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# Automatic Gas Leakage Monitoring System Using MQ-5 Sensor

Muhammad Ahmad Baballe, Usman Yusuf Magashi, Bello Ibrahim Garko, Abubakar Abdullahi Umar, Yunusa Rabiu Magaji

[Kano State Polytechnic, School of Technology, Computer Engineering Department, Kano, Nigeria[1], Bayero University Kano, Department of Electrical and Mechatronics Engineering, Kano, Nigeria[2], Kano State Polytechnic, School of Technology, Department of Mechanical Engineering, Kano Nigeria[3], Kano State Polytechnic, School of Technology, Computer Engineering Department, Kano, Nigeria[4], Kano State Polytechnic, School of Technology, Electrical Engineering Department, Kano, Nigeria[5]]

mbaballe@kanopoly.edu.ng, usmanyusufmagashi@gmail.com, ibrahimgarko.bello@gmail.com, abubakartofa@gmail.com,yunusarabiumagaji@gmail.com

## Abstract

Safety plays a foremost part in our today's world and an automatic safety system must be employed in environments like institutions, hospitals, homes, industries, and workplaces. One of the precautionary measures one has to take to avoid the danger associated with the gas leakage is to install a gas leakage system detector at susceptible places. This paper presents a liquefied petroleum gas (LPG) leakage, monitoring system. The gas detector MQ-5 used in the design is responsible for capturing the gas that is leaking. An Arduino microcontroller that is use acts as the brain of the whole research, it controls all the components used in the design. If the gas sensor detects a gas leakage, it will make an alarm-using buzzer and will send SMS messages to the registered mobile numbers with the help of the GSM module. A Liquid Crystal Display is used in the research to display the gas leakage or absence of gas leakage.

**Keywords:** Detection system, GSM Module, MQ-5 Sensor, LCD Display, Arduino, Buzzer.

## 1. Introduction

The development of any kind of security system begins with the creation of man. To alert frightening information, man implements a form of a signal, through shouting and sound. He then later replaced it with the help of the clapping of hands and with the introduction of signals to inform society or to blowout a certain message if they are any kind of fire outbreak, abduction or burglary, during the early periods of some African society especially in my country Nigeria [1]. All such methods of notifications or warnings are necessary, undependable, and unmethodical. The earliest electronic fire, a security detection system was established by a man named William .F. Channing. Later on, an electrical electronics engineer called Mr. Moses .G. Farmer invented the construction of the alarm system. The alarm detector uses an automatic indicator box to label the position of the fire outbreak and was first lunch in Boston, United States of America. The advancement of the fire alarm detector by Dr. William was then followed by the advancement of distinctly beautiful and arduous intruder and fire security alarm system technology that is so many to measure. The most noteworthy among this security detection system technology is the use of remote signaling thief security alarm [2,3]. This kind of security alarm system was the first design in the early 1970s. They are always a high risk of leakage whenever gas is used, threatening human properties and lives. Therefore, designing an affordable and low-cost gas leakage detector system can assist in decreasing the risk over several years. For the past years, there have been several accidents caused by liquefied petroleum gas (LPG) or methane leakages in industries or homes. This leakage of gases has led to the loss of several lives and properties through fire explosions and outbreaks. The use of modern technology is needed to give early warning signs to assure that adequate time is available to hamper probable peril. In this research, gas leak detection systems have been displayed. This system will detect the existence of gases such as liquefied petroleum gas (LPG) and methane in our environments, industries, schools, and hospitals. If they are a gas leakage of any

kind and it can be a threat or harm to the society or people living in that environment, this sensor MQ-5 used in the circuit design will automatically detect it, the GSM modem used in the design will send a warning signal to the users whose numbers are registered to the system or to the monitoring organization that is monitoring or taking care of the building or the organization. This system also consists of a buzzer that will sound an alarm if they are leakage of the gas in the environment. This system can be used in various other places such as oil and gas pipelines, kitchens, gas storage facilities.

