# GAS LEAKAGE DETECTION SYSTEM (GLDS)

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## ABSTRACT

*This paper mainly focuses on the detection of gas leakage and providing security when the user is around or away from home. The system is Short Message Service (SMS) based and uses wireless technology for providing security against gas leakage to users hence cost effective and more adaptable. The system comprises of sensors for detecting gas leak interfaced to microcontroller that will give an alert to user whenever there is a gas leakage, display warning information by using Liquid Crystal Display (LCD), sending SMS to the user for notification wherever he/she might be and turning off electric power with the help of magnetic relay. This will enable the user to take precaution of explosion disaster which may result on Liquefied Petroleum Gas (LPG) cookers like loss of properties, injury or even death. GLDS provides ideal solution to gas leakage problems faced by home owners in daily life.*

*Keywords— SMS, LCD, LPG, Global System for Mobile (GSM) communication*

## INTRODUCTION

The aim of the paper is to design a cost effective solution that will provide detection of some gases which are highly combustible specifically LPG cookers and alert the user using audible alarm, display hazard information on the LCD, switch off the electric power and send SMS to the user wherever he/she might be.

The motivation is to facilitate users who are using gas as their energy to secure their homes. Gas leakage detection helps users to benefit economically by not loosing leaking gas of which is expensive product. On the other hand, gas leakage is an environmental pollution which irritates in the nose once inhaled and is harmful to human and animal health.

Home safety has been a major issue where fire outbreaks as a result of gas explosion has been increasing every day and everybody want to take proper measures to prevent these accidents. In addition, there was a need to design this system in order to provide assurance to the user in remote place that everything is ok at home. Therefore, this paper proposes a system that detects a gas leakage and provides necessary safety measures to stop any possible fire outbreak accident and also notifies the owner through SMS using GSM technology.

## RELATED WORK

Schweighardt and Zatko (2007) considered a system for detecting gas leaking out of joint in a gas transport and/or storage system. The system makes use of plurality of sensors located at positions e.g. stationary or fixed, as close as possible to potential leak site(s) to provide signals indicative of a leak to data acquisition unit which can then determine

the dominant leak direction, where upon corrective action can be taken e.g. tightening the bolt(s) closest to a leak. Moreover, the system enables one to monitor or track changes in the leakage rate.

Komiyama *et al.*(2003) presented a gas leakage detection system detecting leakage of plurality of kinds of gases by analysing components of a sampled gas and means for determining that at least one kind of specific gases when is included in the sampled gas is equal to one or more than predetermined quantity as a result of analysis. By analysing means, a gas leakage detection method of monitoring an operating state by eliminating a harmful substance included in a plurality of gases that leak and a semiconductor apparatus having a gas detection system that detects a leakage of plurality of kinds of gases.

In their paper, Saidi *et al.* (2008) proposed a method of detecting concentration of predetermined gas, a gas sensor comprising a gas detector, a processor to determine a rate of change of the concentration over a time interval and a communication device to communicate to at least one of a second gas detector and a server.

Yoshida (2009) explores fuel battery system comprising of a fuel battery to which a reactive gas is supplied to generate power, a pipe which communicates with fuel battery and a method of detecting a gas leakage in the fuel battery system. The major task was to improve performance.

In their paper Yokosawa *et al.* (2008) suggested leakage detection system configured by a number of gas sensors; leakage spot is promptly and accurately estimated. An output voltage of each sensor is converted into concentration and a time differential output of concentration

is obtained. A leakage spot is estimated to be on a straight line connecting between the sensors for which the time differential coefficient is large.

Farnsworth (2010) explored passive leak detection device including a pressure switch, a check valve and a balance valve. When the balance valve is closed and fluid is flowing out of a fluid port, the pressure differential from the inlet chamber is operable to couple the electric output lead to the electric input lead thereby indicating a leak.

