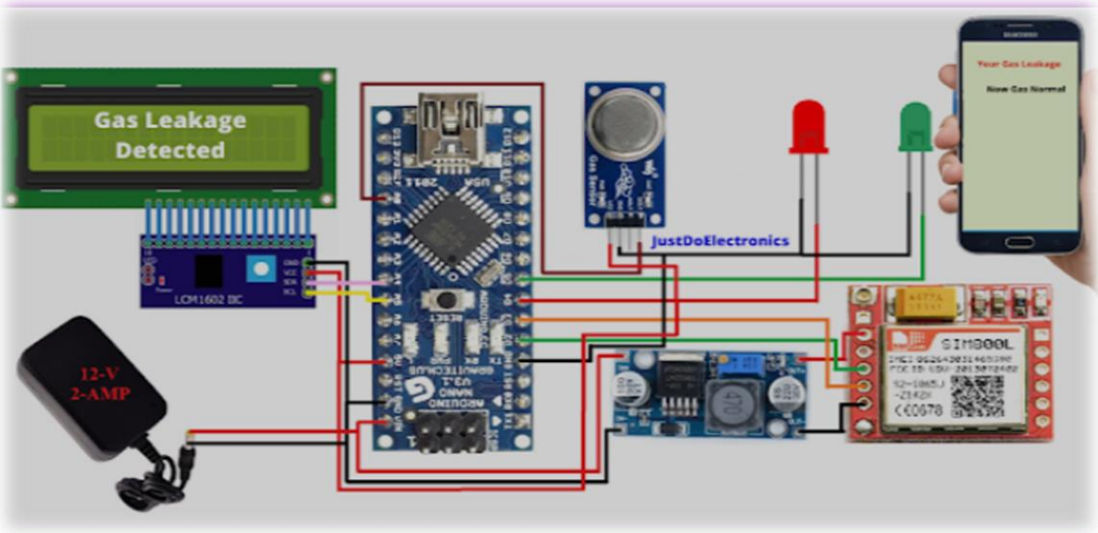
Haldia Institute of Technology

IOT BASED INTELLIGENT GAS LEAKAGE DETECTOR



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ABSTRACT

Gas leakage is a significant safety concern in homes, industries, and commercial spaces, where undetected leaks can result in fire hazards, explosions, or poisoning. This project proposes an IoT-based gas leakage detection system using an Arduino microcontroller, equipped with an MQ-2 gas sensor to detect combustible gases such as LPG, methane, and smoke. The system uses a GSM module for communication, which sends SMS alerts to users when gas concentrations exceed a predefined threshold. In the event of a gas leak, the system activates a local alarm via a buzzer or LED and immediately sends a notification to the user's mobile phone, allowing swift action. This solution is cost-effective and highly reliable, making it suitable for residential and small industrial settings. The system was tested under controlled conditions, and it consistently provided timely notifications and accurate gas level readings. Future improvements could include the addition of multiple gas sensors and advanced mobile app integration for enhanced monitoring and control.

Introduction

IoT (Internet of Things)-based gas leakage alert systems have emerged as a crucial safety measure, particularly in environments where gas leaks can pose serious hazards. These systems leverage the power of interconnected devices and sensors to detect gas leaks promptly and trigger appropriate alerts, mitigating potential risks and accidents.

How IoT-Based Gas Leakage Alert Systems Work:

1. Sensor Network: A network of gas sensors is strategically placed in areas where gas leaks are most likely to occur. These sensors are designed to detect specific gases, such as methane, propane, or carbon monoxide, at even low concentrations.

2. Data Transmission: When a sensor detects a gas concentration exceeding a predetermined threshold, it transmits the data wirelessly to a central hub or gateway. This data may include the gas type, concentration level, and sensor location.

3. Data Processing: The central hub or gateway processes the received data, analyzes it for patterns or anomalies, and determines whether a gas leak has indeed occurred.