## 2. Literature Review

This research aims to design a gas detection system that will automatically detect and alert gas leakage. This device is expected to be used in household security where heaters and gadgets that make use of natural gas and LPG may be a cause of danger. This gas detector system can likewise be used for other functions in the industry or plant that depends on LPG and natural gas for their operation. The gas leakage detector system will send a notification message to the registered mobile phones. An Arduino microcontroller is used as the brain of the whole research. This gas detector system is controlled and monitored through the web application ADAFRUIT. Once notified power supply is automatically cut off and the buzzer is turned on. Using this web application system can be controlled by the user such as switching on the fan and water pump [4]. This smart gas detection system is proposed for use at various hospitals. If they are a sudden leakage of gas, the gas sensor used in the design will send a sign to the Arduino. The Arduino will then processes the signal and then send a notification to other external gadgets involved in the design such as liquid crystal display, the magnetic buzzer, and the GSM module which heretofore stowed phone numbers of the individuals that are responsible for fighting the fires in the hospital, the alarm will send it repetitively until an acquiescent reply message received [5]. The gadget was designed and implemented for ceilings, and wall mounting. If the system is mount in any suitable place or on the wall and they is a supply of electrical energy, this detection system will be ready for automatically sending of short message service (SMS) or calling the house owners if they are a leakage of gas. The detection system comprises of an Arduino microcontroller, MQ-5 gas sensor, with ATmega328 microcontroller mounted on it, an active buzzer for alarming, SIM900A GSM/GPRS module to create the mobile message, solenoid valve to close or open the gas provision and relay module, which is activated by the help of the digital signal, sent from the Arduino [6]. Design of a low-cost innovative gas leakage sensor-based detection system, to notify and control. The gas detection system is very proficient, portable, user-friendly, cost-effective, and small in size [7]. An analog to digital conversion (ADC) method based on electronic gadgets, which is used in detecting leakage of gas using mechanical devices at industries, households, gas stations, and vehicles. Places where detection of this gases leakage is an essential concern to evade any kind of insecurity. This gadget comprises the processing section, which receipts the inputs data, processes the data, and then produces an output. Analogous to this output information, it then starts to dissipate fan and the light-emitting diode is on, if the concentration of the gas surpasses a certain level, it then starts or set the buzzer on, it also switches off the gas power supply units and informs the house owners or consumer by sending an alert message via the monitoring computer system. The gas concentration level for a particular operational area will be stored in the Mat lab “Database Explorer Tool” to get a summary of the gas eminence of this environment or area for imminent scrutiny such as probability to take accident and so on [8]. LPG escape detection and alert system. This system triggers the buzzer and shows the rigorousness of the escape to notify persons once the LPG escape is detected. The system is exceptionally forthright however dependable [9]. Design of gas detector using the Internet of Things. The gas detector sensor used in the design will apprehend the data and post it into an information cloud. If they are a leakage of gas the sensor will now detect it and sound an alarm with the help of a buzzer. They are LCD to display the leakage, notify the

observer, and trigger the exhaust fan in the particular area or section that they are leakage of the gas, it then extracts the leaked gas [10].

## 3. Materials and method

The materials used in this research are shown in Table I below

Table I: materials used in this research

| S/N | Name of components | Number used |
|---|---|---|
| 1 | Arduino Uno Board | 1 |
| 2 | MQ-5Sensor Detector | 1 |
| 3 | Liquid crystal display | 1 |
| 4 | SIM900 | 1 |
| 5 | Buzzer | 1 |
| 6 | Jumper wires | 24 |
| 7 | Number of connections | 12 |

### 3.1.1. Liquid crystal display

The liquid crystal display (LCD) is now the common choice of alphanumeric, graphics, and video displays. They exist in many forms, but the small monochrome LM016L is used in this research. The reason for choosing this particular LCD is its availability in markets. Here the emphasis is laid on the small monochrome alphanumeric type, which displays alphabets, numeric, and symbolic characters from the standard ASCII character set. The display is standard LM016L, which displays two lines of 16 characters (16x2).

