

# SMOKE AND LPG GAS DETECTION ROBOT WITH WIRELESS CONTROL BY SOLAR ENERGY

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**Abstract** — *This Project describes the making of a robot for early Gas Leakage and eventual fire accidents particularly in kitchen and bedroom all over the year can be avoided from making a huge damage if we have systems installed that can detect gas leakage or fire at the earliest and notify to the respective authority to act upon it.*

*This project using some sensors and wireless communication achieves this feat of detecting the occurrences of such events and notify the authorities present at the premises so that the damage incurred in life or property can be minimized*

*If Robot detects a gas leakage within a suggested distance say few meters and raises the alarm to*

**Keywords:** *Relay, Arduino, Current, Solar, Bluetooth module HC-05, Gas Sensor, GSM Module.*

## 1. INTRODUCTION

Over the years, technology is fast paced and different security devices were innovated. Robotics is one of the quickest rising engineering research projects of today. Detection and locating hazardous gases are a public interest in preventing harms to humans, nature and assets. Robots are intended to avoid human factor from difficult job or unsafe work and for remote location applications. Robotic solutions are available in the form of in-pipe inspection robots and tank inspection robots. It can detect leaks in a pipe system through the use of electronic sensors. It has the ability in detecting single or multiple leaks in pipeline. In fact, there are robotic technologies widely used in offshore oil and gas industry nowadays. Gas detection is one of the important roles in fire prevention for households. Gas detection is made possible through several approaches like gas leakage localization applied through the help of a mobile carrier or wheeled robot. It can also

*avoid more gas leakage. If the alarm is not switched off physically within 5 minutes, the microcontroller starts sending SMS to the registered mobile number every 15 minutes until the alarm is switched off physically. The authors are certain of such domestic robots can protect human lives from household accidents. The system also has a fire sensor to detect fires. As soon as a fire is detected, the system shuts off gas supply thus preventing the fire from spreading further and avoiding any chances of explosions.*

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detect gas through the application of passive IR- thermography or can be IR-optical sensor to allow remote leak detection based from the gas pressure.

Chemicals like gas can also be sensed through a mobile robot equipped with chemical sensors that can follow chemical trails left on the ground and find their roots. Through the emergence of new technologies, remote gas sensing is made possible through mobile robots. The main device used in this paper is the integration microcontroller. Microcontroller can be programmed to detect gas leakage. This can be applied to

detect LPG gas with a mobile communication for security measures. This

automated hazardous gas detecting robot using wireless sensor networks with gsm-sms alert and fire control system for households is designed and built with an embedded system that aimed as an aide in fire protection. With this kind of device, human and property can be saved in a much higher percentage with comparatively minimal destruction caused by the fire.

This paper implemented a wireless sensor network (WSN) because it involves multiple sensors and its capability to process and communicate with other electronic devices.

This paper also adopted WSNs due to its multi-sensory capability to improve its intelligence

system and robotics applications. Furthermore, robotics is one of many applications of multiple sensors and is being used for automation. Aside from the WSN feature of this paper, it also involves GSM module for SMS notification. This module sends SMS to the mobile phone that will provide a warning that there might be a fire detected by the robot. This GSM module is built with Dual Band GSM/GPRS engine SIM900A with 900/1800 MHz frequency. It is suitable for SMS, voice as well as for data transfer application. This is integrated to secure and monitor home as what previous study established.

Through this, the author come up with a novel robotics application intended for fire protection that can detect flame, an object, smoke and gas with an alarm system composed of LED and buzzer, a GSM module for SMS notification and a water pump to extinguish the fire. The combination of these functions makes the author challenged to establish research that can help our society.

