*i*Journals: International Journal of Software & Hardware Research in Engineering (IJSHRE)
ISSN-2347-4890
Volume 10 Issue 10 October 2022

Gas Detectors and Leak Detectors for the Industry

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Abstract: ***This paper highlights the technology behind a gas-leakage detection system to alert industrial workers about the excessive discharge of toxic gasses in their surroundings. A variety of sensors such as MQ-2, MQ-7, MQ-135 and MQ-136 will be utilized to detect the concentration of hazardous gasses such as Carbon Monoxide, Methane, Propane, Hydrogen, Ammonia, Benzene, alcohol etc. These sensors are attached with an Arduino NANO controller which will notify the workers about the gas concentration levels through a MIT application. These gas-detection systems are crucial in many of the industries such as semiconductor manufacturing, wastewater treatment plants, oil and gas industries, chemical industries, and mining.***

Keywords-**Industry, Bluetooth, Arduino, MQ series gas sensor, data store.**

1. Introduction:

Nowadays, there is progress in every field, from small factories to large-scale factories. Automation is now required in all fields. We are aware of the incident in Bhopal.More than 15,000 people were killed and 600,000 workers were affected by at least 30 tonnes of methyl isocyanate gas. The Bhopal gas tragedy is regarded as the world's worst industrial disaster [5]. and this problem was discovered recently in the twenty-first century in Visakhapatnam, affecting over 1000 people. These tragic events are the driving force behind my desire to develop a gas-leak detection system. This system uses automation and special sensors to notify users of gas leaks. It is adaptable and can be used at home or in the workplace.

Fig.1- Bhopal Gas Tragedy

Many industries, such as the chemical, semiconductor, and many manufacturing industries, produce waste in the form of water and gasses, depending on the production of that industry. When water is heated above its boiling point, it produces gasses, which can be harmful to workers' health. To protect workers from harmful gasses, we can build a circuit that alerts the owner or maintenance department to the concentration of gas levels.
The circuit is designed by using the Arduino Nano controller. Different gas sensors are used to detect the gasses. There is a series of MQ gas sensors available in the market to detect different gasses. Depending on the manufacturing industry we can use the sensors.

2. Literature Survey:

A wide variety of research has been undertaken to propose systems regarding gas leakage detection. Many of these projects have been implemented using IoT and other automations to alert users.

I. Sensor-based Gas Leakage Detector System:
This research paper proposes a gas-leakage detection system with a single gas sensor- MQ6 and the Arduino UNO R3 microcontroller. It will input the concentrations of LPG gasses and sound an alarm through a buzzer to alert users in case of high concentration of gasses.[1]
II. New Gas Leakage Detection System using Internet of Things: The proposed system in this paper is sensitive to LPG gasses. It is cost-effective and uses an android based application to alert and notify users. The paper also recommends other forms of improvements and adaptations that can be made to the project.[2]
III. Toxic Gas Detection and monitoring utilizing Internet of Things: This research proposed a multi-gas detection device using Arduino UNO R3 as the microcontroller along with temperature, gas and alcohol sensors. It makes use of the IoT technology for gas-detection and user-alerting.[3]
IV. Smart LPG Analyzer: This proposed system has the MIT app for the indication of low weight of LPG gas cylinder. Using a load cell, it will monitor the weight of the cylinder and give the notification to the dedicated person using the MIT app.

3. Effect Of Hazardous Gasses

Industry Gasses are a complex mixture of harmful and harmless gasses that can exist in varying concentrations depending on the source. It is formed when household and industrial waste decomposes.

I. Carbon Monoxide: This gas is formed because of the incomplete combustion of carbon in oxygen. It reduces the amount of oxygen that can be transported around the body in the bloodstream. Being exposed to EPA concentrations surpassing 9 ppm of carbon monoxide for more than 8 hours can be unhealthy. The US Occupational Health and Safety limit for healthy workers is 50 ppm. Our sensors will detect concentrations greater than 100 ppm and sound a buzzer.

II. Benzene: The US Occupational Health and Safety limit for exposure of Benzene is 1 ppm averaged over an 8-hour work-shift and maximum 5 ppm during any 15-minute work-period. The most nerve-wrecking fact is that post high-exposure, it may cause sudden death from irregular heartbeat.

III. Methane: this decreases the amount of available oxygen and may cause headaches, dizziness. Excess exposure can lead to adverse health effects such as Cancer. The National Institute for Occupational Safety and Health's methane exposure limit is 1000 ppm for workers over an 8-hour period.