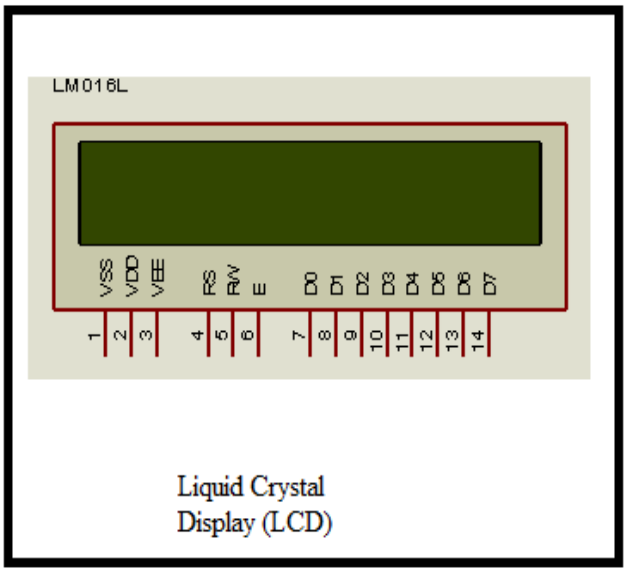


Fig. 1: Liquid Crystal Display

### 3.1.2. Magnetic buzzer

The vibrating disk in the magnetic buzzer is appealed to the pole by the magnetic field. When a fluctuating signal is moved through the coil, it produces a fluctuating magnetic field, which vibrates the disk at a frequency equal to that of the drive signal. The magnetic buzzer is just an electronic device that is being used as an alarming device in the design of the circuit in case if they are any form of leakage of the gas, it will sound an alarm to notify the house owner.


Fig. 2: Magnetic buzzer

### 3.1.3. Mq-5 gas sensor

The sensing material in TGS2442 gas sensors is a metal oxide, most typically $SnO_2$. When a metal oxide crystal such as $SnO_2$is heated at a certain high temperature in air, oxygen is adsorbed on the crystal surface with a negative charge. Then donor electrons in the crystal surface are transferred to the adsorbed oxygen, resulting in leaving positive charges in a space charge layer.Thus, the surface potential is formed to serve as a potential barrier against electron flow. Inside the sensor, electric current flows through the conjunction parts (grain boundary) of $SnO_2$ microcrystals. At grain boundaries, adsorbed oxygen forms a potential barrier that prevents carriers from moving freely. The electrical resistance of the sensor is attributed to this potential barrier. In the presence of a deoxidizing gas, the surface density of the negatively charged oxygen decreases, so the barrier height in the grain boundary is reduced. The reduced barrier height decreases sensor resistance.