Hydrocarbon is a major source of energy, both for industrial and domestic applications. Liquefied Petroleum Gas (LPG) is a flammable hydrocarbon gas which consists of a mixture of propane and butane hydrocarbons. LPG is a product obtained from the refining of crude oil and gas, and it is a source of energy for domestic cooking, industrial ovens, electric power generators, and it serves as fuel for vehicles. LPG can also be used as a propellant, refrigerant and as a petrochemical feedstock. LPG has no odour and as such, Ethanethiol is added to it as a powerful odorant, for the

detection of gas leakage via the sense of smell. Globally, fire accidents and hazards caused by gas leakage have been a major challenge in the industries (e.g., oil and gas industry), and even in homes (in the kitchen). Several cases of fire accidents and explosions due to gas leakage from gas pipes, the burners of gas cookers or the gas cylinders have been reported. The 1984 San Juanico tragedy in Mexico City; one of the most severe LPG disasters in history, was caused by undetected LPG leakage. Although, gas leakage detection

## 2. COMPONENTS USED

### a. ARDUINO UNO:

The Arduino Uno is a microcontroller board based on the Microchip ATmega328P microcontroller. It consists of digital and analog pins that may be interfaced to various boards and circuits. The board has 14 digital and 6 analog pins, and is programmable with Arduino IDE. The Arduino board can be powered by the external 9-volts battery or by USB cable. The inputs to the Arduino are power supply, X-OR. It collects the data from input and

is very important, but preventing fire requires adequate control of the detected gas leakage. In order to prevent gas explosion, there should be statutory environmental requirements on the use of LPG so as to prevent accidents, and protect life and property from disaster.

The safety of life and property is vital in all our daily activities whether domestic or industrial. Achieving utmost safety requires adequate planning, early fault detection, and the use of appropriate forms of protection.

Over the years, there have been several accidents caused by the leakage of LPG in homes and industries (especially oil and gas industries) from gas pipes and gas cylinders, which has led to the loss of several lives and properties through fire outbreaks and explosions, poisoning and suffocation due to lack of oxygen. In 2013, a report on LPG related accidents in Japan was filed

by the High-Pressure Gas Safety Institute of Japan (KHK). It showed the number of accidents caused by LPG leakage, and a comparison was made with the previous years. As at 2013, there were 206 recorded accidents which left 3 people dead and 52 people injured. From 2014, up to January 2015, there were over 12 recorded LPG leakage related accidents in Chennai in India,

and according to the report, this is an indication that the loss of life and damages caused by LPG accidents is on the increase in India. As at January 2015, in Chennai, two incidents had already

been reported which left 3 people dead, and 6 others injured. In this study, a smart, gas leakage detector is designed and implemented to detect gas levels above the normal threshold level,

especially in a confined environment. When leakage is detected, the system shuts off the gas supply

by activating a solenoid valve, and it also evacuates the leaked gas by activating an exhaust fan.

The gas leakage detector notifies the residents by activating a loud alarm, and it also sends an SMS text to a pre-configured number, so as to ensure that the residents are notified of any gas leakage even when they are not at home.

accordingly gives commands to Relay and LCD display.

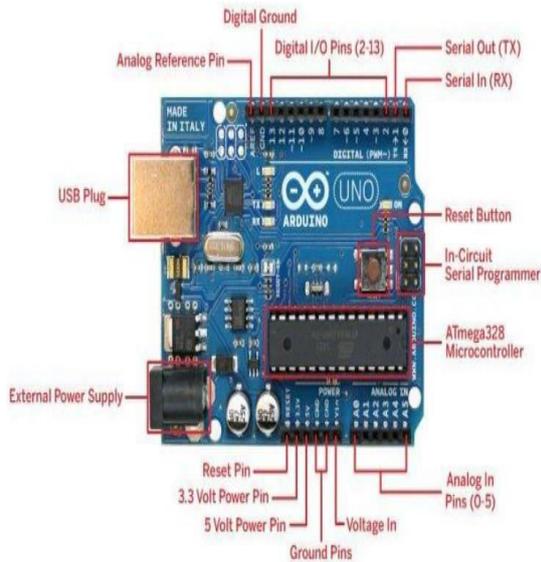


Figure :2.1 arduino uno

a. Relay :

A Relay is an electrically operated switching device as it works to isolate or change the state of electric circuit from one state to another. It consists of set of input terminals and operating contact terminals.

