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IOT Based Gas Leakage Detection System With Database Logging, Prediction And Smart Alerting

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Abstract: *Internet of Things is next generation's aggrandizement of Internet, where network of physical devices are combined with different types of things such as sensors and they exchange data with the help of connectivity to the internet. IOT is advantageous, efficient and its implementation on a large scale has transformed many aspects of the way we live. It is fully interconnected network which provides powerful data collection and analysis capabilities, thus, aiming towards smart world of progress.*
The leakage of gas if undetected can prove to be hazardous and fatal. With the use of IOT, we have implemented Gas Leakage System which includes Database logging, Prediction and Smart Alerting techniques involving sending text message and an e-mail to the concerned authority. The Database Logging is done by storing the sensor values in the database with the help of XAMPP server. The data is stored for maintaining a record and is used for analysis. Naive Bayes algorithm is used for prediction which gives accuracy above 75%.
Keywords : *Data science, Database Analysis, DHT22 temperature and humidity sensor, Gas leakage detector, Internet of Things, MQ5 gas sensor, Prediction, Python, Smart alerting techniques.*

I. Introduction

Liquefied Petroleum Gas is an odorless gas which is highly flammable in nature and thus detection of gas leakage becomes very important to prevent mishaps. To overcome such mishaps, gas leakage detection system is made with the help of IOT. Internet of Things is extension of Internet to provide connection with physical objects. The regular objects can be made smart by addition of sensors and communication interfaces and can be accessible via Internet. Projections for the impact of IoT on the Internet and economy are impressive, with some anticipating as many as 100 billion connected IoT devices and a global economic impact of more than $11 trillion by 2025. [1]

The "IOT Based Gas Leakage Detection System with Database Logging, Prediction and Smart Alerting" is aimed at detecting and constantly monitoring the gas leak and alerting users about the leak and also analyzing the leakage and performing predictions. The main objective of the project is to inform the neighbors about the gas leakage by activating the alarm and informing the user and concern authorities via SMS and Email. Also the data is collected in a database which is used for further predictions and analysis.

II. Related Works

Hina Ruqsar, Chandana R, Nandini et al. [2] have proposed a system that along with monitoring and detection of gas leakage, real time data is made available through real time feed over internet They have used Xively IOT platform to provide real time sensor data over the internet. [2] The proposed paper by Ashish Shrivastava, Ratnesh Prabhaker, et al [3] aims to present a design that not only detects gas leakage but also alerts and turn off main power and gas supplies. It alerts by sending SMS with the help of GSM module.[3]Asmita Varma, Prabhakar S, Kayalvizhi Jayavel [4] have proposed Gas leakage detector system that uses IOT technology which also has Smart alerting techniques like calling, sending SMS and email to concerned authority. The system also cuts of the main power supply of the house or building using relays when the concentration of gas is about to reach a lower explosion limit. The system sends the sensor readings to cloud so that analytics can be done. [4]

III. Requirements Analysis

3.1 Hardware Requirements:

3.1.1 NodeMCU ESP8266:

NodeMCU is an open source interactive IOT platform which is simple and smart. It has inbuilt WiFi called ESP8266 which inexpensive System-On-Chip (SOC)[5]. It is designed and implemented by Expressif Systems. The General Purpose Input Output pins are digital pins on the board. It also has one analog pin AO onboard. It is easy to use and very affordable.

3.1.2. MQ5 gas Sensor:

Also known as Grove-Gas Sensor[6] , this gas sensor is able to detect presence of gas in any given area. This sensor measures the concentration of gas in its surrounding. It first ionizes the gas constituents and then absorbs it by its sensing element. The gas sensor module consists of a steel exoskeleton under which a sensing element is housed [7]. It consists of 4 pins: vcc and ground pin, one analog pin and one digital pin.

3.1.3 GSM module:

It is GSM/GPRS module which is compact and reliably wireless. It is compatible Quad-Band cell phone [8]. It works on a frequency of 850/900/1800/1900MHz. It can be used for oral as well as verbal communications. It is connected to NodeMCU via transmitter and receiver pins.

