ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 9 , September 2021

# Automatic Gas Leakage Detection and Control System against Kitchen Accidents

**IWAYEMI Ayodeji , OLOKUN Mayowa S , AYODELE Kehinde D.**

Department of Computer Engineering, Federal Polytechnic, Ile-Oluji, Nigeria

**ABSTRACT:** Most fire accidents that took place in homes emanated from the kitchen as a result of unnoticed and uncontrolled cooking gas leakage that possibly started as a little thing but increased with time. This paper focuses on the detection of gas leakage and provision of proactive measures to prevent destructive consequences of gas accidents in kitchen. The system comprises of sensor for detecting gas leak (MQ6 gas sensor) interfaced to Arduino UNO microcontroller which acts upon the sensing of gas. The buzzer blows alarm and warning message is displayed through Liquid Crystal Display (LCD)while the SIM900D Global System for Mobile communication (GSM) module was configured to route alert message to the user simultaneously notifying about the gas leakage and activity taken. As a control mechanism, message is passed to the servo motor to trigger open the automated vent thereby allowing air to help neutralize the diffused gas. The user can then navigate to the kitchen to ensure precaution of explosion and disaster which often lead toe loss of properties, injury or even death. This cost effective measure helps in reduction of gas accidents in kitchen.

**KEYWORDS**: SMS, LCD, LPG, Sensor, Global System for Mobile communication (GSM)

## I. INTRODUCTION

The Liquefied Petroleum Gas (LPG), or propane, is a flammable mixture of hydrocarbon gases used as fuel in many applications like homes, hostels, industries, automobiles, and vehicles because of its desirable properties which include high calorific value, less smoke, less soot, and meager harm to the environment. Liquid petroleum gas (LPG) is highly inflammable and can burn even at some distance from the source of leakage. This energy source is primarily composed of propane and butane which are highly flammable chemical compounds. These gases can catch fire easily. In homes, LPG is used mainly for cooking purposes. When a leak occurs, the leaked gases may lead to an explosion. Gas leakage leads to various accidents resulting in both material loss and human injuries. Gas leakage is an environmental pollution which irritates in the nose once inhaled and is harmful to human and animal health. Home fires have been occurring frequently and the threat to human lives and properties has been growing in recent years. The risks of explosion, fire, suffocation are based on their physical properties such toxicity, flammability, etc. The number of deaths due to the explosion of gas cylinders has been increasing in recent years.

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.

The aim of the paper is to design a cost effective solution that helps provide detection of Liquefied Petroleum Gas (LPG) cookers and alert the user using audible alarm, display hazard information on the LCD, open the automated vent and send SMS to the user about the situation. This development helps gas users secure their lives and properties when they are home and away.

## II. LITERATURE REVIEW

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.

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

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

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.

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.

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.

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.

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.

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.

From related works, several measures have been used to prevent, report or cob gas leakages some of which include the use of detector sensor (Falohun et al, 2016; Katole, 2016; Meenakshi, et al, 2016; Shrivastava et al, 2013), SMS alert system (Folorunso et al, 2019; John et al, 2017; Faisal, 2015), and buzzer alarm system (Manichandanaet al, 2018; Naik et al, 2014).

## III. MATERIALS AND METHODS

A MQ6 semiconductor sensor is used which comprise of SnO2 having lower conductivity in clean air. When the target combustible gas exists, the sensor conductivity increases along with the rising gas concentration. The MQ6 gas sensor has a high sensitivity to Propane, Butane and LPG, and response to Natural gas. The sensor could be used to detect different combustible gasses, especially Methane; it is low cost and is suitable for different applications. The MQ-6 can detect gas concentrations anywhere from 200 to 10,000 ppm. The sensor's output is an analog resistance. Figure 1 shows the block diagram of the automatic kitchen fire accident prevention system.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