IV. Alcohol: The US Occupational Health and Safety limit for exposure of Alcohol is 1000 ppm averaged over an 8-hour work-shift. Excessive exposure may damage the nervous system and lead to skin, eye problems.

V. Hydrogen sulfide: This is a colorless, flammable and an extremely hazardous gas with a "rotten egg" smell. H2S is also referred to as the "knock down gas" because inhalation of high concentrations can cause immediate loss of consciousness and death. However, prolonged exposure to lower concentrations, such as 10 to 500 ppm. It can cause various respiratory symptoms that range from rhinitis to acute respiratory failure.

4. Proposed System:

Exposure to toxic gasses such as CO can be detrimental and life-threatening. According to the CDC(Centre of Disease Control and Prevention), 5,149 people died of unintentional Carbon Monoxide poisoning in the US between 1999 and 2010. The risk of inhaling toxic gasses persists not only in industries but also at home.

An ideal way to prevent exposure to toxic gasses is to utilize technology and automation. The gas-leakage detector will consist of MQ-2, MQ-7, MQ-135 and MQ-138 sensors. Each of these sensors will be utilized to detect levels of Carbon Monoxide, Methane, Propane, Benzene, alcohol etc. To ensure that the data regarding the concentration of the gasses is accessible by the user, it will be programmed with a MIT application.

5. Technical Solution:

We will be using Arduino NANO as a microcontroller along with the sensors due to its small size. The sensors will detect the concentration of gasses continuously and update it on the server. This is a REAL-TIME based project which uses IoT. If the concentration of the gas exceeds its acceptable exposure limit, a buzzer will sound, and the user will be notified through the application.

6. Need of Factor gas detection system:

1. Cost-effective- Easy maintenance and repair. The microcontroller and components used are less expensive.

2.Real-time data generated- regularly updates the values of the concentration of the gasses on the server.

3. Convenient user interface-MIT app inventor used to design user interface which allows easy navigation and access to data.

4. Automated manual inspection- This can save multiple lives by cautioning users in case of high concentration of toxic gasses.

7. Block Diagram:

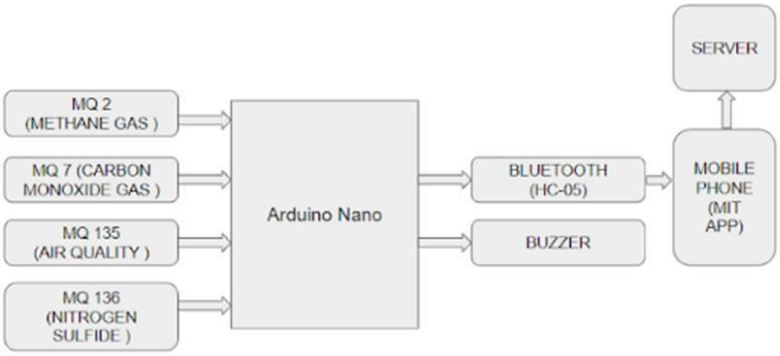

Fig.2-Block Diagram

The block diagram shown above has the Arduino Nano as a microcontroller which acts as the brain of the system. It is interfaced with the input and output devices for the operations. At the input we have four gas sensors which will detect the different gasses as shown in the diagram. After getting the input the microcontroller will receive the gas level and then it sends it to the output.

The output device is the Bluetooth module and buzzer; ;Bluetooth module uses the concept of serial communication which is connected to the mobile device. The continuous monitoring of the sensor value is sent on the mobile with the help of Bluetooth module and with the help of MIT App the values are displayed on the mobile screen. The second output device we have used is the Buzzer. There is continuous monitoring of the sensor value, and it has been updated on mobile so when the value of sensor exceeds the range then it will give the alert via buzzer.