3.1.4. DHT22 temperature sensor:

DHT22 is low cost digital humidity and temperature sensor which measures the surrounding air using a capacitive humidity sensor and thermistor. It gives out a digital signal on data pin. The DHT22 sensor has four pins, VCC, GND, data pin and a not connected pin which has no usage. [9]

3.2 Software Requirements:

3.2.1. XAMPP:

XAMPP is open source, lightweight and simple Apache distribution which helps to develop local web servers. XAMPP consists of Apache(a web server application),MySQL(open-source database management system),PHP(server side scripting language) and Perl(dynamic high level programming language).[10]

3.2.2. Arduino IDE:

Arduino is combination of a physical programmable circuit board and a piece of software. To write and upload computer code to a physical board this IDE(Integrated Development Environment) is used that runs on computer. [11]

3.2.3. Python:

Python is high-level, interactive, object oriented programming language. It emphasizes on code readability and allows user to express concept in fewer lines of code [12]. Python has features like it is easy to learn, extensible, embeddable, portable, free open-source and has large standard libraries. [13]

IV. Implementation

The system detects and constantly monitors the gas concentration, if it finds the gas concentration to be high i.e. gas leak, it makes use of its alert mechanism to notify users and concerned authorities. It also sends data to database for analysis and prediction which is helpful in future use. The steps involved in working of system are as follows:

1) The MQ5 gas sensor senses the gas concentration in air, DHT22 sensor senses temperature and humidity of the atmosphere and sends the sensed data to the NodeMCU.
2) NodeMCU receives the data and sends it to the database via XAMPP. If it finds the gas concentration to be high, it sends activation signals to Piezzo Electric Buzzer, GSM module and LED.
3) The Buzzer then gives sound indication, LED is turned ON and GSM module sends SMS to the concerned authority. NodeMCU also sends Email to the concerned authority using its inbuilt WiFi.
4) The database receives the data send by the NodeMCU via XAMPP and stores it.
5) The data in database is then analyzed by graphs on user side and is used for prediction using Python.

Figure 1 represents the block diagram of the system and it gives information of all the main processes carried out by the system.