Fig. 3 (a): The TGS2442 gas detector sensor internal circuitry

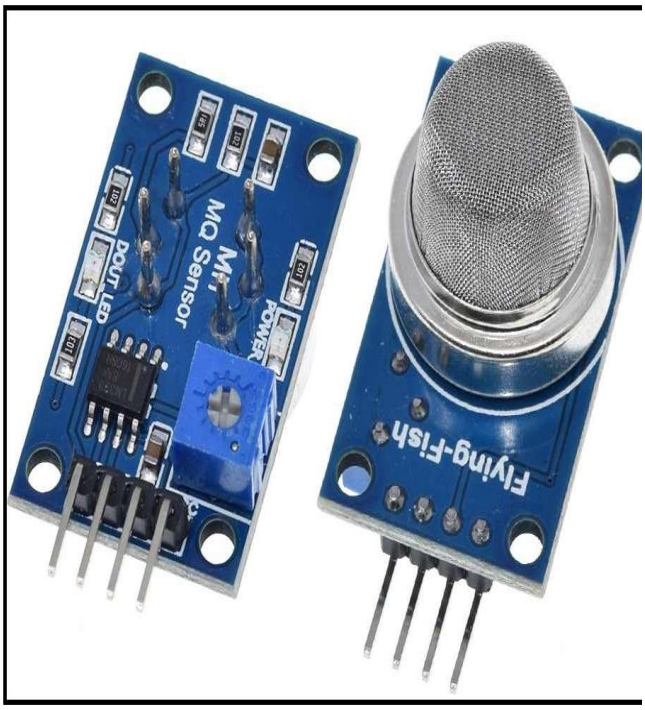


Fig. 3 (b): MQ-5 gas detector sensor

3.1.4. Arduino

The Arduino Uno as shown in figure 2.4 is a microcontroller board based on the ATMEL microcontroller ATmega328. It has 14 digital input or output pins (of which 6 can be used as Pulse Width Modulation outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Arduino Uno can be power via a USB connection or with an external power supply. The power source is selected automatically when connected to a computer. Below is the front and back view of the Arduino microcontroller.

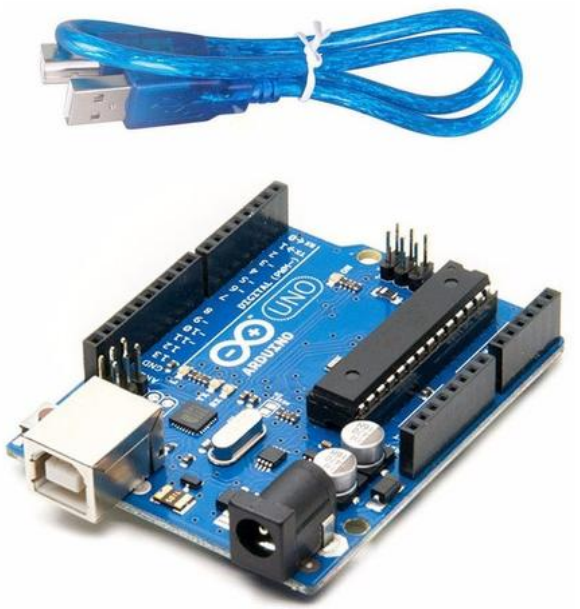


Fig. 4: Arduino Uno board microcontroller

3.1.5. The SMS-based alert module

GSM SIM 900 Quad-band GSM/GPRS engine, works on frequencies 850MHz,\ 900MHz, 1800MHz. It is very compact and designed with RS232 level converter circuitry, which allows you to directly interface PC Serial port. GSM uses a combination of Time Division Multiplexing and Frequency Division Multiplexing. The baud rate can be configurable from9600-115200 through AT command. Initially, the Module is in Auto band mode. This GSM/GPRS RS232 Module is having an internal TCP/IP stack to enable you to connect with the internet via GPRS. Using this module, we will be able to send & read SMS, Connect to the internet via GPRS through simple AT commands. The suitable operating voltage level is12V DC.

Fig. 5: SMS Based Alert Module

3.2. Method

This section of research handles the operation of the whole system. When the user activates the system, the Arduino will read the data when the MQ-5 sensor detects gas leakage. The Arduino will now activate the buzzer and sends a signal to the LCD Display. The GSM modem gets information from the Arduino and sends a short message service to the designated Mobile number registered in the system. Communication between the GSM modem and phone, AT command is applied to this research. This is because the GSM modem can merely comprehend AT command statements. From this, it can communicate with phones, computers, and Arduino. To complete this research, the whole component must work efficiently. The GSM modem acts as a medium to receive the instructions from the Arduino and Sends a message to the designated mobile number. C programming is used for the Arduino application to develop the program.