Grimberg (2010) proposed an imaging system and method for detecting a substance that has a detectable signature in a known spectral band. The system comprises a thermal imaging sensor and optics and two interchangeable band-pass filters located between the optics and the detector. A first filter transmits electromagnetic radiation in a first spectral band that includes the known spectral band and blocks electromagnetic radiation for other spectral bands. A second filter transmits only electromagnetic radiation in a second spectral band in which the substance has no detectable signature. The system also includes a processor for processing the images to obtain reconstructed fused image involving using one or more forms of transforms aiming at obtaining similarity between one or more images acquired with the first filter and one or more images acquired with the second filter before reconstructing the fused image.

Chudnovsky (2000) suggested a method and apparatus for remote detection of gas leak and determination of the relative concentration of a gas using non dispersive infrared absorption of backscattered laser light with background compensation. The method includes source of coherent infrared radiation, measuring output signals. The apparatus

includes video camera to record a visual image of an object at a point where a maximum relative concentration was recorded and laser pointer to indicate a position of invisible infrared beam on target.

Nawa *et al*. (2004) presented a gas leakage detection system that includes a flow path, a dual mode valve disposed in the flow path, an ultrasonic measuring section including a pair of ultrasonic transducers, disposed in the flow path upstream from the dual mode valve, a flow rate calculation section for computing with flow rate based on the signal from the ultrasonic measuring section and a control section for controlling a dual mode valve. The control section closes or opens the valve instantaneously, and the flow rate calculation computes a flow rate when the dual mode valve is closed. Thus gas leakage can be detected substantially without stopping a gas flow when a user is using the gas.

Komiyama *et al*. (2005) consider components of sampled gases are analyzed by Fourier transform infrared spectrophotometer. It is determined whether or not the analyzed gases include at least one kind of specific gas equal to or more than a predetermined quantity, a controller supplies an operation display monitor with a signal indicating leakage of the kind of specific gases. Hence it is possible to realize detection by kind of gases with high accuracy irrespective of the kind of leaked gas.

## PRELIMINARIES

### *Gas Leakage Detection System (GLDS)*

Gas leakage detection system incorporates a LPG sensor for use to detect the presence of dangerous LPG leak in your car or in service station, storage tank environment or at home. This unit can be easily incorporated into an alarm unit, to sound an alarm or give a visual indication on the LPG concentration on the LCD screen. The sensor has excellent sensitivity combined with a quick response time. The sensor can also sense iso-butane, propane, Liquefied Natural Gas (LNG) and cigarette smoke. Furthermore, the microcontroller will send SMS to the mobile phone number of the user indicating a gas leakage. The SMS will prompt the user to take action before things get worse by escaping any possible accident especially when a user is at remote place. The system will count some few seconds checking a gas leakage, if gas leakage persists it will shut down the power by the changeover switch interfaced through a magnetic relay as shown in figue1.

An analog to digital (A/D) converter read an analog voltage signal from the LPG sensor and converts it into a digital equivalent number that can be read by a microcontroller. It has one input voltage and 8 bits as output. A/D converter is embedded in most microcontrollers only pin definitions have to set input as analog or digital.