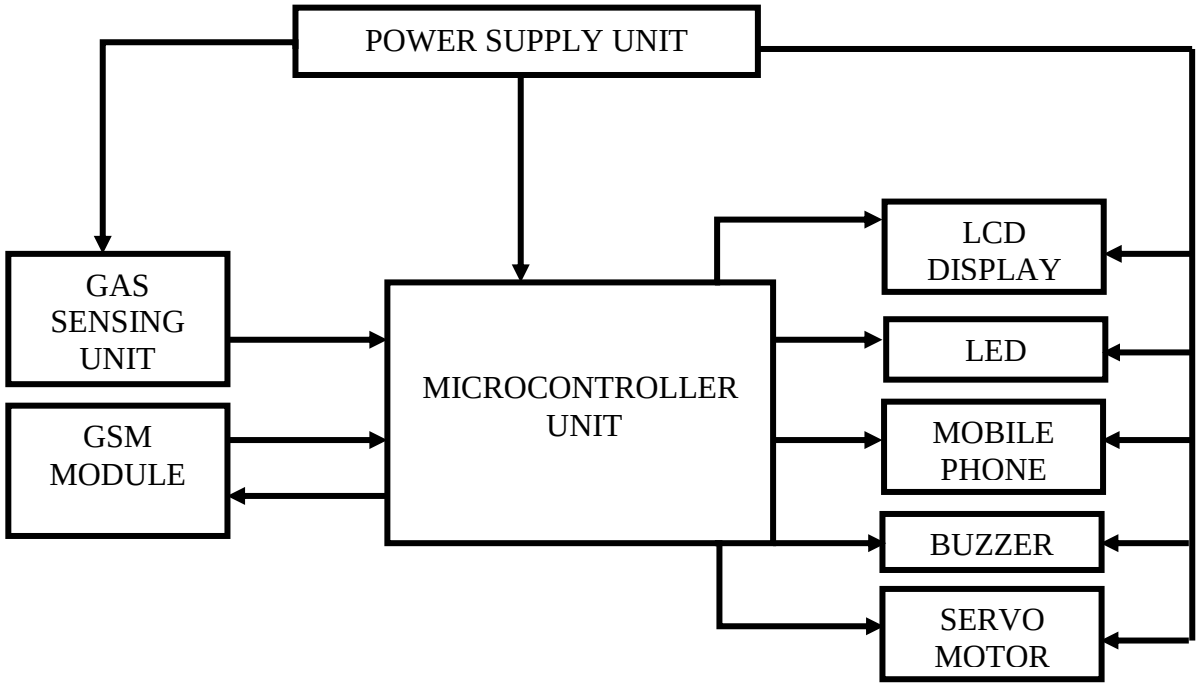



**Figure 1: Block diagram of the automatic kitchen fire accident prevention system**

This system is based on the Arduino UNO R3 interfaced with MQ-6 gas sensor. When the sensor detects gas in the atmosphere, the LCD digital output display GAS DETECTED! OPENING WIDOWS and if gas in not detected the sensor will display standby. Arduino will receive the sensor output as digital input, If the sensor output is high, then the buzzer will start beeping along with the LCD that will show that "Gas detected! Opening Windows". If the sensor output is low then buzzer will not beep, and the LCD will show that "Gas detected: No". The buzzer most commonly consists of a number of switches or sensors connected to control unit that determines which button was pushed or whether a preset time has lapsed, and usually illuminates a light on the appreciate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. The device is portable, light weight, user friendly and efficient with multi-functional features. In Figure 2, some important components that are needed to design the gas leakage detection and alert system are presented.

The SIM 900 is a shield for the Arduino UNO therefore it sits on top of the Arduino Uno and also acts as an extension for it. The Arduino communicates to it using digital pins 0 and 1. This module draws a lot of power which the Arduino can't cater for hence the need for an external power supply. The pins VCC, GND and OUT of the gas sensor are connected to pins 5V, GND and analog pin 0 of the Arduino respectively while the pins VCC, GND, SDA and SCL of the LCD screen are connected to pins 5V, GND, and analog pins 4 and 5 respectively. The pins of the servo are color coded where BROWN is the GROUND, RED is the POSITIVE pin and ORANGE is the PWM pin. These are also connected to the Arduino's GND, 5V and digital pin 10. The LEDs' positive terminals are connected to the Arduino's digital pins 3 and 4 while the positive terminal of the buzzer is connected to Arduino's digital pin 5. The negative pins of these components are connected to ground. It should be noted that the Red LED is connected to pin 3 while the green LED is connected to pin 4.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021


**D . 12C 1602 LCD screen  E. MQ2 Gas Sensor  F. Alarm Buzzer  G. LED**

**Figure 2: Some important components of the gas leakage detection and control system**

## IV. DESIGN PRINCIPLE

The design was done on Proteus software, a proprietary software suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. The MQ-6 gas sensor measures LPG(Liquefied Petroleum Gas) and converts it to analog voltage which the Arduino can read. The Arduino then passes in this value and convert them into PPM (Parts Per Million) which is the unit of measuring gas in the atmosphere. When the level of the gas in the atmosphere exceeds a certain limit, the Arduino sends commands to the GSM module to send a text message to the user while sounding the buzzer and also opening the windows with the help of the servo for the actuation. The Arduino also prints to the LCD screen its current status during operation. When the sensor detects gas in atmosphere, it will give a digital output of 1 but if the gas is not detected the sensor will give a digital output of 0. Arduino will take the sensor output as the digital input. If sensor output is high, then the buzzer will startup and the LCD will show that “GAS DETECTED: OPENING WINDOW”; an SMS will be sent to the user concurrently. If sensor output is low then the buzzer will not beep, LCD will display ready”. The detector incorporates a MQ-6 sensor (with gas detection range of 300–10,000 ppm) as the LPG gas sensor, LCD for displaying gas concentration, a buzzer as an alarm and a number of LEDs to indicate the gas leakage status. The circuit diagram where the various components and connected is shown in Figure 3 while the flowchart of the design is shown in Figure 4.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

