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IOT BASED SMART GAS LEAKAGE DETECTION & ALERTING SYSTEM

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ABSTRACT –

Gas leakages are causing massive explosions in places throughout the world.The conventionally available gas leakage detectors only have the provision to alarm the user who is physically present at the spot . Hence, to overcome this limitation, this project implements a model which sends an email to the user in case there is a leakage. This model detects the leakage of Liquid Petroleum Gas & Benzene. LPG is highly inflammable and results in blasts. Benzene when inhaled in higher concentrations affects the health of workers in industries since it is carcinogenic. Hence, this cost-effective project uses MQ 6 and MQ 135 sensors for detecting the aforementioned gases using Arduino -UNO ,Wifi Module ESP8266 and Thingspeak cloud.

The real-time information of the above-mentioned gases are uploaded in the cloud and displayed in the form of a graph to the user. The prototype of this model generates an email to the concerned person using IFTTT web service. An LED is also used as a visual alarm at the site of leakage.

Keywords: Gas Sensor, Arduino-UNO, Thingspeak,MQ-6,MQ-135,IFTTT, IOT

1. INTRODUCTION

A. Gas and Fire Hazards

Gas leakage is one of the major problems observed in homes and various industries working with Compressed Natural Gas (CNG). Dangerous incidents have occurred due to gas leakage in recent times [1-2]. LPG and propane are highly inflammable gases used in homes and industries due to their low cost, high calorific value and less damage to the environment [3-5]. Gas leaks lead to explosions which results in material loss and human injuries. LPG and Natural gases comprises a variety of gases [6]. According to a study in Colorado and Wyoming, exposure to benzene were calculated to be above recommended levels. The workers could be exposed to dangerous levels, putting their lives at a huge risk. Hence, detection of Benzene is of prime importance [7-10].

The infamous Bhopal gas tragedy of 1984, which claimed the lives of thousands is one of the major accidents due to gas leakage. And another instance, the HPCL refinery disaster destroyed the lives of many families [11].

Early leakage detection is very important in leakage-prone areas like industries.<Figure 1>.

Figure 1: Gas Leakage in industries

B. Scope And Innovation

Gas monitoring system using ArduinO-UNO and Thingspeak cloud is developed to enhance man and machine safety in homes and industries to achieve the following objectives

a.To efficiently detect gas leakage in domestic and industrial areas

b.To provide real time alerts during leakage using IOT cloud thingspeak [12-14]

The main objective of the project is early detection of gas leakage . With the detection of a gas leak the sensor present in the area alerts the control personnel [15-18]. We have also analyzed various wireless technologies and various hardware and software approaches that can be implemented [19-24].

2. METHODOLOGY

A. Architecture

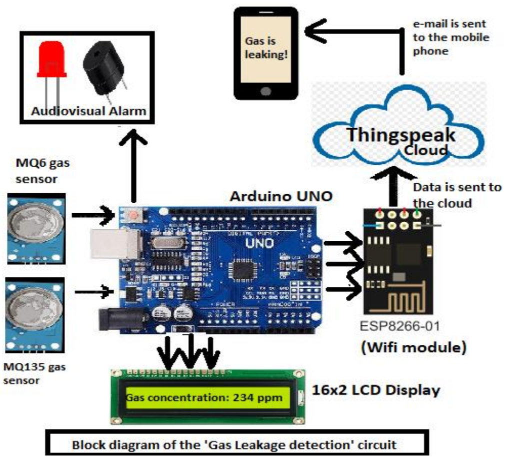

Figure 2: Architecture block diagram

The project as indicated in the <Figure 2> consists of Arduino-UNO, Wifi module esp8266, a 16x2 LCD display, MQ6, MQ135 gas sensors, LED and a buzzer.

The MQ6 and MQ135 sensors read the concentration of LPG and Benzene respectively and provides the proportional voltages which is fed to Arduino-UNO analog pins [36-40]. The microcontroller converts the voltage readings to concentration readings (in ppm) using the formula given in by the user and displays it on the LCD.

The real time updates are sent to the Thinkspeak cloud and stored there instantaneously and can be presented as a graph [31-35]. Any changes in the concentration of the gases that the sensors detect, above a certain threshold (set by the user), is visually alarmed by the LED at the site of leak and is also sent to the cloud. The cloud then uses the IFTTT platform to send an email alarm to the authority-in-charge [40-43].

A. IOT Cloud Thingspeak

ThingsSpeak is a platform that is IoT based that enables you to work on a real-time data cloud. Thingspeak executes MATLAB code which allows the user to perform online analysis and data processing at every instant. ThingSpeak is generally used for prototyping IoT systems [24-25].