8. **Flow Diagram:**

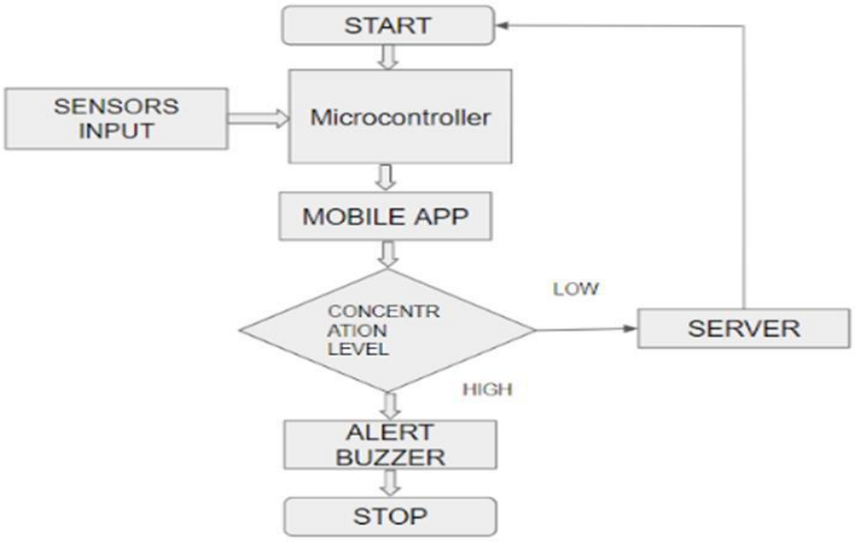

Fig.3-Flow Diagram

Multiple sensors are being installed in the factory to detect the presence of dangerous gasses. utilising sensors We will use Arduino programming to check the concentration level and presence of gasses, and the value of detected gasses (in percentage and PPM) will be sent via Bluetooth by Arduino. When the concentration level Threshold rises, a notification is sent to the appropriate person.

9. **Hardware Description:**

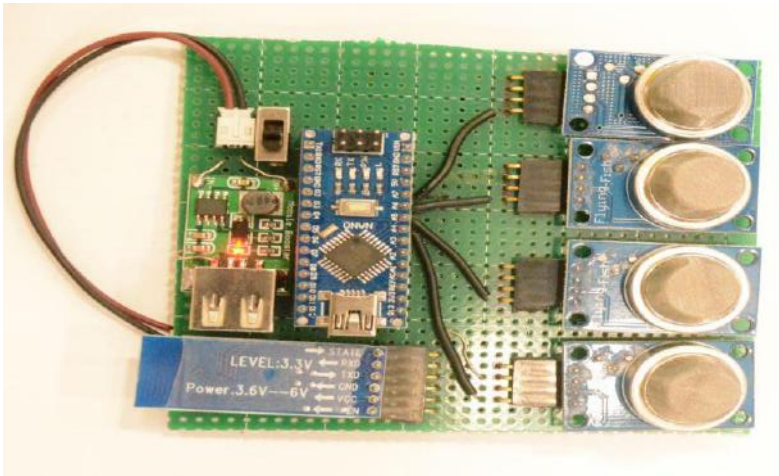

Fig.4-Hardware Description

1. **Arduino Nano:** This is a small microcontroller. It has an operating voltage of 5 volts with 22 Input/Output pins; Analog Pins: A0 to A7 and Digital pins: D0 to D13. Arduino nano is similar to Arduino uno they both use the Atmega328p processor so the programming software we are using is the same i.e., Arduino IDE software. The big difference between them is in size. Arduino uno is twice as big as Arduino Nano; so, to reduce the space in the project we have used Arduino nano.

Fig.5-Arduino nano

2. **Gas Sensors:**

1. MQ-2: This is a metal-oxide semiconductor type sensor. The voltage divider network is used to measure the concentration of gasses in the sensor. It works on 5V DC voltage and can detect concentrations ranging from 200 to 10000 ppm.

Fig.6-MQ-2 sensor

2. MQ-7:Used to detect the concentration of CO in the air. It works on 5V DC voltage and can detect concentrations ranging from 10 to 500 ppm.

Fig.7-MQ-7 sensor

3. MQ-135:This sensor detects concentrations of Ammonia, Sulfide and Benzene steam, smoke and other harmful gasses. This is low cost, operates on 5V DC supply with detection Range:
10 - 300 ppm NH3
10 - 1000 ppm Benzene
10 - 300 ppm Alcohol.

Fig.8-MQ-135 sensor

4. MQ-136:

This is a semiconductor sensor. It is highly sensitive to Hydrogen Sulfide gas and can detect concentrations ranging from 1 to 200 ppm.

Fig.9-MQ-136 sensor

3. **Bluetooth module (HC-05):**

This is a Bluetooth model designed for wireless communication. It has a range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.
It makes use of serial communication with devices. It communicates with a microcontroller using a serial port (USART).

Fig.10-HC-05[7]

10. **Generalized formulas used in Coding:**

We used an analogue sensor with an Arduino to generate analogue values ranging from 0 to 1023. As a result, we must convert analogue values to percentages and parts per million.
We used the following formula to convert analogue values to percentages and parts per million.

