to the microcontroller Rx and Tx pins. The GSM module used is SIMCOM 300 which uses SIM memory to store the number of system owner or housemates and distributor or to whoever the messages have to be forwarded. It requires very less memory to send and receive text messages and operates on simple 12 Volt adapter.

E. Displays

As the system performs controlling and monitoring operations, it is primary requirement to put a display in the system which shows various message such as gas leakage detection, booking number of cylinder in case of refill of

cylinder and also will display actions taken by microcontroller.

Liquid Crystal Display (LCD) of 16X2 characters operating on +5Volt supply and operated in 4-bit mode is implemented for the task of displaying required messages .Interfacing with ATMega16A and short code of programming makes it very useful to make system more user friendly.

F. DC Motor

The pipeline leakage detection is another part of our system. In which a rack and pin arrangement is driving using a dc motor. The arrangement has two sensor attached to it. The dc motor driven by a l293d IC.

III. SYSTEM OPERATION

There are two flow charts for gas leakage detection and continuous gas monitoring, automatic gas booking which explain the methodology of the operation as follows:

A. Leakage Detection

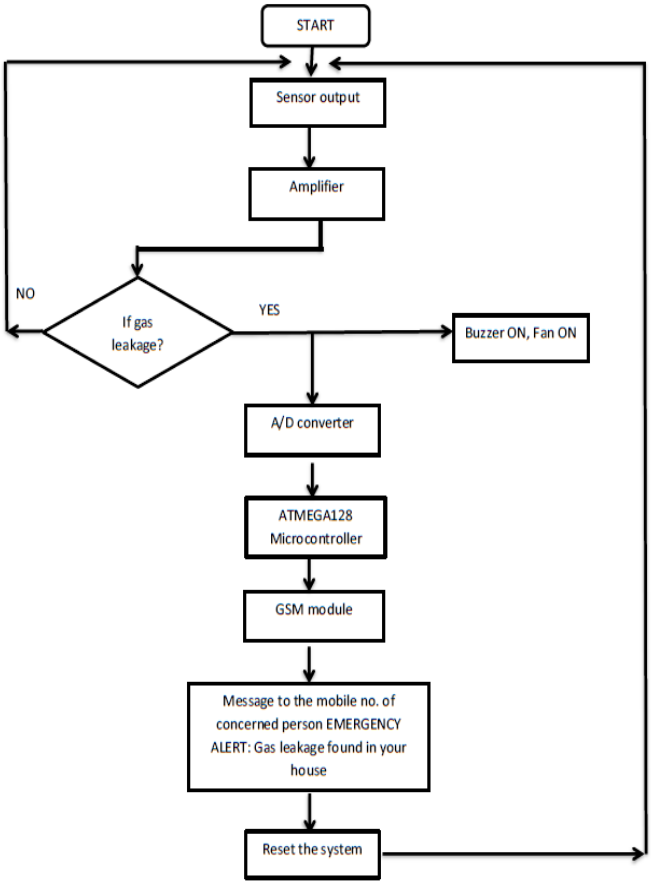

Figure 4. Flow chart of leakage detection

In this system gas leakage detection has been given highest priority. MQ-6 are placed at different places like near the gas stove, near the regulator and rack and pin arrangement which is used to move along the pipeline. If any leakage is detected the output of sensor goes high which is given to port F of MCU. The Analog voltage is converted into digital by inbuilt ADC, simultaneously MCU switch on the buzzer, exhaust fan and sends message "EMERGENCY ALERT, LPG leakage found in your house" to customer via GSM module and same will be displayed on the LCD. The flow chart of working is as shown in figure4.

B. Monitoring and Automatic Booking system

In this system the amount of gas is continuously monitored by displaying the same on the LCD. Load cell (weight sensor)is used to measure the weight of cylinder and is sent to MCU which will be displayed on LCD. There are two threshold values, in which load cell output reaches the threshold value1 a message is to user as "LPG level is low" and to distributor as "book a new cylinder" along with user name and id and same message is displayed on LCD. When output of load cell equal to threshold value2 one more message is sent distributor about delivering of cylinder and user to change the cylinder and same message is displayed on LCD. The work flow is as shown in the figure5.