Smith (2006) explains microcontroller is essentially an inexpensive single chip computer. Single chip means the entire computer system lies within the confinement of sliver of silicon encapsulated inside the plastic housing of an integrated circuit. The microcontroller has features similar to those of a standard personal computer. The microcontroller contains a Central Processing Unit (CPU), Random Access Memory (RAM), Read Only Memory (ROM), Input/Output (I/O) lines, serial and parallel ports, timers and sometimes other built-in peripherals such as Analog to Digital (A/D)converters and Digital to Analog (D/A) converters.
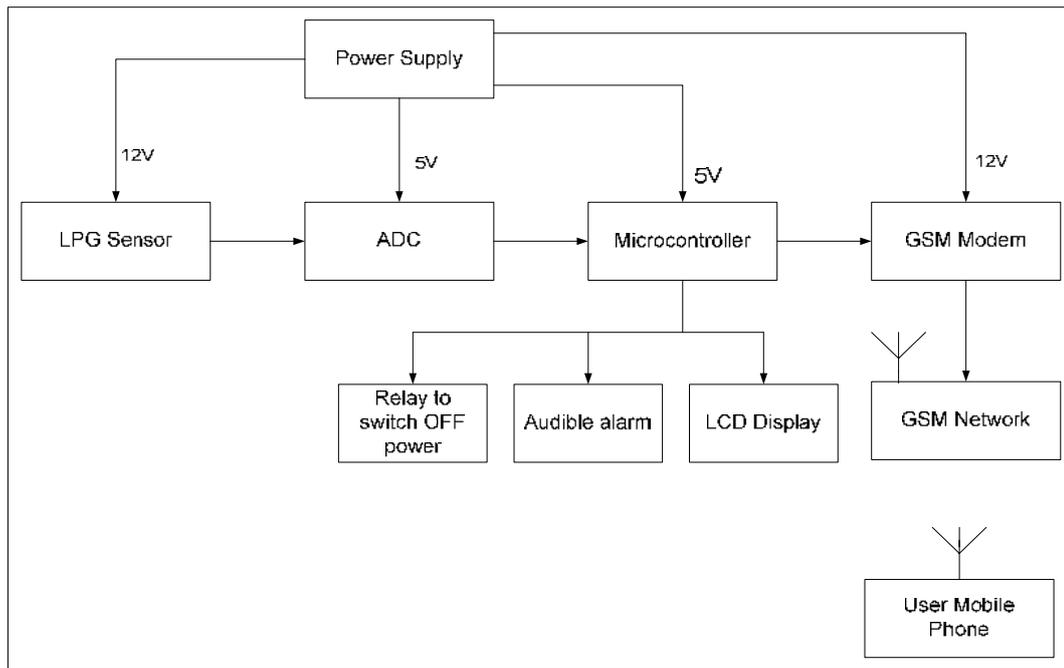
**Figure 1:** Block Diagram of the Gas Leakage Detection System

### Connection of GSM module and microcontroller

GLDS system is based on GSM network technology for transmission of SMS from the microcontroller once the gas leak is detected, through the level changer MAX232 to a modem. In order to enable users to find out about on-the-spot gas leakage situation at home, we can utilize GSM module as shown in Fig. 2. Nokia 3310 GSM module 900/1800MHZ high integration frequency was chosen and interfaced with microcontroller's Transmit (Tx) and Receive (Rx) ports. By microcontroller PIC16F877A serial communication interface standard asynchronous communication way, we change the interface into standard RS-232 through the interface chip MAX232, then connecting the module on RS-232 interface directly, and carry on the conveyance of data. It is programmed to send messages with Attention (AT) command language. The message to be sent can be "WARNING: DANGEROUS GAS LEAKAGE AT HOME IN KITCHEN". Then the user upon reception of the SMS will take an appropriate action.