- Percentage % = ((analogue sensor value-Minimum) *100)/ (Maximum-Minimum)
- PPM values = percentage value*10000

11. **Integration and Testing:**

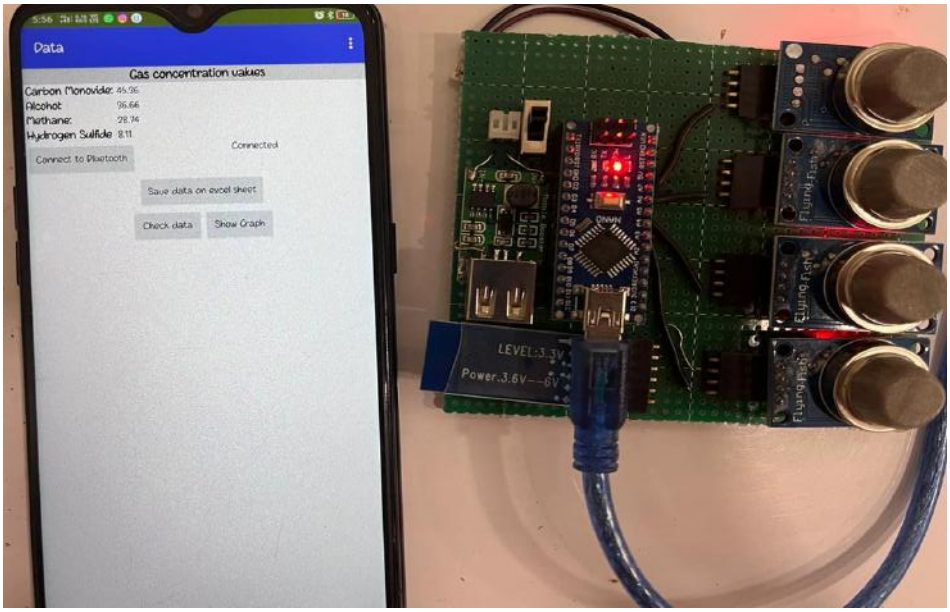

Fig.11-Integration and Testing

The circuit has been turned on to detect any unusual changes in the physical parameters. If there are any changes, the sensors detect them and send the data to the microcontroller, which acts accordingly.

1. For sensing Gas, we have used MQ2,MQ6,MQ135 and MQ136 with arduino Nano board.

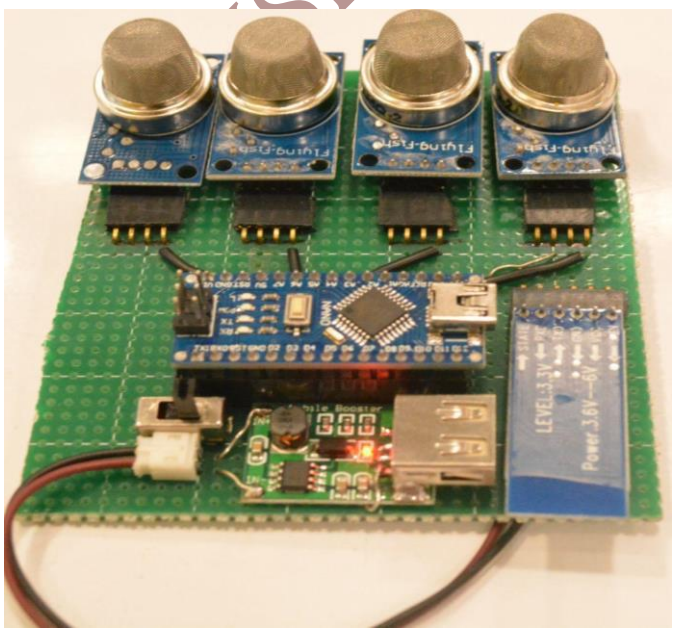

Fig.12-Connection of Arduino and sensors

2.After connection, we uploaded the code using Arduino IDE open software platform.

```
//
float  Map_sensor_value1 = ((sensor_value1 - minimum) * 100) / (maxium - minimum);
float Map_sensor_value2 = ((sensor_value2 - minimum) * 100) / (maxium - minimum);
float  Map_sensor_value3 = ((sensor_value3 - minimum) * 100) / (maxium - minimum);
float  Map_sensor_value4 = ((sensor_value4 - minimum) * 100) / (maxium - minimum);
  delay(1000);
  Serial.print("MQ2 sensor value= ");
  Serial.println( Map_sensor_value1);
  Serial.print("MQ7 sensor value= ");
  Serial.println( Map_sensor_value2);
  Serial.print("MQ135 sensor value= ");
  Serial.println( Map_sensor_value3);
  Serial.print("MQ136 sensor value= ");
```