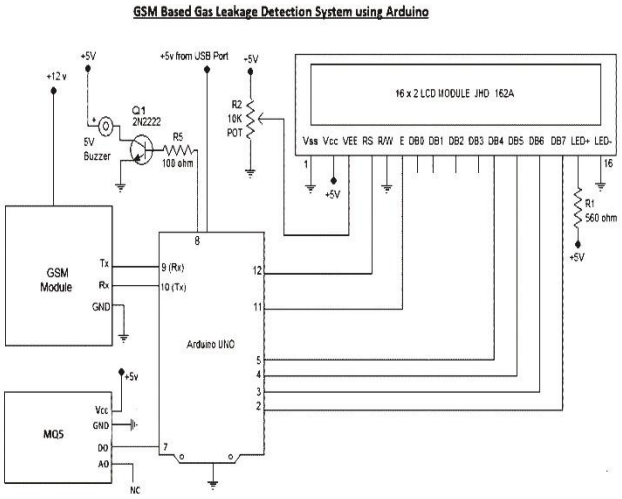


Fig. 6: Circuit Diagram Showing all the Connections between the Components

3.2.1. The pin assignment of the whole system connection is as follows below

**LCD**

The LCD RS pin to digital pin 12 of the Arduino.

The LCD enables pin to digital pin 11 of the Arduino.

The LCD D4 pin to digital pin 7 of the Arduino.

The LCD D5 pin to digital pin 6 of the Arduino

The LCD D6 pin to digital pin 5 of the Arduino.

The LCD D7 pin to digital pin 4 of the Arduino.

The LCD R/W pin to the ground of the Arduino.

The LCD $V_{SS}$ pint to the ground pin of the Arduino.

The LCD $V_{CC}$ pin to 5 volts of the Arduino.

The LCD $V_O$ to 10KΩ resistor ends to +5V and ground of the Arduino.

**BUZZER**

The ground of the buzzer is connected to the ground of the Arduino.

The $V_{CC}$ of the Buzzer is connected to digital pin 8 of the Arduino.

**GSM MODULE**

The $V_{CC}$ pin of the GSM module is connected to 5 volts of the Arduino.

The ground pin of the GSM module is connected to the ground pin of the Arduino.

The $T_X$ pin of the GSM module is connected to $R_X$ pin of the Arduino.

The $R_X$ pin of the GSM module is connected to the $T_X$ pin of the Arduino.

**MQ-5 SENSOR**

The $D_0$ pin of the MQ-5 sensor is connected to the digital pin of the Arduino pin 7. In addition, the +5 volt of Arduino is connected to the Vcc of the sensor. Then finally, the ground of the Arduino is connected to the ground of the sensor.

