ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

A Wireless Gas Leakage & Level Detection with Auto Renewal System

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ABSTRACT: A wireless safety device for gas leakage detection is proposed. The device is intended for use in household safety where appliances and heaters that use natural gas and liquid petroleum gas (LPG) may be a source of risk. The system also can be used for other applications in the industry or plants that depend on LPG and natural gas in their operations. The proposed wireless home gas leakage system consists of three major modules: the gas leakage and level detection and transmission module (GSM/GPRS MODEM), and the receiver module (GSM mobile). The gas leakage detection and transmission module detects the change in concentration of LPG and natural gas and activates an audiovisual alarm when it exceeds a certain threshold. Furthermore, it sends another alarm message to the mobile. Continuous monitoring of the level of the LPG is done to detect the weight of the cylinder at the time of dispatch and throughout the usage. Auto renewal system is alerted when the cylinder is going to be emptied and auto booking is done with the gas station also giving the information to the consumer.

KEYWORDS: Gas Leakage, level detection, Gas sensor, Embedded system, ARM Controller.

I. INTRODUCTION

Household safety is becoming an issue due to the increase use of LPG and natural gas for heating and home appliances. Petroleum gases (LPG) and natural gas (consists mainly of methane) are used to meet the increasing demand for energy and to replace oil or coal due to their environmental disadvantages.

LPG and natural gas burn cleanly and are less harmful to the environment. They have been widely used in industry, heating, home appliances, and motor fuel .Although LPG and natural gas are environmental friendly, they can pose a serious threat if they leak. They are normally stored in pressurized steel cylinders in liquid form and vaporize at normal temperatures. LPG is heavier than air, therefore it flows along the floor and settle in low points which makes it difficult to disperse. If leak happens, LPG and natural gas boil into air and replace oxygen which can cause suffocation. Moreover, ignition may happen and cause an explosion. Therefore, the detection of gases has gain more interest in recent years especially in fields of safety, industry, environment, and emission control. In developing countries besides the huge use of LPG in household activities, 50% is used in industries and vehicles also use LPG. As a result, accidents from gas leakage increase each and every day. So gas leakage and level detection is at most needed and auto renewal system reduces the burden of user's manual effort.

The remainder of this paper is organized as follows: Section II introduces the proposed gas safety system and section III Components design. Section IV discusses the proposed Auto renewal system and in Section V the Communication module and summary of the paper is presented in section VI respectively.

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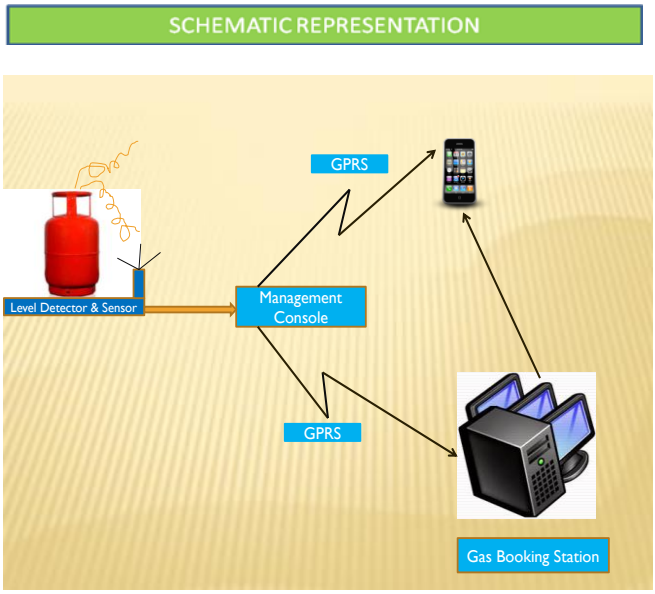
II. PROPOSED GAS SAFETY SYSTEM

A wireless safety device for gas leakage detection is proposed. The device is intended for use in household safety where appliances and heaters that use natural gas and liquid petroleum gas (LPG) may be a source of risk.[1] The system also can be used for other applications in the industry or plants that depend on LPG and natural gas in their operations. The proposed wireless home gas leakage system consists of three major modules: the gas leakage detection and transmission module(GSM/GPRS MODEM), and the receiver module(GSM mobile).[2] The gas leakage detection and transmission module detects the change in concentration of LPG and natural gas and activates an audiovisual alarm when it exceeds a certain threshold. Furthermore, it sends another alarm message to the mobile through serial communication using GPS/GPRS technologies .[3]

Also continuous monitoring of the level of the LPG to detect the weight of the cylinder at the time of dispatch and throughout the usage is performed.[4] Auto renewal system is alerted when the cylinder is going to be emptied and auto booking is done with the gas station also giving the information to the consumer. The schematic diagram of the proposed system is shown below.[5]