Programmable Interface Controllers (PIC) was developed by Microchip Technology. It has many electronic circuits built into it, which can decode written instruction and convert them to electrical signal. The microcontroller will then step through these instructions and execute them one by one. The input components consist of push buttons and LPG sensor. The control unit is the microcontroller PIC16F877A. The microcontroller monitors the inputs and as a result the program would turn output ON and OFF depending on the state of the sensor. The microcontroller stores the program in its memory, and executes the instructions under the control of clock circuit. The output devices are made up from Light Emitting Diodes (LED), buzzers, magnetic relay, LCD, audible alarm and GSM interface for triggering SMS in case gas leakage is detected.
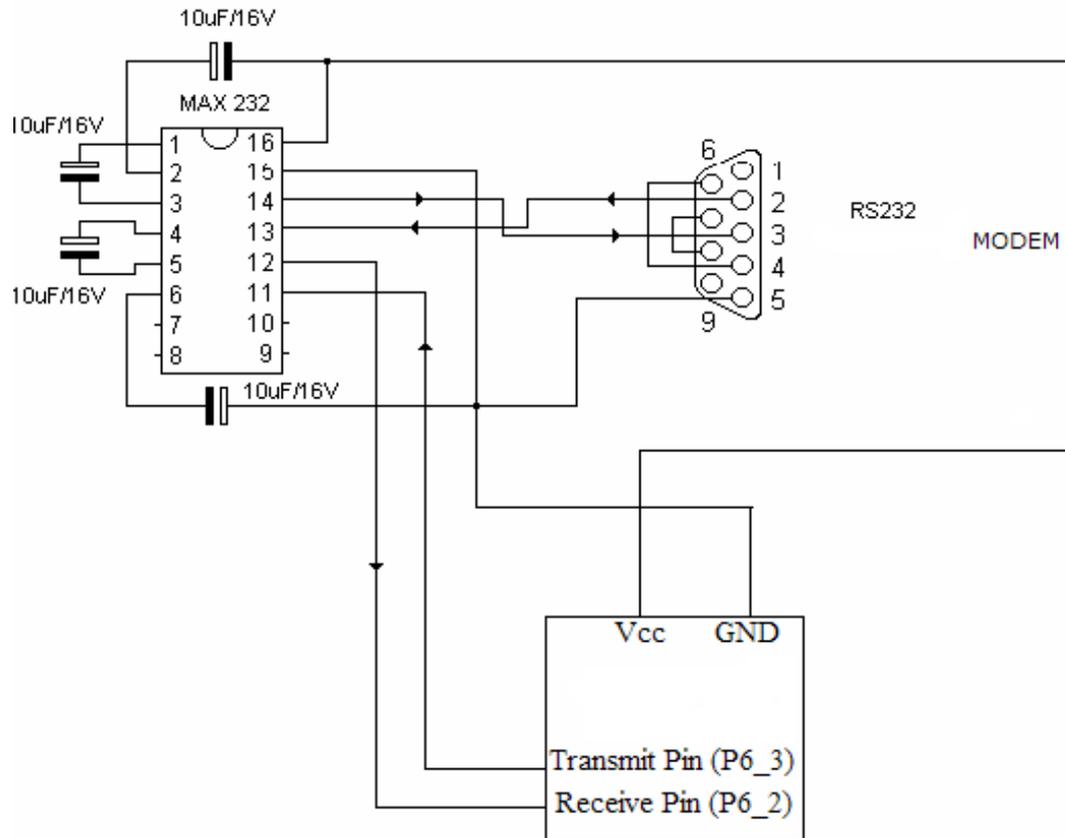
**Figure 2:** Circuit diagram for connecting the microcontroller to the modem.

### The operating principle

The operating principle of GLDS, as shown in Figure 3 is given as follows:

- GSM hardware tests are run in order to check the hardware support. The system will send SMS to the mobile phone of the user. The microcontroller serial ports are interfaced with the level shifter MAX232, the output which is connected to the GSM modem.
- After activation, the modem will check the hardware support. In case the hardware is missing or hardware malfunction, error will occur, resulting in a communication failure and the application will be terminated.

- If the hardware responds then the serial ports will be opened for communication and the GSM hardware will allow transmission of SMS.