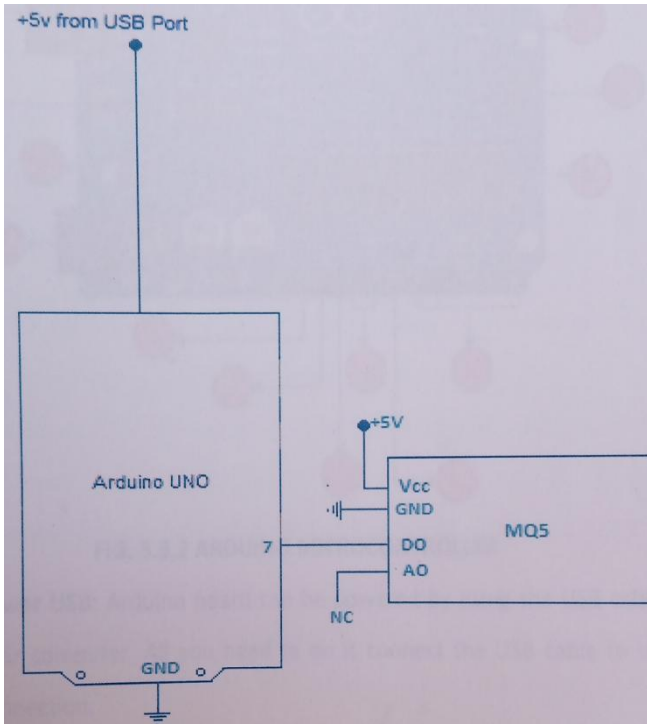


Fig. 7: Interfacing the MQ-5 sensor to Arduino contents

## 4. Results and discussion

**DISCUSSION:** Testing was carried out by releasing LPG into the atmosphere around the sensor MQ5. The gas detector and response unit are there to detect it. The results of the test were carried out on the device at different times and days for the concentration of gas in the air around the sensor. The last four values are the case of an endless loop due to high gas concentration. The device was tested by placing the LPG device at different distances from the gas source. It was observed that when the LPG device was tested by placing it at different distances from the gas source, the response time of the LPG system decreased as the distance from the gas source increased. Also, it was observed that the sensitivity of the gas sensor was very high in clean air. The gas sensor sensitivity varied with temperature while the reference voltage remained constant over time. At constant gas concentration, the sensed voltage will always be constant. The gas sensor has a very fast response to gas since the time difference between test results with the same concentration is very small while the difference between the sensed voltages is very high, as escape could result in severe accidents which end in material losses and human injuries. Gas escape happens chiefly because of poor maintenance of apparatus and inadequate awareness of the individuals. Thus, LPG escape detection is useful to stop accidents and to avoid wasting human lives. This technique triggers a buzzer and displays the severity of the escape to alert individuals once LPG escape is detected.

Table 2: Shows the simulation testing and results obtained

| S/N | Test conducted | Result obtained |
|---|---|---|
| 1 | System Activated | Initializing |
| 2 | After some seconds | No gas leakage, Relax please figure 8 (a, b) |
| 3 | If they are gas leakage | Gas leakage detected in figure 9 (a, b) |
| 4 | Message sent to the registered phone numbers | Hello boss, Gas is leaking detected figure 10 |

Fig. 8(a): Implementation result showing no gas leakage

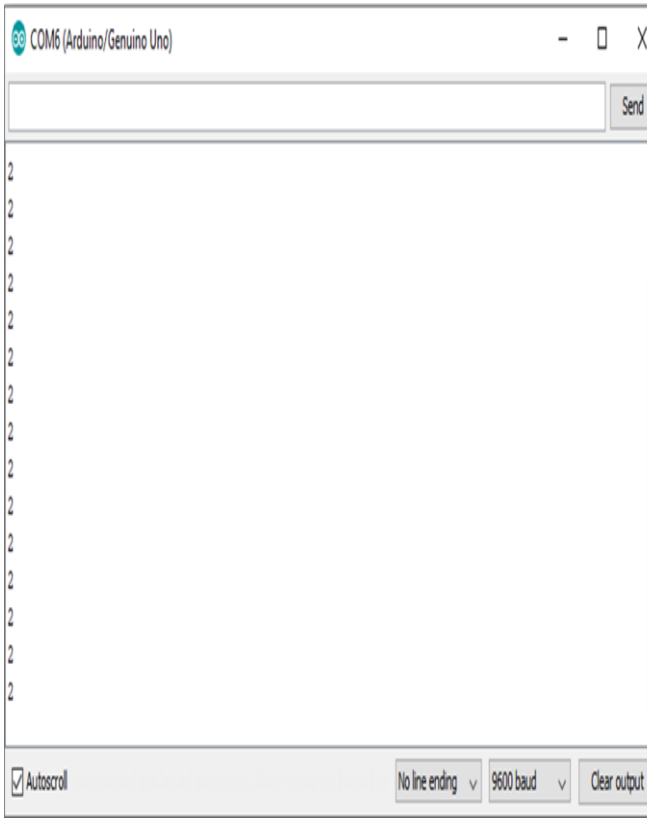


Fig. 8(b): Simulation result showing there is no gas present in the environment or no gas leakage