4. Alert Generation: If a gas leak is confirmed, the system triggers appropriate alerts, such as:

- Visual alarms: Flashing lights or displays to warn nearby personnel.
- Audible alarms: Loud sirens or beeps to attract attention.
- Notifications: SMS, email, or app notifications to alert relevant individuals or authorities.
- Automatic shutoff: In some cases, the system may be integrated with valves or control systems to automatically shut off gas supply.

Benefits of IoT-Based Gas Leakage Alert Systems:

- Early Detection: These systems can detect gas leaks at an early stage, when concentrations are still low, allowing for timely intervention and preventing accidents.
- Remote Monitoring: IoT-based systems can be monitored remotely, providing real-time insights into gas levels and enabling proactive maintenance.
- Enhanced Safety: By promptly alerting personnel and initiating appropriate measures, these systems significantly improve safety in industrial, commercial, and residential settings.
- Cost-Effective: IoT technologies have become more affordable, making it feasible to deploy gas leakage alert systems in various environments.

Applications of IoT-Based Gas Leakage Alert Systems:

- Industrial Facilities: Factories, refineries, and chemical plants can use these systems to monitor gas levels in hazardous areas and prevent explosions or fires.
- Commercial Buildings: Restaurants, hotels, and shopping malls can benefit from gas leakage detection to ensure the safety of occupants and prevent property damage.

- Residential Homes: Gas leak detectors can be installed in homes to alert residents to potential dangers and prevent accidents.
- Public Spaces: Parks, public transportation, and other public areas can be equipped with gas sensors to monitor for leaks and protect the public.

In conclusion, IoT-based gas leakage alert systems offer a reliable and efficient solution for detecting and mitigating gas leaks, safeguarding lives and property. As IoT technology continues to advance, we can expect to see even more sophisticated and innovative systems emerging in the future.

OBJECTIVES

1.To research and identify the appropriate gas sensors, wireless and GSM technology, and microcontrollers needed to detect LPG gas leakage.
2.To design and develop a gas leak detection system that can detect the presence of LPG gas and trigger an alarm or shut off the gas supply in case of a gas leak.
3.To integrate the gas leak detection system with wireless and GSM technology to send an SMS alert to a designated phone number in case of gas leakage.
4.To provide an effective solution to address the growing concerns of LPG explosions and their catastrophic consequences, enhancing the safety of households and industries.
5. Enhance Safety: The primary objective of the Automatic LPG Gas Leakage Detection and Cut-off System is to significantly improve safety measures in households and industrial settings by promptly detecting gas leaks and activating a cut-off mechanism to prevent potential accidents and hazards.
6. Minimize Risks: By leveraging IoT technology, the system aims to minimize the risks associated with gas leaks by providing real-time detection and immediate response capabilities, thereby reducing the likelihood of fire outbreaks, explosions, and other gas-related incidents.

Component Used

- ## ARDUINO NANO :-

The **Arduino Nano** is an open-source breadboard-friendly microcontroller board based on the Microchip ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor.

The Arduino Nano is equipped with 30 male I/O headers, in a DIP-30-like configuration, which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-B mini USB cable or from a 9 V battery.