Internet of Things involves numerous embedded devices called things, connected to the Internet. These connected devices exchange information with people and provide sensor data to cloud storage and cloud computing resources where the data is processed and examined [26].

The diagram below describes IoT systems at a high level.<Figure 3>:

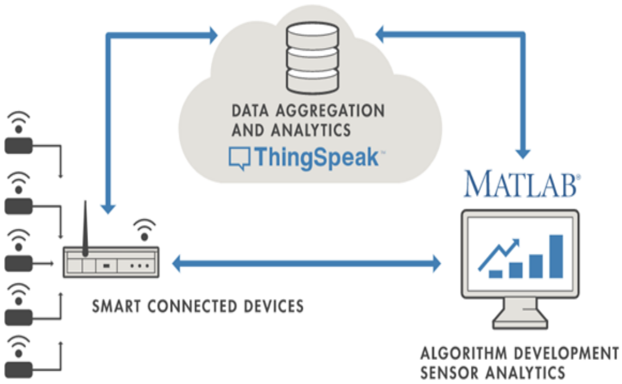

Figure 3: Architecture of IOT Cloud Thingspeak

On the left , are the various smart devices . In the center , we have the cloud where the information is assimilated and analysed in real time.

The right side of the diagram shows the algorithm used for the development of the application [27]. Here the engineer tries to get an overview of the data gathered by performing analysis of the data collected [28]. Here the data is taken from the platform into the desktop to permit the engineer to replicate the algorithm that runs in the device or the cloud itself [29].

ThingSpeak is located in the cloud part of the figure and provides an interface to receive and examine data from the sensors connected [30].

3. IMPLEMENTATION

A.Hardware design

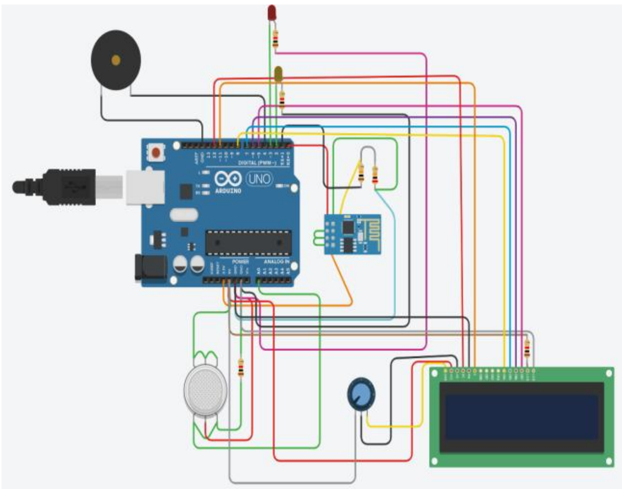

Figure 4: Circuit diagram and connections

Gas sensor

The gas sensors consist of chemiresistors which conduct current. Tin Dioxide(SnO2) is one such chemiresistor with free electrons. The O2 particles present in the atmosphere attract the free electrons in SnO2, to its surface. Hence, due to the non-availability of the free electrons for the conduction of current, it results in 0 output current [31]. When this sensor is placed in a combustible environment, the gases react with the O2 that is bonded with the free electrons and breaks the existing bonds between the free electrons and oxygen, which results in the release of free electrons. Now the chemiresistor conducts current due to the presence of these electrons and this current is proportional to the concentration of free electrons. Using this principle, the MQ-6 and the MQ-135 sensors detect LPG and benzene leakage respectively [32].

Arduino-UNO

Arduinos use a variety of microprocessors. The board has a set of input/output digital and analog pins that are used in the expansion of the circuits through breadboards .The board uses the USB as a link for developing the programs.

Working:

In this project, the Arduino UNO uses voltage values sent by the gas sensors and displays it on the LCD in terms of ppm (parts per million). The Arduino is programmed to make the LCD functional, by using the 'LiquidCrystal_I2C' library on the Arduino IDE. The Arduino also sends it to the Wifi-module (ESP8266). The Wifi module then sends this information to the Thingspeak cloud on a real-time basis and is displayed in the form of graphs [33].

When the concentration of the gas goes above a certain threshold, the buzzer is activated and the LED glows, at the site of leak. Then the IFTTT platform uses the data from the cloud and sends an email <Figure 6>to the authority-in-charge using simple, user-friendly algorithms [34].