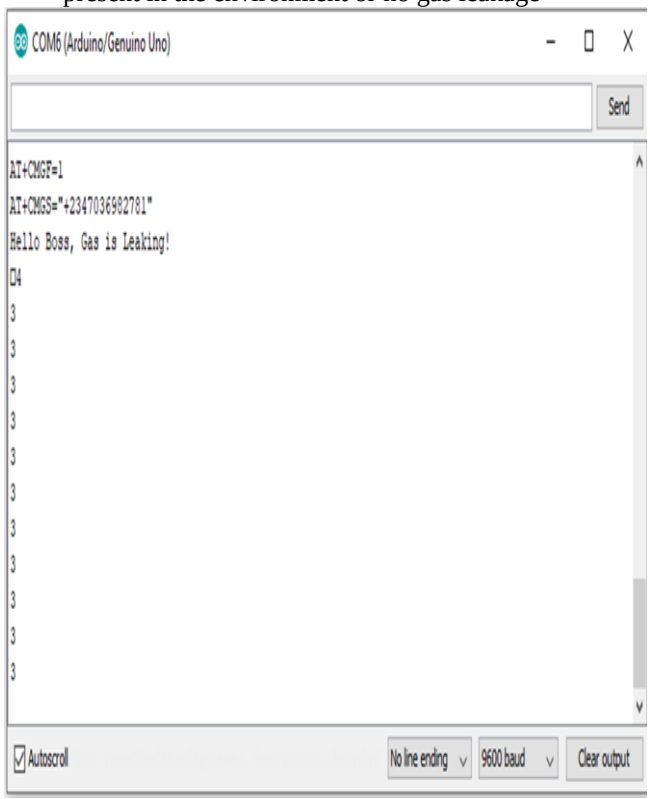


Fig. 9(a): Simulation result showing there is gas present in the environment, Hello Boss, Gas is leaking

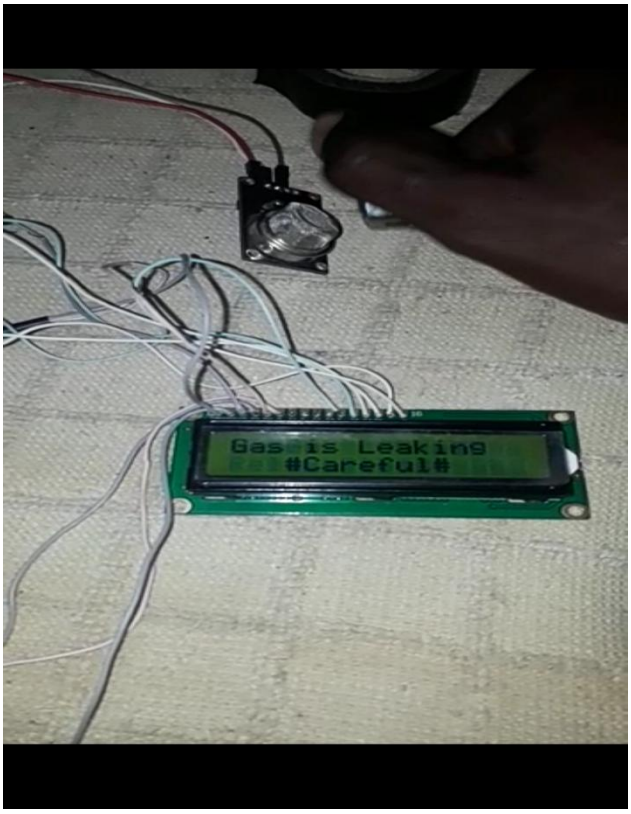


Fig. 9(b): Implementation result showing gas is leaking, careful


Fig. 10: Message from the registered mobile phone showing, Hello Boss, Gas is leaking

## 5. Conclusion

The main aim of the research is to detect the leakage of the gas when the gas is above the certain requirement needed in the environment. When the user activated the system. The Arduino microcontroller will read the

presence of gas in the environment i.e. when it detects above the required value needed. Then the GSM modem gets the data from the Arduino Microcontroller and sends SMS to the owner's handphone. To communicate between the GSM modem and handphone, AT command is applied to this project. It is because the GSM modem just can only understand AT command declaration. From this, it can communicate with a handphone, computer, and Arduino microcontroller.

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