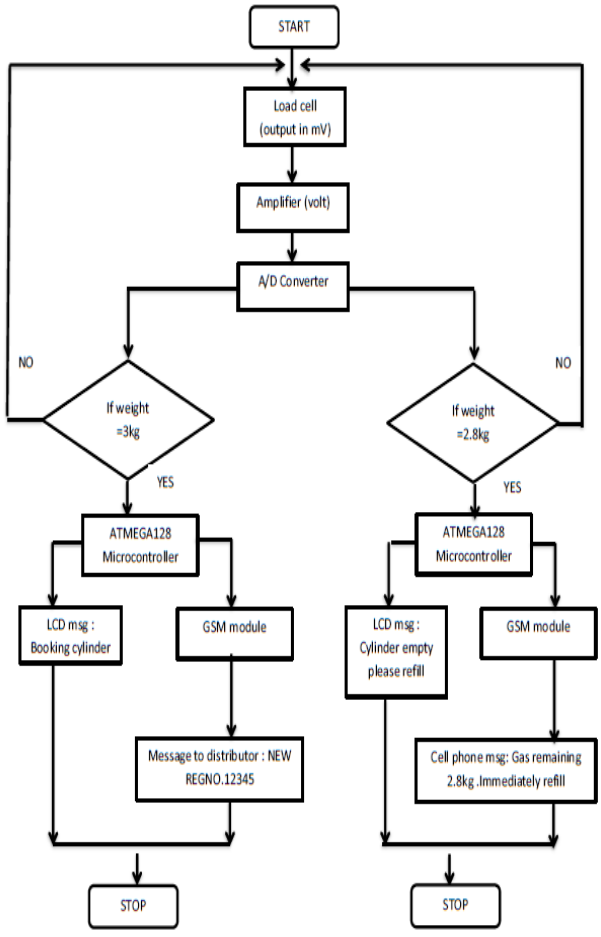

Figure 5. Flow chart of monitoring & automatic booking system

IV. IMPLEMENTATION AND WORKING

Atmega128 is the base of the system. The inputs given to the Atmega128 are the output of gas sensor MQ-6 and load cell.The output of Atmega128 are given to the SIMCOM 300 and LCD 16×2 display. The gas outputs of MQ6 is given to the port F of Atmega128 as far as the highest priority is given to the leakage detection. The output

of load cell is amplified and digitized and digital output is given to port A of Atmega128. Port C is used as data port to LCD and port G is use as control line for LCD.

Atmega128 has two Tx and Rx. Here we use Tx1 and Rx1 for communication of GSM with microcontroller.

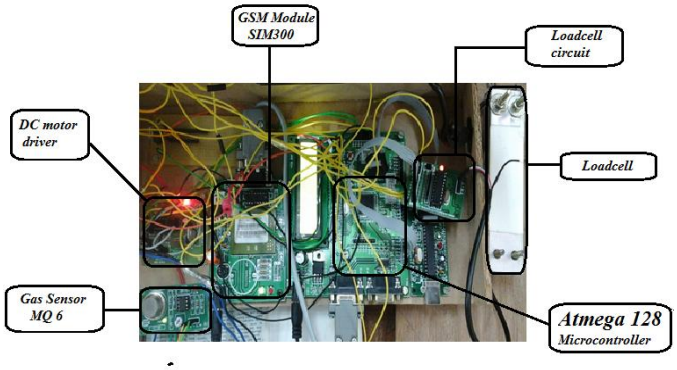

Figure 6. Hardware setup of system.

The output of the MQ6 drives the relay circuitry which eventually switches on the alarm and exhaust fan as soon as the gas is detected.

V. RESULT

The system prototype is designed, when a small amount of LPG is brought near the sensor (MQ-6), detects the leakage and sends the SMS to housemates and activates the alarm and switches on the exhaust fan. Also system prototype continuously monitors the LPG level of the cylinder and books the cylinder automatically when the gas level equal to pre fixed threshold values. A rack and pin arrangement will move along the pipeline when system gets reset. The gas sensor detects the gas around 10 cm radius and output of sensor is as shown in table below.

Condition	Output Voltage (Volts)
Without leakage	0.93
With leakage	4.94

Table 1. Gas Sensor Output

CONCLUSION

Overall system is to be designed and tested by introducing the small amount of LPG gas near gas sensor module. The system detect the level of gas in the air if it exceeds the safety level then send a SMS to the consumer using GSM modem and activate the audio-visual alarm which includes LED, Buzzer to alert the user at home in abnormal condition and to take the necessary action and display the message on LCD display .

The real-time control of home is affordable at low cost and achievable by the use of pervasive sensors and actuators. The automatic working makes the total system much simpler and easily controllable. The wireless modules will be helpful in monitoring any of the devices remotely even over long distances.

Along with gas leakage detection, this system gives a fully automated approach towards the gas booking. Real time weight measurement of the gas and its display on LCD makes it an efficient home security system and also can be used in industries and other places to detect gas leaks. The cost involved in developing the system is significantly low and is much less than the cost of gas detectors commercially available in the market.

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