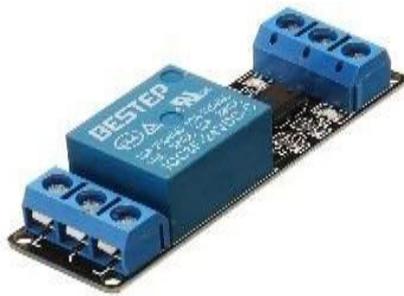


Figure:2.2 relay

b. Gas Sensor:

The MQ3 (LPG Gas Sensor) is a simple-to-use liquefied petroleum gas (LPG) sensor. It can be used in gas leakage detecting equipment in consumer and industry applications, this sensor is suitable for detecting LPG, iso-butane, propane, LNG. Avoid the noise of alcohol, cooking fumes and cigarette smoke.



Figure:2.3 gas sensor

c. Flame Sensor:

A flame-sensor is one kind of detector which is mainly designed for detecting as well as responding to the occurrence of a fire or flame. The flame detection response can depend on its fitting. It includes an alarm system, a natural gas line, propane & a fire suppression system. This sensor is used in industrial boilers. The main function of this is to give authentication whether the boiler is properly working or not. The response of these sensors is faster as well as more accurate compare with a heat/smoke detector because of its mechanism while detecting the flame.

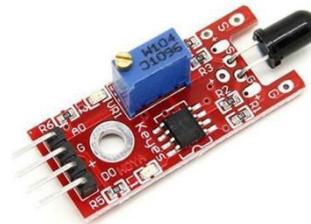


Figure:2.4

d. Smoke Sensor:

An optical smoke alarm contains a photoelectric sensor, which measures variations in a light signal emitted by an electroluminescent diode. Under normal conditions and if no smoke is present, the signal is continuous and normal. Smoke alarms detect fires by sensing small particles in the air using a couple of different kinds of technologies. Once they detect those particles above a certain threshold, they signal the alarm to sound



Figure: 2.5 Smoke Sensor

e. GSM MODEM:

A GSM modem or GSM module is a device that uses GSM mobile telephone technology to provide a wireless data link to a network. GSM modems are used in mobile telephones and other equipment that communicates with mobile telephone networks. They use SIMs to identify their device to the network. A GSM modem or GSM module is a device that uses GSM mobile telephone technology to

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Figure-2.6 Gsm Modem

f. Bluetooth Module HC-05.

The **HC-05** is a popular module which can add two-way (full-duplex) wireless functionality to your projects. You can use this module to communicate between two microcontrollers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop. There are many android applications that are already available which makes this process a lot easier

■ It is very easy to pair the HC-05 module with microcontrollers because it operates using the Serial Port Protocol (SPP). Simply power the module with +5V and connect the Rx pin of the module to the Tx of MCU and Tx pin of module to Rx of MCU

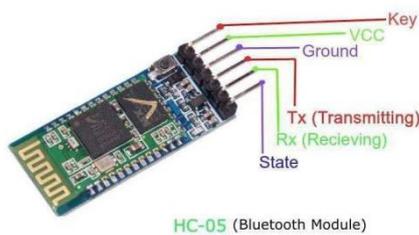


Figure:2.7 Bluetooth Module HC-05.

g. Solar panel.

A panel designed to absorb the sun's rays as a source of energy for generating electricity or heating. Solar power can be captured and used in several ways, primarily to generate electrical or thermal energy for homes, businesses, utilities, and more. Solar power is a renewable resource, and as such, is a critical part of our clean energy future. This is a type of solar thermal energy which is used to generate solar power electricity.



Figure:2.8 Solar Panel

h. Buzzer.