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III. COMPONENT DESIGN

The proposed wireless home gas leakage system consists of three major modules: the gas leakage detection and transmission module(GSM/GPRS MODEM), and the receiver module(GSM mobile).[6] The detection and transmitting module detects the changes in the gas concentration using a special sensing circuit built for this purpose. This module checks if a change in concentration of gas has exceeded a certain pre-determined threshold. If the sensor detects a change in gas concentration, it activates and audiovisual alarm and sends a signal to the receiver module.[7] The receiver module acts as a mobile alarm device to allow the mobility within the house premises. The receiver module is a mobile unit that could be placed anywhere within the premises of the house so that the alarm can be detected and heard at a distance from the place of gas leakage. [8]The system was tested using LPG and the alarm was activated as a result of change in concentration. The block diagram of the gas leak and level detection system is shown below.

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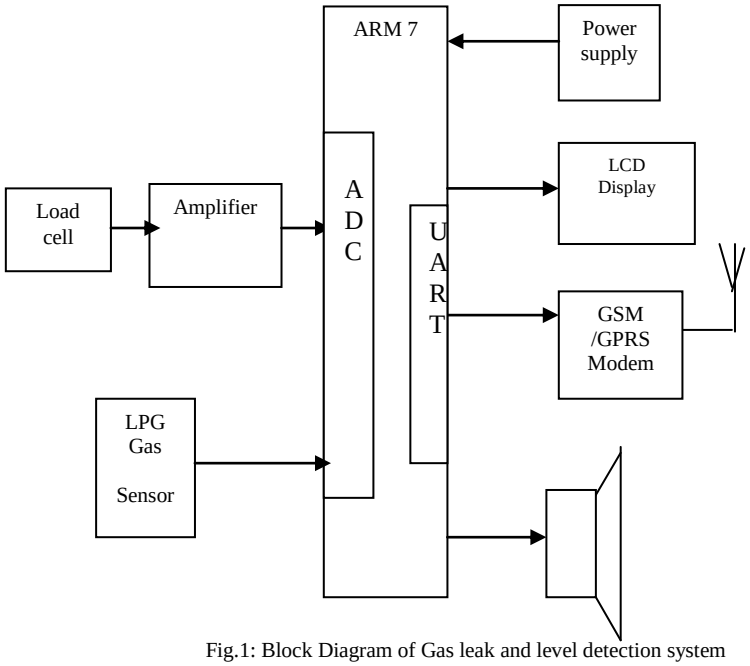

Fig.1: Block Diagram of Gas leak and level detection system

A. Gas leakage and Level detection module

The main functions of this module are to detect changes in gas concentration, activate an audiovisual alarm, and transmit a signal to the receiver unit. It consists of a gas detection sensor, a sensing circuit, a microcontroller, and an GSM/GPRS Modem.[9] The gas detection is done using a solid state gas sensor (Model:MQ-5,) that is sensitive to LPG, natural gas (or methane) and other gases such as CO and H2 but not sensitive to air; therefore the reading is not affected by the presence of air.[10] The sensing part is made from Tin Dioxide (SnO2) layer, which is a resistive element with a resistance (*Rs*) that changes with the change of concentration of gases like LPG,CH4, CO, and alcohol . The sensor can detect small concentrations of the above mentioned gases as small as 0.1 mg/L [11], which makes it suitable for gas leak detection.

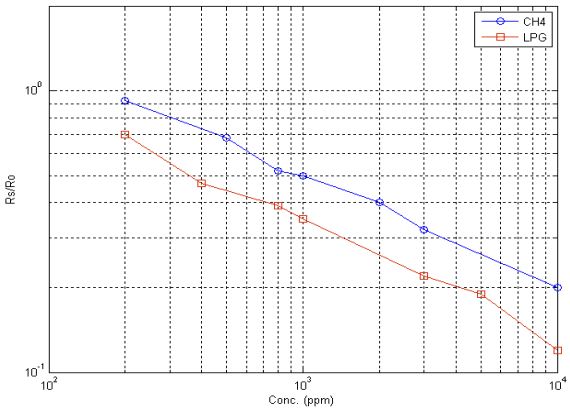

Figure 2 shows the sensitivity characteristics of the MQ-5 sensor normalized to the sensor resistance *Ro* at 1000 ppm of H2 in air. The driving circuit of the gas sensor requires a DC power supply of 5 Volts and a load R_l
The output voltage *Vo* from the sensing circuit is given by:

$$V_o = (R_L/(R_s+R_L))*V_C$$

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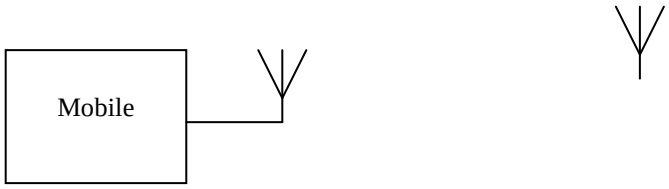
and is fed into a ARM processor where it is digitized using an 8-bit analogue to digital converter (ADC). The microcontroller reads the voltage from the sensor and uses it to calculate change in concentration. Under normal conditions, the microcontroller starts with a calibration stage where it reads the sensor voltage under normal conditions and considers it as the zero value.[12] Also, the calibration of the system can be done by pressing a 'calibrate' button. The microcontroller continuously reads the voltage from the sensor and compares the reading with the calibration value. It displays the change of sensor voltage (_V) relative to the threshold (the maximum allowed change _Vth). If the reading of the sensor voltage exceeds the threshold, the microcontroller activates an audiovisual alarm and sends a message to the receiver module indicating that there is change in gas concentration. This is done by the ARM processor by sending out a UART encoded packet through I/O port.The load sensor is used for continuous monitoring of the level of the LPG to detect the weight of the cylinder at the time of dispatch and throughout the usage .when the cylinder is emptied the information is displayed in the LCD display and also in the mobile.[13]

B. Receiver module

The receiver module is a mobile unit that receives state events from the gas detection and sends it to the ARM Processor.[14] The receiver module is a mobile unit that could be placed in within the premises of the house so that the alarm can be detected and heard at a distance from the place of gas leakage The ARM Processor reads the data, decodes it, and displays it onto the output devices (buzzer, and LCD display) and If the controller predicted that the load cell value is more than the critical limit then the information is sent to the presorted number in the processor through SMS to Home user using GSM technology.[15]

U User mobile:



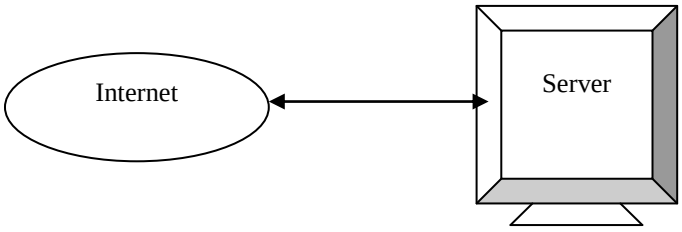
C. ARM Processor

The ARM processor reads the sensor voltage continuously using the 8-bit ADC. If there is a normal gas concentration detected, the ARM Processor displays a message onto the LCD display indicating normal conditions.[16] The message also contains the percentage. In this way the change of concentration can be tracked even if it was below the threshold level for the alarm. In case of an elevated gas concentration levels, the LCD displays a dangerous gas levels message and a buzzer goes on. The microcontroller sends a message to the receiver mobile module to activate the alarms and also SMS is sent to the user.[17]

D . Auto Renewal System

This section describes the structure and functions of the new proposed Auto renewal system which provides the basic platform to simulate

Gas Booking Office



The currently proposed system uses wireless technologies like GSM/GPRS for transferring information[18].

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The auto renewal system is used to automatically book the gas cylinder when the information from the load cell that the cylinder is empty is received. This reduces the manual effort of the consumer to call and book the cylinders and also saves time and energy and thus reduces the delivery time of the cylinders.

IV.COMMUNICATION MODULE

Low-cost and effective communications with sufficient bandwidth is necessary to pass information between vehicles and the controllers in order to perform effective process. Various communication protocols achieve reliable, two-way communication networks such as ZigBee, Bluetooth, but sending information through mobile phone or GSM/GPRS modem is used .This is used to send SMS messages to the authorized user

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up-modem; it sends and receives data through radio waves. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier to operate. A GSM modem can be an external device or a PC Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable.

V. CONCLUSION

This paper presents a prototype for wireless gas leakage and level detection systems that can be used mainly in household safety and many other applications in the industry and environment. For example it can be used in facilities where gas cylinders are stored. Any leakage can be recognized through the detection module and intimated to the user immediately through the SMS. The use of a sensor that is sensitive to small changes of concentration provides an excellent tool to detect a gas leak as it can detect small concentrations down to 100 ppm. The sensor used in the system may be affected by the surrounding temperature and humidity, therefore calibrating the system must be done to avoid any false alarms. The algorithm used in the microcontroller system depends on detecting the change of gas concentration levels and therefore the output voltage of the sensor. This gives the system the advantage of detecting leaks of the gases that the sensor detects.The level detection of the cylinders helps the user in identifying the status of the usage of cylinders and the auto renewal system helps in saving time and effort of the user.

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ISSN (Print) : 2320 – 3765
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