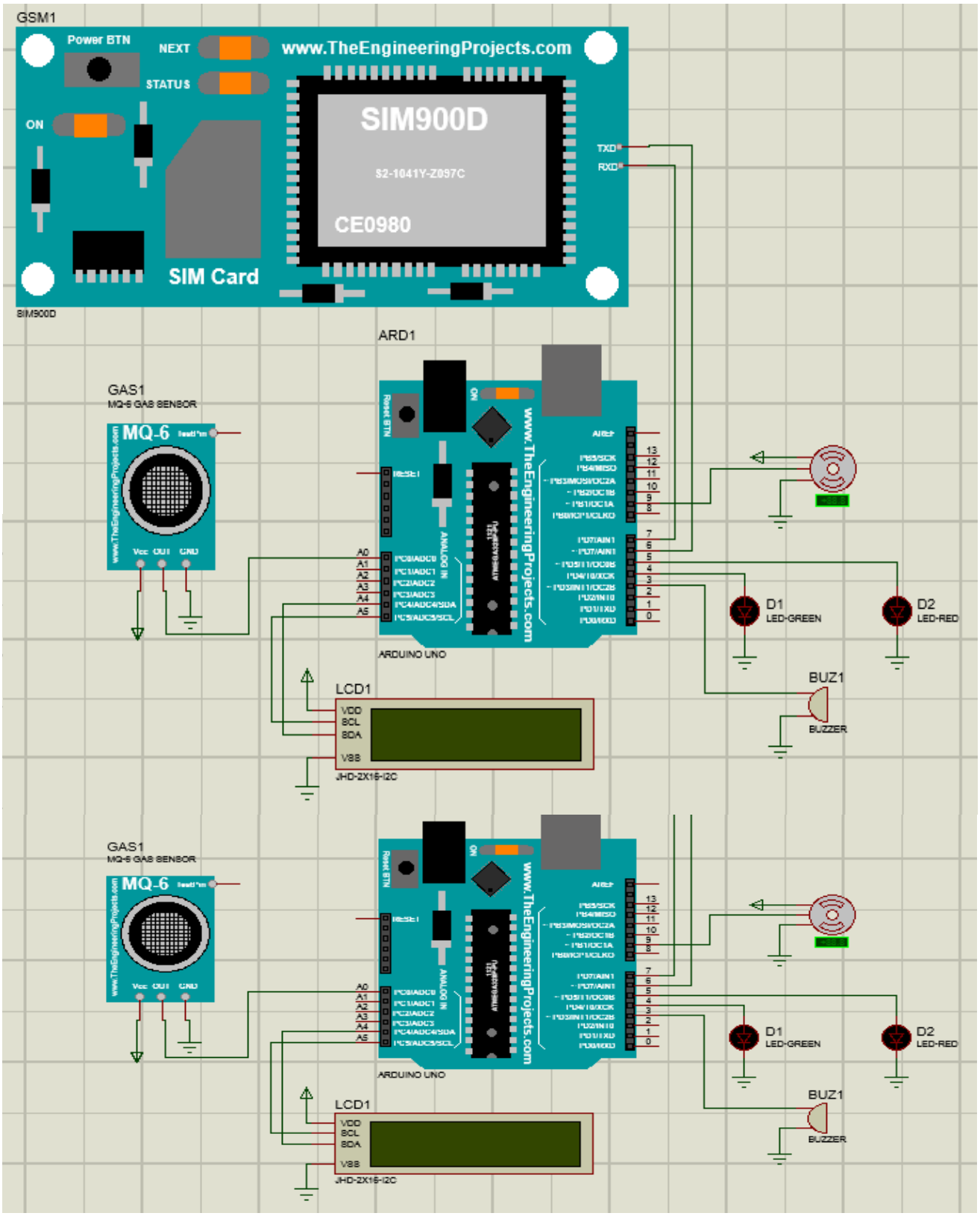
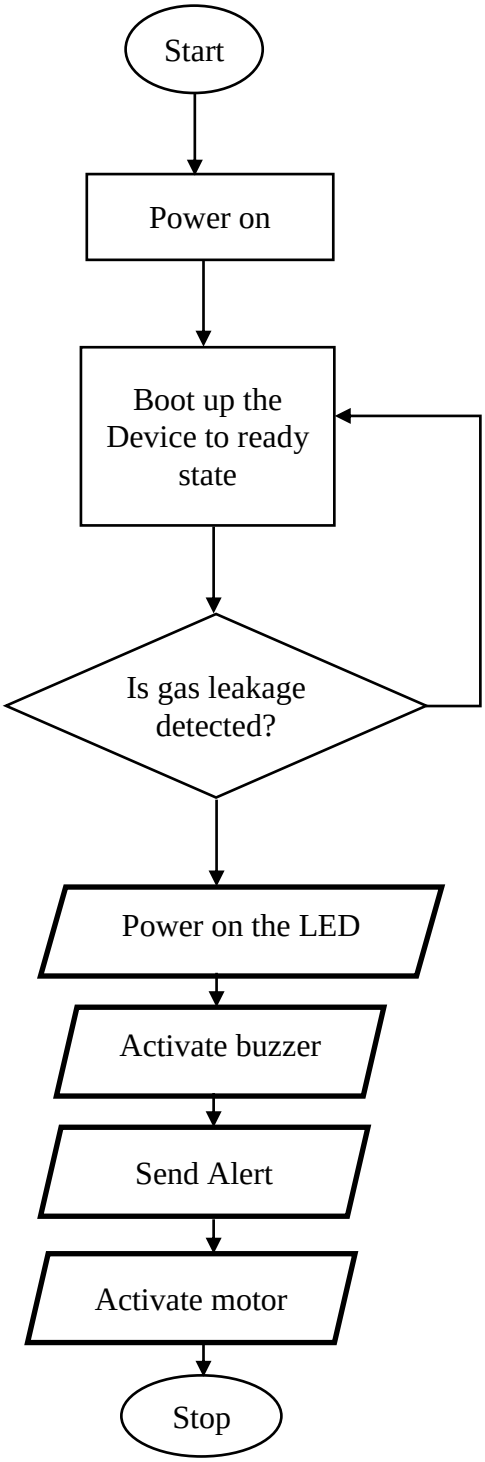