A buzzer is an efficient component to include the features of sound in our system or project. It is an extremely small & solid two-pin device thus it can be simply utilized on breadboard or PCB. So in most applications, this component widely used. There are two kinds of buzzers commonly available like simple and readymade



Figure:2.9 Buzzer

i. Exhaust Fan.

Exhaust fans are used to pull excess moisture and unwanted odors out of a particular room or area. Exhaust fans operate using electricity. They can be controlled by a wall switch, or certain models are equipped with a thermostat that signals the unit to come on when certain temperatures are reached in the area



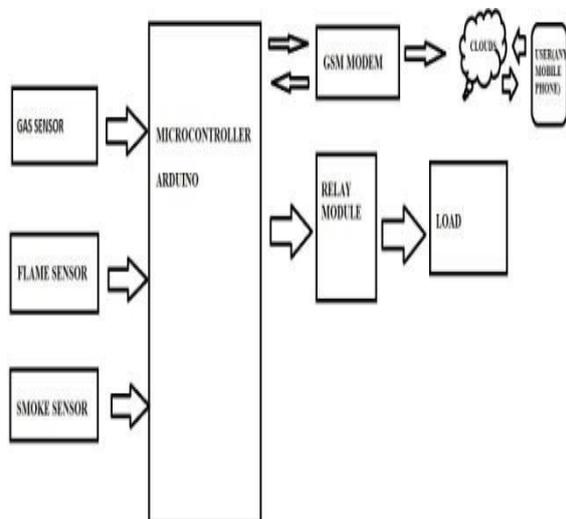
Figure:2.10 Exhaust fan

j. L298 Motor Drive:

The L298 is an **integrated monolithic circuit in a 15-lead Multiwatt and PowerSO20 packages**. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. The L298 is a dual H-Bridge

motor driver which **allows speed and direction control of two DC motors at the same time**. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A

### 3. BLOCK DIAGRAM



### 4. WORKING

**Gas Concentration Detection** When the system was powered up, the computer program continuously asks for the status of the sensor. The program is designed to get the output voltage of each sensor from the microcontroller and calculate each gas concentration and upload it to the server. Gas Sensor MQ-2, MQ-4 & MQ-135. Gas Sensors are designed to detect or measure the following gases: LPG, Alcohol, Propane, Hydrogen, CO and methane, NH<sub>4</sub>, smoke, CH<sub>4</sub>. The sensor-based module version has a digital pin and an analog pin which is TTL driven and works on 5V. For the measurement of a particular gas or multiple gases, read the analog values with the analog pin of the module (0-5V).

The analog output voltage provided by the sensor changes in proportional to the concentration of smoke/gas. The greater the gas concentration, higher the output voltage, while lesser gas concentration results in low output voltage. Arduino reads analog voltage from the sensor, Arduino has 10-bit converter means there are 1024 distinct values. i.e  $2^{10}=1024$  Output value =  $(\text{Input value}/1023) * \text{Max Output value}$ . Here we are mapping output voltage (0-5V) into integer value between 0 and 1023. Ex  $(511.5/1023)*5=2.5V$ .

#### a) Sensing materials:

The tubular sensing element inside the sensor is made up of Aluminum Oxide (AL<sub>2</sub>O<sub>3</sub>) based ceramic and has a coating of Tin Dioxide (SnO<sub>2</sub>).

The Tin Dioxide is the most important material being sensitive towards combustible gases. However, the ceramic substrate merely increases heating efficiency and ensures the sensor area is heated to a working temperature constantly. So,

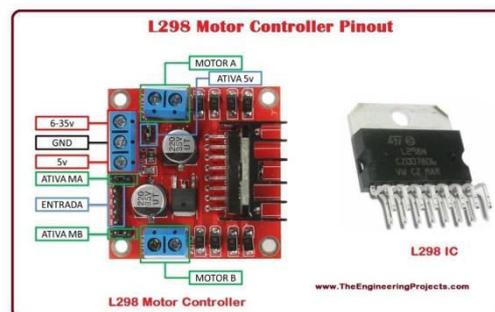


Figure 2.11 L298 Motor Drive

the Nickel-Chromium coil and Aluminum Oxide based ceramic forms a Heating System, while Platinum wires and coating of Tin Dioxide forms a Sensing System.