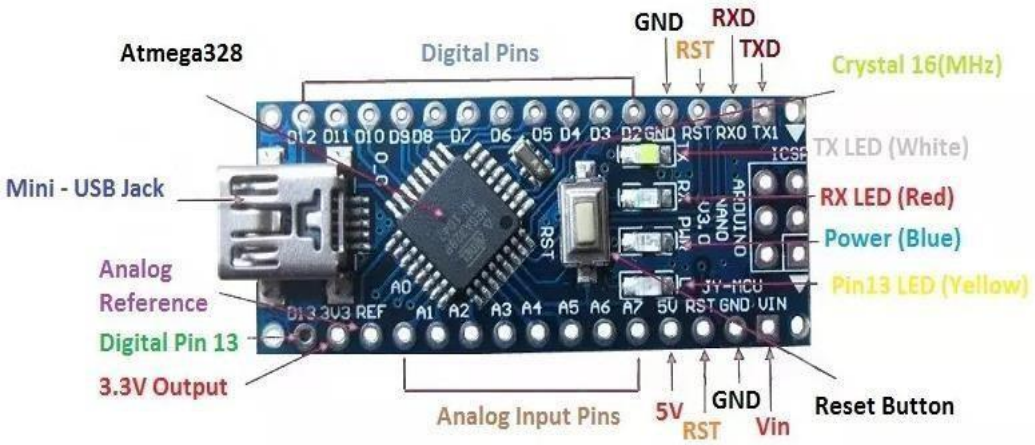


Fig. 1 Arduino NANO

- ## LCD 16×2 :-

An LCD is an electronic display module which uses liquid crystal to produce a visible image. The 16-2 LCD display is a very basic module commonly used in DIYs and circuits. The 16-2 translates o a display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5×7-pixel matrix,

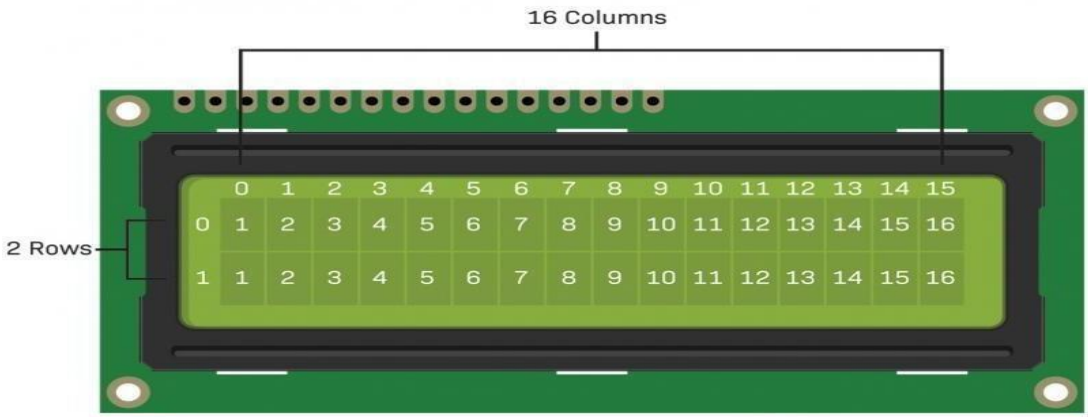


Fig. 2 LCD 16×2

- **POWER ADAPTER :-**

In this project we use 5 Volts 1 Ampere SMPS (Switch Mode Power Supply) power supply that is an indispensable part of any electronic design. It is used to convert mains high-voltage AC to low voltage DC, and it does it by first converting the mains AC to high voltage DC, then switching the high voltage DC to generate the desired voltage.

The output voltage of the circuit is 5V with 1A of current rating, which means this circuit can handle a power of 5W. This circuit operates under **constant voltage mode**, so the output voltage should stay pretty much the same irrespective of load current.

Fig. 3 5V 1A Power Supply Board

- **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. 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.

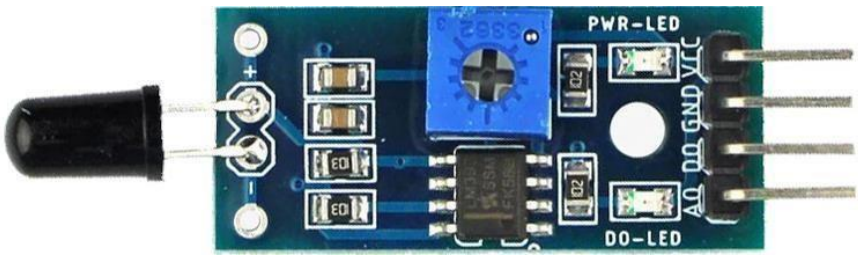
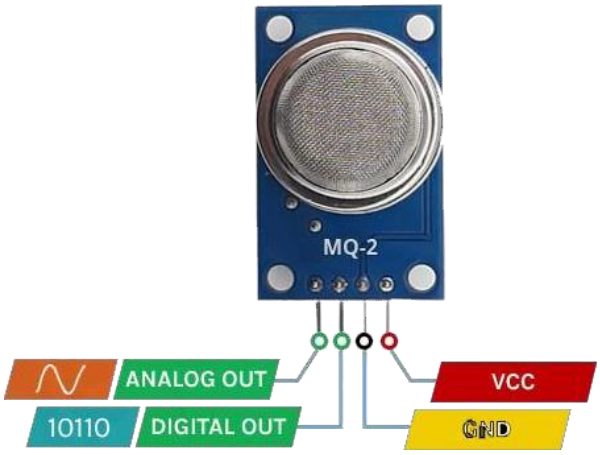