### Characteristics of GLDS

The system will be able to detect gas leakage, ring audible alarm, display warning information about gas leakage on LCD and send SMS to the user. The proposed system characteristics involve detection of gas leakage. The system has useful features such as displaying a warning message on the LCD screen, ringing audible alarm and sending SMS to the user in case gas leak is detected.
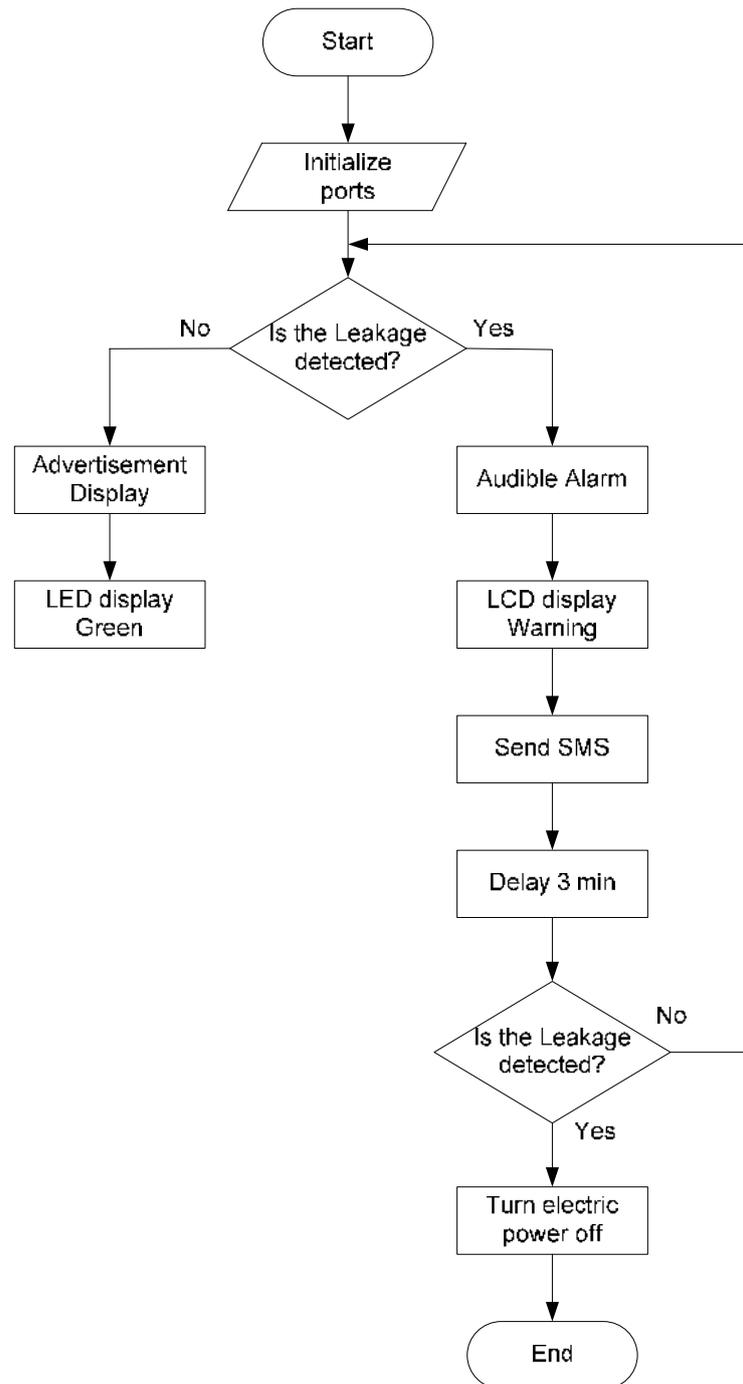
**Figure 3:** Algorithm for PIC

### Strengths of GLDS

GLDS has many advantages such as availability and user friendly, awareness of gas wastage and thus reduce running cost and run business profitably. The user can get alerts anywhere through GSM technology thus making system location independent to take precaution of fire hazard that may happen. The system contains low cost components easily available that cuts down the overall system cost. The system switches-off electric supply in case the user is late thus performing self protective action if no one is around the area and user's number is out of coverage. The LCD screen will be useful for displaying advertisement in case no gas leak is detected thus increasing usability.

### Constraints of GLDS

The system functionality is based on GSM technology so the technological constraints must be kept in mind. The chip in the modem needs to be recharged airtime. The system is designed to be used by home users and industries.

### RESULTS

Fig.4 shows hardware tests that will be run to check the hardware functionality. For simulation purposes we have used switch that acts as a LPG sensor. When a gas leakage is detected from the LPG sensor, the sensor gives the output voltage signal to the input pin of the microcontroller. The system then gives the audible warning using an alarm bell, writes warning message to the LCD, and opens the serial port for communication with GSM modem. On successive port opening, the system communicates with the GSM modem but if fails the system does not communicate. The system delays for some time (1000 milliseconds), if the gas leakage persists it activates the relay disconnecting electric power supply of the house.