#### b) Actual working principle of the sensor:

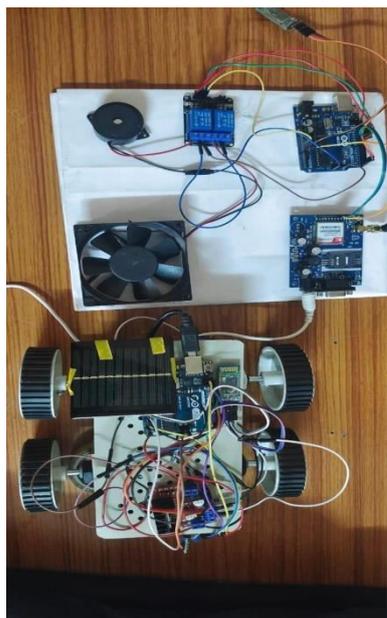
When tin dioxide (semiconductor particles) is heated in air at high temperature, oxygen is adsorbed on the surface. In clean air, donor electrons in tin dioxide are attracted toward oxygen which is adsorbed on the surface of the sensing material. This prevents electric current flow. In the presence of reducing gases, the surface density of adsorbed oxygen decreases as it reacts with the reducing gases. Electrons are then released into the tin dioxide, allowing current to flow freely through the sensor.

The working of the planned robot is simple and user friendly. The entire robot is built on the acrylic sheet. Acrylic sheet is utilized for the assembling the base for robot on account of novel properties like light weight, more effect obstruction, increasingly adaptable, amazing protection from synthetic compounds, protector, and climatic conditions. The robot is designed to work both with both commercial power supply and battery as well. Once the robot gets the power supply, the microcontroller starts functioning according to the basic functions programmed. The basic program for gas leakage detection is shown above. The domestic robot uses the solid-state sensor to sense any LPG/AC gas leakage within 10 to 15 feet. As mentioned, the solid-state sensors are of high sensitivity in detecting gas leakage. The output voltage from the gas sensor increases when the concentration of gas increases. Sensitivity can be adjusted accordingly. The best preheat time for the sensor is above 24 hours. The concentration of few

gases . If the robot detects any suspicious gas leakage, it raises the alarm. If the alarm is not switched off substantially within 5 minutes, the microcontroller starts mentioning SMS to the registered mobile number every 5 minutes until the alarm is switched off physically.

## 5. RESULTS

Fig. 5.1 Hardware kit of smoke and Lpg gas detection robot with wireless control by solar energy.



The evacuator fans were automatically activated to suck away the leaked gas from the enclosure so as to prevent a potential ignition and fire. This smart device offers a number of safety benefits that are vital for early gas leakage detection, and response towards preventing LPG leakage related house fires in India. This project presented the specifics of the structure of the actual robot. The components used in this project includes multiple sensors that served as wireless sensor network that could detect gas hazards, flame. It is built with fire extinguisher that served as a first responder to the fire. The buzzer and Exhaust fan worked as an alarm indicator for its alert system.