Fig. 5 Flame Sensor

- **MQ2 GAS SENSOR :-**

MQ2 gas sensor is an electronic sensor used for sensing the concentration of gases in the air such as LPG, propane, methane, hydrogen, alcohol, smoke and carbon monoxide. MQ2 is a metal oxide semiconductor type gas sensor. Concentrations of gas in the gas is measured using a voltage divider network present in the sensor. This sensor works on 5V DC voltage. It can detect gases in the concentration of range 200 to 10000ppm.



MQ2 Gas Sensor

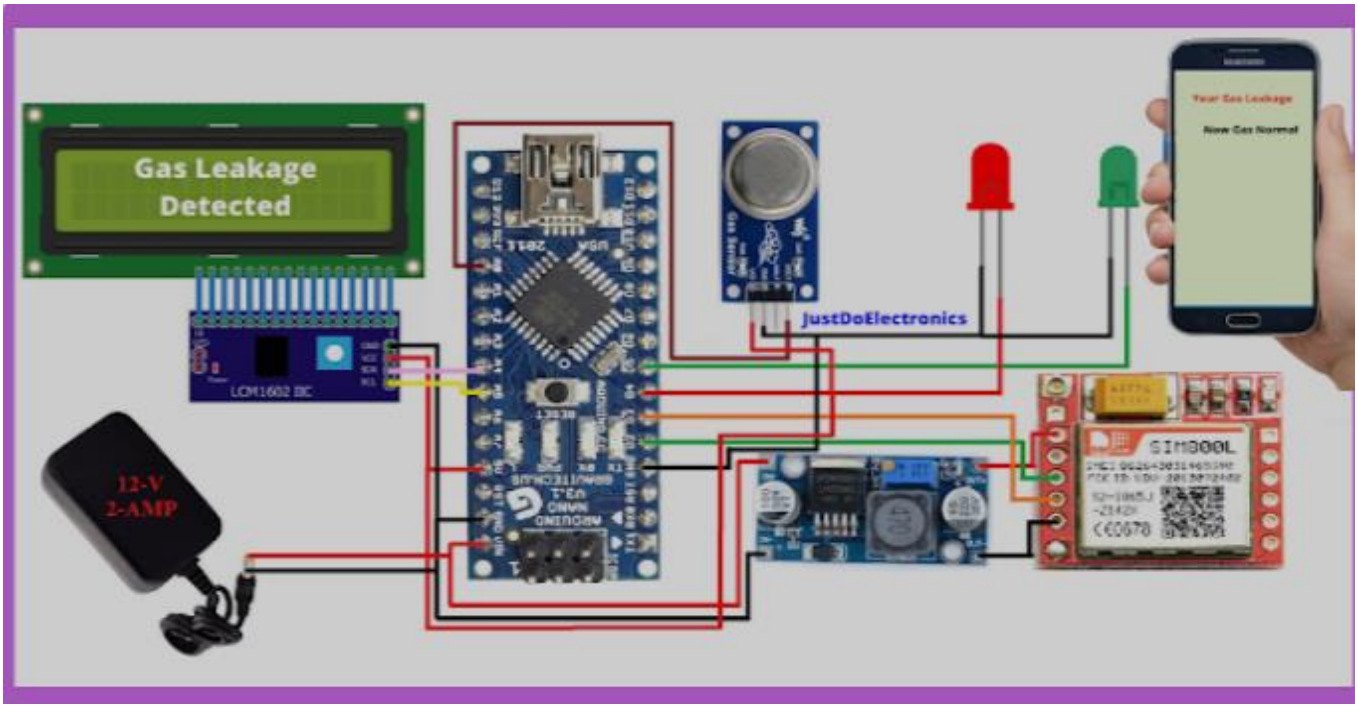
- **GSM MODULE :-**

A GSM (Global System for Mobile Communications) module is a hardware component that allows devices to communicate over mobile networks. It operates on the GSM standard, which is widely used for mobile telephony. Here's an overview of its key features, functionalities, and common applications:

- **BUZZER :-**

A buzzer is a crucial component in gas leak detection systems, serving as an alert mechanism to notify users of potential hazards. It activates when gas levels exceed a specified threshold, drawing attention to the situation for immediate response.

Circuit Diagram



ARDUINO IDE CODE

```
#include "LCDIC2.h"

LCDIC2 lcd(0x27, 16, 2);
#include <SoftwareSerial.h>

SoftwareSerial mySerial(3,2);


int sensorPin = A0; // choose the input pin (for GAS sensor)
int buzzer = 13; // choose the pin for the Buzzer
int G_led = 8; // choose the pin for the Green LED
int R_led = 9; // choose the pin for the Red Led


int read_value; // variable for reading the gaspin status
int set = 200;  // we start, assuming Smoke detected
const int fireSensorPin = A2;
void setup(){

mySerial.begin(9600);
Serial.begin(9600);
pinMode(sensorPin, INPUT); // declare sensor as input

pinMode(buzzer,OUTPUT); // declare Buzzer as output
pinMode(R_led,OUTPUT); // declare Red LED as output
pinMode(G_led,OUTPUT); // declare Green LED as output

lcd.begin();
lcd.clear();
lcd.setCursor(0,0);
lcd.print("   WELCOME To   ");
lcd.setCursor(0,1);
lcd.print("  GAS Detector  ");
delay(2000);
 lcd.clear();

 Serial.begin(9600);
   pinMode(buzzer, OUTPUT);
   pinMode(fireSensorPin, INPUT);
}

void loop(){
read_value = (analogRead(sensorPin)); // read input value

 read_value = read_value - 100;
if(read_value<0){read_value=0;}


lcd.setCursor(0, 0);
lcd.print("Smoke Level: ");
lcd.print(read_value);
lcd.print("   ");

if(read_value>set){
SendMessage();// check if the Smoke variable is High
lcd.setCursor(0, 1);
lcd.print("Alert....!!!     ");
digitalWrite(buzzer, HIGH); // Turn LED on.
digitalWrite(R_led, HIGH); // Turn LED on.
```

```
digitalWrite(G_led, LOW); // Turn LED off.
delay(1000);
}

if(read_value<set){ // check if the Smoke variable is Low
lcd.setCursor(0, 1);
lcd.print(".....Normal.....");
digitalWrite(buzzer, LOW); // Turn LED on.
digitalWrite(R_led, LOW); // Turn LED on.
digitalWrite(G_led, HIGH); // Turn LED on.
}
delay(100);

 int fireValue = digitalRead(fireSensorPin);
  Serial.println(fireValue);
  if(fireValue == 0)
  {
    SendMessage();
    lcd.setCursor(0, 1);
lcd.print("Alert! FIRE ");
    digitalWrite(buzzer, HIGH);
    digitalWrite(R_led, HIGH); // Turn LED on.
digitalWrite(G_led, LOW); // Turn LED off.
    delay(5000);
  }
  else
  {
    digitalWrite(buzzer, LOW);
  }
  delay(500);
}

 else
 {
   digitalWrite(buzzer, LOW);
 }
 delay(500);
}

void SendMessage()
{
Serial.println("I am in send");
mySerial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
delay(1000); // Delay of 1000 milli seconds or 1 second
mySerial.println("AT+CMGS=\"+917484944100\"\r"); // Replace x with mobile number
delay(1000);
mySerial.println("Excess Gas Detected. Open Windows");// The SMS text you want to send
delay(100);
mySerial.println("ADT+917484944100;");
mySerial.println((char)26);// ASCII code of CTRL+Z
delay(1000);
}
```