**Figure 3: Circuit diagram of the detection system using Proteus Arduino libraries**

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021



ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

**Figure 4: Flowchart of the Gas dectectinσ system**

## V. RESULTS

The system was turned on and tested appropriately. All connected devices were detected by the operating system. The system detects modules and detect network. The system boots up for 30 seconds and gives sign that the system is ready to be used by turning on the green LED and the Buzzer make a ready sound. When gas leaked, the microcontroller sensed the presence of a gas when the voltages signal from the MQ-6 sensor went beyond a certain level and gave an audiovisual alarm. The MQ2 sensor sensed the gas in the atmosphere. If LPG is sensed, it displays Gas leakage detected as indicated in Figure 5; sends message to the registered mobile number as shown in Figure 6; the Buzzer is activated to give beep sound; and the window of the built prototype is opened as shown in Figure 7.


**Figure 5: interface showing Gas leakage detected opening window**


**i**

**Figure 6: Gas leakage SMS alert**

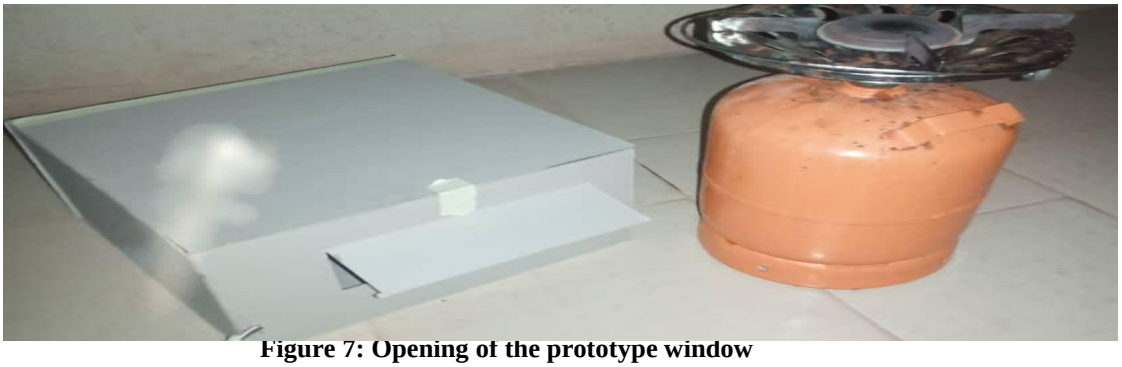


**Figure 7: Opening of the prototype window**

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 9 , September 2021

## VI. DISCUSSIONS

If the system detects the level of gas in the air that exceeds the safety level it will activate the alarm which includes the buzzer to alert the users of the abnormal condition and to take any necessary action by opening the automated window and sending SMS alert to the user. Most sign of a leaking gas is the smell of gas in the home. The output result of this paper is that the leakage will be neutralized when the window is open as well is sending Notification SMS to the user. This is an efficient method for automatically detecting and controlling the gas leakage. The idea for gas detection and control can be implemented at a large scale for various industries. This system can be installed in a kitchen, at a hostel cafeteria, and any other areas. This can be helpful in reducing accidents caused by gas leakage in household as well as in any similar commercial set up. This product is affordable and low cost; it will prevent many accidents and save many properties and human lives.

## VII. CONCLUSIONS

The design of Arduino based automatic gas leakage detector with an alert and control system has been proposed and discussed in this paper. This is a low-cost, low power, lightweight, portable, safe, user friendly, efficient, multi featured and simple system device for detecting gas. The implementation will help us save lives and properties and also not contaminate the atmosphere and waste gases which will affect the economy. The proposed system is easily affordable for everyone. In the open literatures it is noticed that much work has not been done for a smart gas detection system. In future, more advanced features will be integrated with this system which will provide users with more safety and relaxation. The proliferation of handheld devices has led to developments in the field of smart gas sensors, which has considerably widened their scope of application. The need for ensuring safety in workplaces is expected to be the key driving force for the market over the coming years.