B. Software Design and Program

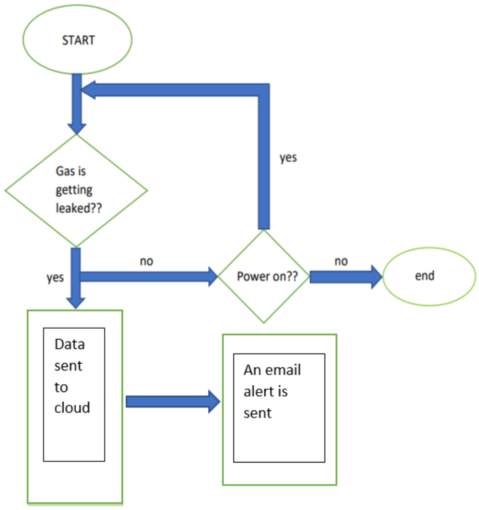

Figure 5: Algorithm of the project

Formula to calculate gas concentration: The following formula is used to compute the gas concentration (ppm) ,whereMQ_Voltage is the voltage read by the Arduino-UNO produced by the gas sensor.

```
MQ_value = analogRead(A0);

MQ_Voltage = MQ_value/1024*5.0;

gas_conc= pow(10,((MQ_Voltage+158.631)/62.877))
```

Program to check the threshold value: Program Statements to check the gas concentration exceeding the set thresholds,

```
{  if(gas_conc>360) // setting threshold

{ lcd.setCursor(0,1);

        lcd.print("Gas is leaking!!");

        digitalWrite(LED, HIGH);   // turn the          LED on (HIGH is the voltage level)

Serial.print(" The gas is leaking rapidly!!Quick action needs to be taken");

        Serial.println(" ");

        }

      if(gas_conc<=360)
```

```
{ lcd.setCursor(0,1);
        lcd.print("                ");
        digitalWrite(LED, LOW);
       }
  }
```

Uploading the data to the cloud and generation of email: The gas concentration levels are uploaded to the thingspeak cloud using the write API Key and using IFTTT web platform email is generated as shown in the figure<Figure 6>.

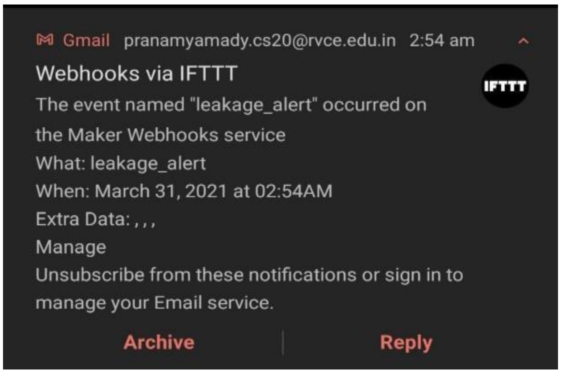

Figure 6: email notification received by authority in-charge

4. RESULTS AND DISCUSSIONS

The system is successfully built using the required hardware and tested practically <Figure 8> .The data collected from the gas sensors was successfully uploaded to the thingspeak cloud .The data was plotted using the graphs and the required alert information was communicated to the user<Figure 7>.

Implementing this system is found out to be more efficient than the previously existing system. And with the introduction of Arduino-UNO the whole project cost was also reduced and human safety level was also increased. Practical applications of the proposed system-

- Used in industries to detect the leakage of toxic gases.
- Used in hotels to detect smoking by customers.
- Used to check the quality/purity of air in offices.
- Used to check concentration of gases in mines.
- Used in detecting fire.

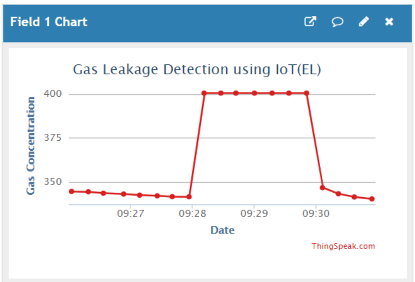

Figure7: Real time graph obtained during leakage

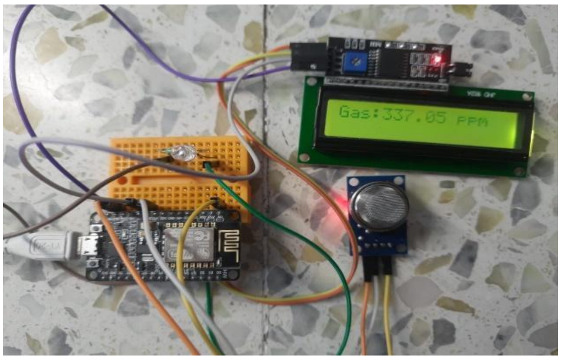

Figure 8:Final assembly of components

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