Fig.13-Arduino Programming

3. For designing android applications, we have Used MIT app inventor platform.

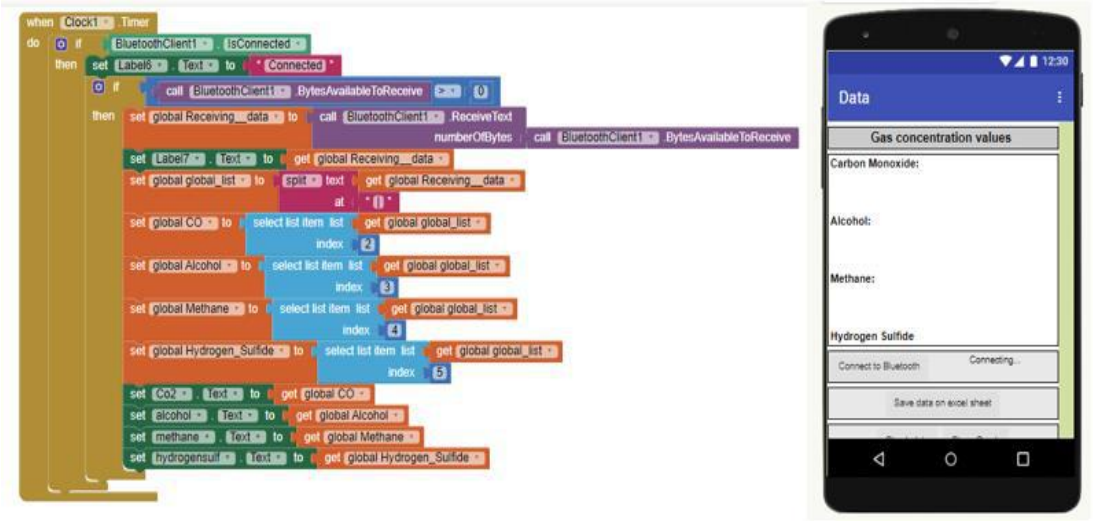

Fig.14-Android application Programming

3. While testing,Users can save all data in the Excel sheet and real time respective person can monitor using android application.

Timestamp	Carbon Monoxide concer	Alcohol concentration:	Methane concentration:	Hydrogen Sulfide concentration:
10/1/2022 10:14:48	10	2	32	43
10/1/2022 10:18:15	20	45	34	4
10/1/2022 10:21:54	3	35	1	3
10/1/2022 13:29:55	5	6	2	3
10/3/2022 11:04:46	6	5	3	4
10/3/2022 11:05:07	51	12	34	1
10/13/2022 11:30:43	0	0	0	0

Fig.15-Data storing in execl sheet

4. Users can check Real time data Graph on an android application.

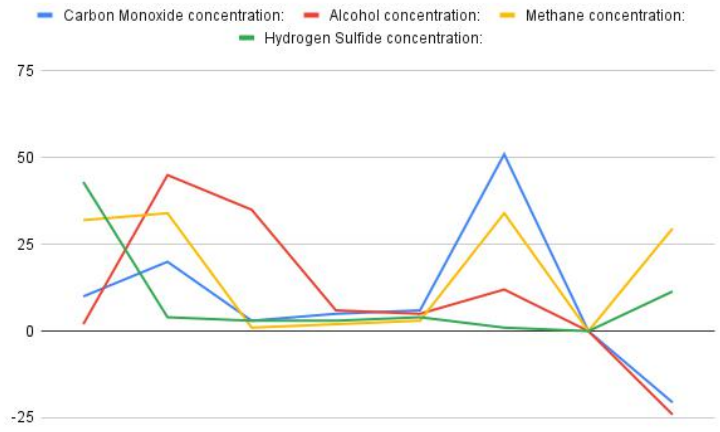

Fig.16-Real time data graph

13. Conclusion:

The designed system is active properly, the gas sensor is successfully detected and displayed natural gas on the application. A notification can be sent to the appropriate person in order to store and monitor the parameters. This system is extremely useful in detecting gas leaks in industry. The proposed methodology aids in the prevention of workplace injuries and accidents.

14. Acknowledgement:
I'd like to thank the mentors at On My Own Technology Private Limited Mumbai for their assistance. I'd also like to express my deepest gratitude to my parents for their support and motivation, which helped me finish my project.

15. Reference:

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