### Achieved analytical results:

- The system displayed advertisement when no gas leakage was detected. No message was sent to the user, indicating home status is safe.
- When gas leakage was detected, the system sounded the alarm, sent a warning SMS to the user about gas leakage and displayed warning message to the LCD.
- After some delay, when leakage persisted, the system shut down the electric power.
- After reset, the system returns to its normal operation.

### CONCLUSIONS

In this work, a gas leakage detection system using PIC microcontroller and GSM technology is introduced. It realizes the remote wireless monitoring of the gas leakage at home by sending an early warning text message to the owners mobile phone number, displaying a warning message on the LCD screen and ringing audible alarm notification when gas leak is detected. The system contains low cost components easily available that cuts down the overall system cost. The system is extensible and more levels can be developed using more advanced sensors, processors and other hardware devices.
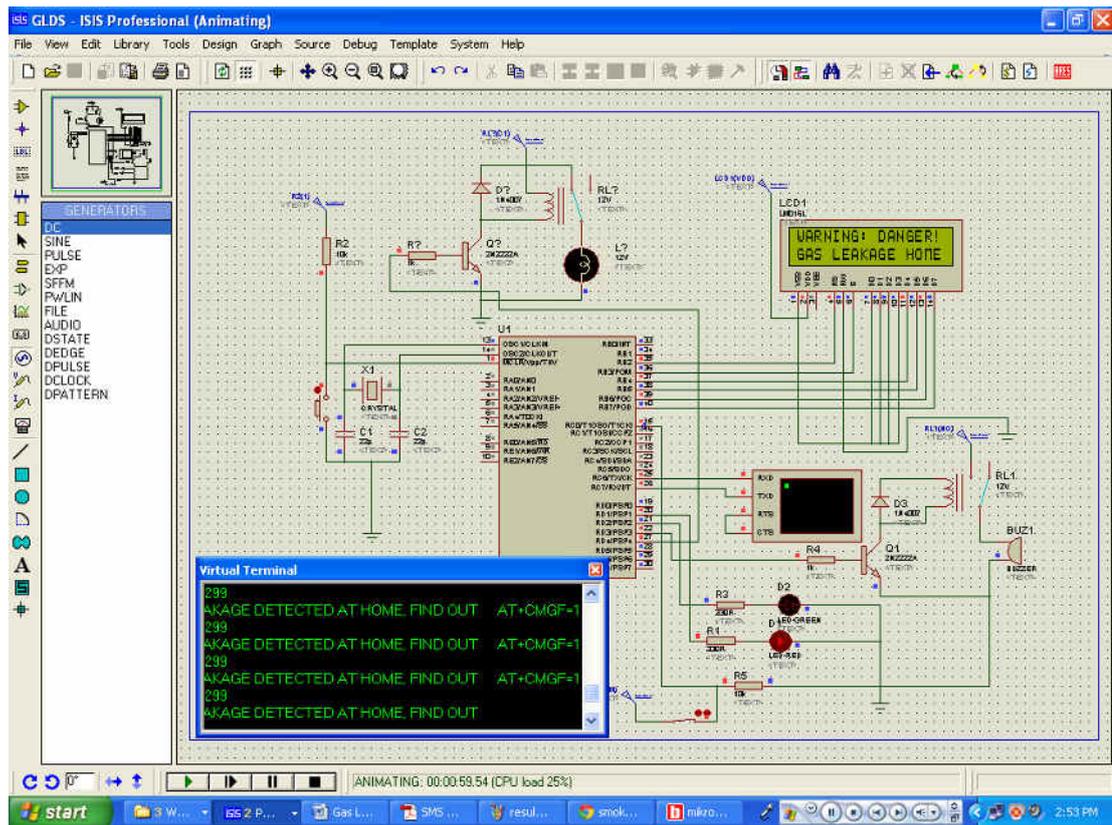
**Figure 4:** Hardware Simulation

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