Gsm module automatically sends a message to the person concerned. The robot has four wheels perform and roam around. Development and

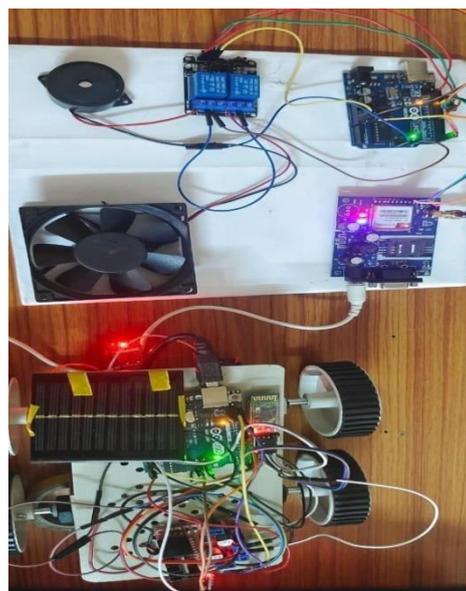


Figure :5.3 shows the working condition of hardware. The project “**Smoke and LPG Gas Detection Robot with Wireless Control by Solar Energy**” was designed to save human lives from fire accidents at household and at industry level by using solar energy as power to run the sensor’s present on wheeled robot. When the sensor senses any kind of temperature due to fire or gas leakage then it automatically raises an alarm and switch on the exhaust fan.

If the alarm is not switched off substantially within 5 minutes, the microcontroller starts mentioning SMS to the registered until the alarm is switched off physically.

## 6. A CONCLUSION

Safety is the proactive, and the cheapest option to preventing accidents and mishaps. Gas leakage induced fire is a menace that has occurred in different parts of the world. In INDIA, LPG gas is supplied via cylinders for household use, and cases of gas leakage from the cylinder, the supply hose or the gas burner has been recorded by different users over the years with some resulting in gas explosion, property destruction, injury and fatality. This study presents the design of a model gas detection and evacuation system. After design implementation, the device accurately detected simulated gas leakage, and the SMS and buzzer, Experimental tests were done and obtained the desirable outputs based from its objectives.

### B) FUTURE SCOPE

The first detectors were for the detection of heat, and as time and technology advanced, they were also used for fixed temperature, rate-of-rise, rate anticipation and linear. These detectors are still in use today and for a number of applications remain a viable means of detection, though not for the purpose of life safety.

Through the use of thermistors and the software/firmware of the detector and the system, I do see that the Response Time Index (RTI) of a heat detector can be reduced so that the detection of a thermal event could be more quickly detected. Fire alarm systems, however, are designed and installed in the majority of applications for life safety. The only detector that is used for this application is the smoke detector. Smoke detectors

and smoke alarms are and remain as the single best method for the early detection of a fire and have saved countless lives. These devices however have one principal problem, they are a source for unwanted alarms.

The detector when the products of combustion are not present. Smoke detectors and alarms are migrating from just the detection of smoke, to combination detectors and multicriteria detectors. The future will be with multicriteria detection in which the detector will be more of a sensor, with the detection more for the products of combustion, such as carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxides in addition to heat and particulate matter

Sensors will also have the ability to sense or track when a room is occupied or not and have the ability to be integrated with occupant notification and evacuation. The development of more advanced algorithms and artificial intelligence, both within the sensor itself and the front-end control unit will decrease the time from the beginning of an event to the notification of the event.

Since the first generation of smoke detectors were released, there have been a number of advancements to both decrease the time of detection while at the same time decrease the activation

## REFERENCES

- [1] A. Shukla And H. Karki, "Application Of Robotics In Onshore Oil And Gas Industry-A Review Part I," *Rob. Auton. Syst.*, Vol. 75, No. 2016, Pp. 490–507, 2016. D. Waleed Et Al., "An In-Pipe Leak Detection Robot With Aneural Network-Based Leak Verification System," *Ieee Sens. J.*, Vol. 19, No. 3, Pp. 1153–1165, 2019.
- [2] S. Soldan, J. Welle, T. Barz, A. Kroll, And D. Schulz, "Towards Autonomous robotic Systems For Remote Gas Leak Detection And Localization In industrial Environments," *F. Serv. Robot.*, Pp. 233–247, 2011
- [3] P. S. Murvay And I. Silea, "A Survey On Gas Leak Detection And Localization techniques," *J. Loss Prev. Process Ind.*