## REFERENCES

Chudnovsky, B. H. (2000). Leak Detection System. United States Patent Pub. No. 6,157,033.

Farnsworth, J. M. (2010). Passive Leak Detection Devices and systems for Detecting Gas Leaks. United States Patent Pub. No US 2010/0089127 A1.

Folorunso, C., Raheem, W., Akinyemi, L., & Raji, A. (2019). Development of a Liquidified Petroleum Gas Leakage Detector, Level Indicator and Automatic Shutdown System. *Covenant Journal of Engineering Technology (CJET), 3*(2), ISSN: e. 2682-5325.

Grimberg, E. (2010). System and Method for Gas Leakage Detection. United States Patent Pub. No US 2010/0284570 A1.

John, A., Purbia, B., Sharma, A., &Udapurkar, A. (2017). LPG/CNG Gas Leakage Detection System with GSM Module. *International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), 6*(5), DOI10.17148.65103 536.

Komiyama, K., Watanabe, S. and Gotoda, K. (2003). Method and Apparatus for Leak detecting, and Apparatus for Semiconductor Manufacture. United States Patent Pub. No US 2003/0010918.

Komiyama, K., Watanabe, S. and Gotoda, K. (2005). Gas Leakage Detection System, Gas Leakage Detection Method and Semiconductor Manufacturing Apparatus. United States Patent Pub. No US 6,900,439 B2.

Manichandana, K., Umme Ruman, S., Biderkota, H., Anisha, P., Murthy, R., & Kumar, K. (2018). Gas Leakage Detection and Smart Alerting System. *Global Journal of Engineering Scienceand Researches*, ISSN 2348 – 8034.

Naik, N., Reddy, S., Kishore, N., Tharun, K., & Reddy, T. (2016). Arduino Based LPG gas Monitoring & Automatic Cylinder booking with Alert System. *IOSR Journal of Electronicsand Communication Engineering (IOSR-JECE), 11*(4), 06-12, DOI:10.9790/2834 1104010612, e-ISSN: 2278-2834.

Nawa, M., Iwanaga, S. and Nanba, M. (2004). Gas Leak Detection System. United States Patent Pub. No. 6,725,878 B1.

Saidi, A., Chiricescu, Norris, J.M., and Schuette M. A. (2008). Method and System for Gas Leak Detection and Localization. United States Patent Pub. No US 2008/0168826 A1.

Schweighardt, F. K. and Zatko D.A. (2007). Gas Sensor Array System and Method for Detecting Gas Leaks at a Connecting Joint. United States Patent Pub. No US 2007/0056354 A1.

Smith, D. W. (2006). PIC in Practice, a Project-Based Approach, Second Edition, page 312.

Yokosawa, K., Nakano, S. and Saitoh, K. (2008). Leakage Detection System. United States Patent Pub. No US 2008/026275 A1.

Yoshida, N. (2009) Fuel Battery System, Method for Detecting Gas leakage in Such System and mobile Object. United States Patent Pub. No US 2009/0239105 A1.