RESULT AND DISCUSSION

The Proteus Design Suite is a proprietary software tool 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. Figure 3 shows the circuit diagram that was designed using Proteus libraries. This system is based on Arduino UNO R3 and MQ-6 gas sensor. When the sensor detects gas in atmosphere, it will give a digital output of 1 and if 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 start tuning and the LCD will show that “Gas detected: Yes”. If sensor output is low then the buzzer will not be tuning, LCD will show that “Gas detected: No”. The detector incorporates a MQ-6 sensor (with gas detection range of 300–10,000 ppm) as the LPG gas sensor, PIC16F690 microcontroller as the control unit, LCD for displaying gas concentration, a buzzer as an alarm and a number of LEDs to indicate the gas leakage status. The microcontroller senses the presence of a gas when the voltages signal from the MQ-6 sensor goes beyond a certain level and gives an audiovisual alarm.

CONCLUSION

In this project, an IoT-based gas leakage detection system was successfully designed and implemented using an Arduino microcontroller, an MQ-2 gas sensor, and a GSM module. The system demonstrated the ability to detect combustible gases such as LPG, methane, and smoke, triggering local alarms and sending SMS notifications to users when gas concentrations exceeded predefined safety thresholds.

The use of the GSM module provided a reliable method of communication, ensuring that users received real-time alerts even in areas with limited or no internet access. This makes the system highly suitable for residential, commercial, and industrial environments where internet connectivity may not be guaranteed. The MQ-2 sensor's versatility in detecting multiple gases enhanced the system's applicability across various use cases.

Key Achievements:

- **Real-time monitoring**: The system continuously monitors gas concentrations and responds immediately when a leak is detected.
- **Remote alerts**: The integration of GSM technology enabled SMS notifications, ensuring that users were informed about leaks regardless of their location.
- **Cost-effectiveness**: Using readily available components like Arduino and MQ-2 sensor makes the system affordable and accessible for wide-scale deployment.

.FUTURE SCOPE

A human nose has around 400 different types of scent receptors that enable us to smell approx. 1 trillion different odors. But still, most of us cannot identify the type of gas present in the atmosphere. Hence, there are different sensors to measure accurate gas concentration in the atmosphere. Gas detection sensors are most commonly used to develop an IoT-powered system and identify the variation of toxic gases around an industrial facility. It helps benefit the factories and refineries by keeping them safe against any unexpected threats like explosions.

The future of gas leakage detection systems is poised for significant advancements driven by technology and safety needs.

1. IoT Integration :- Enhanced connectivity through the Internet of Things (IoT) will allow gas detectors to communicate in real-time with central monitoring systems, enabling faster responses to leaks.

2. Smart Sensors: Development of more sensitive and selective sensors will improve detection accuracy for various gases, minimizing false alarms while ensuring rapid identification of hazardous leaks.

3. AI and Machine Learning: These technologies will enhance data analysis, enabling predictive maintenance and automated responses to potential leaks by analyzing patterns and anomalies in sensor data.

4. Wireless Technologies: Wireless gas detection systems will become more prevalent, allowing for easier installation and flexibility in monitoring hard-to-reach areas.

5. **Integration with Smart Buildings:** Gas detection systems will increasingly be integrated into smart building management systems, allowing for automated ventilation adjustments and alerts to occupants in case of a leak.

6. **Mobile Applications:** Users will have access to mobile apps that provide Realtime alerts, monitoring data, and control options for gas detection systems.

7. **Enhanced Safety Protocols:** Regulatory bodies will likely mandate stricter safety standards, pushing industries to adopt advanced detection systems that comply with new guidelines.

8. **Environmental Monitoring:** Detection systems will play a crucial role in monitoring environmental impacts, helping to detect emissions from industrial processes and ensuring compliance with environmental regulations.

9. **Remote Monitoring:** Systems will incorporate remote monitoring capabilities, enabling operators to oversee multiple locations from a single interface, enhancing overall safety management.

10. **Collaboration with Drones:** Drones equipped with gas detection sensors could be employed for inspecting large areas or hard-to-reach locations, improving safety and efficiency in leak detection.

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