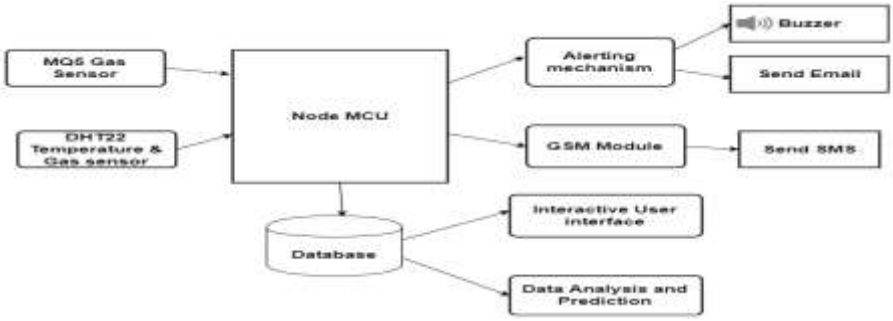

Figure 1: Block Diagram

4. Flow Diagrams

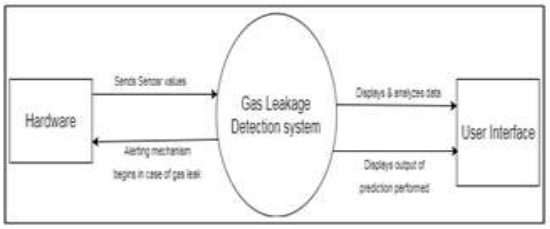

Figure 2: Level 0 DFD

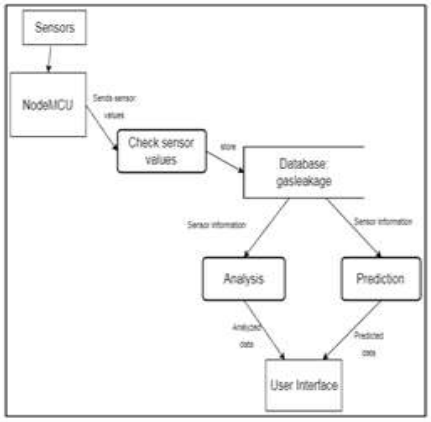

Figure 3: Level 1 DFD

The level 0 Data Flow Diagram shown in Figure 2 gives the overall structure of our system. It explains how hardware and user interacts with the system.

The level 1 Data Flow Diagram shown in Figure 3 explains how the system works. It shows how the sensor values from the sensors are stored in the database and how the user is fed with analyzed data and prediction.

4.1. User interface to interact with database:

Normal webpage is shown to the user. It shows the sensor values stored in the database. It also displays the prediction to the user, for the values entered by him.

4.2. Database analysis and Prediction:

Analysis is done using graphs using the sensor values stored in database. It shows the graph between gas concentration and the temperature at that time.

Prediction can be done using Naive Bayes algorithm. Naive Bayes is classification technique which can solve predictive problems. When attribute values are continuous, an assumption is made that the values associated with each class are distributed according to Gaussian i.e., Normal Distribution. [14].

If in data, an attribute say "x" contains continuous data. We first segment the data by the class and then compute mean μ_y & Variance ${\sigma_y}^2$: of each class , shown by equation (1).

$$P(x_i|y) = \frac{1}{\sqrt{2\pi {\sigma_y}^2}} \exp\left(-\frac{(x_i-\mu_y)^2}{2{\sigma_y}^2}\right) \qquad (1)$$

This approach divides the dataset in the ratio of 7:3, where the majority proportion is for training set and the other is for testing set. According to this, it obtains summary dataset which is then used for prediction for the values entered by the user.

V. Results

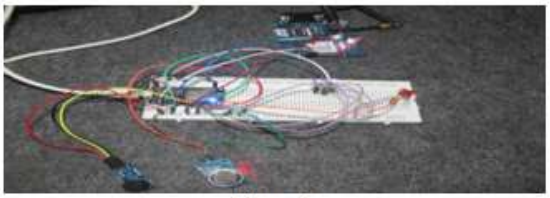

Figure 4

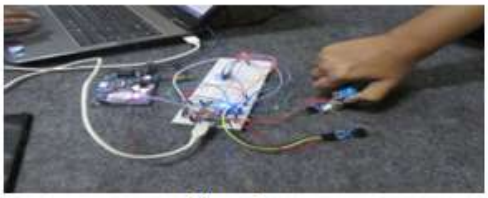

Figure 5

Figure 4 and Figure 5 shows the setup of gas leakage detection system. In figure 4, the gas leak is not yet detected, hence the LED is off initially. When gas leak is detected as shown in figure 5, the LED is turned on.

Figure 6

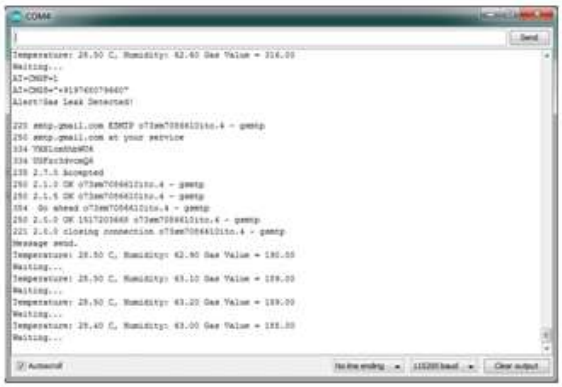

Figure 7

Figure 6 shows the basic main page which connects various other webpages for easy navigation.
Figure 7 shows the Serial Monitor of Arduino IDE which is like an output screen displaying current sensor values and shows if SMS and Email are sent.

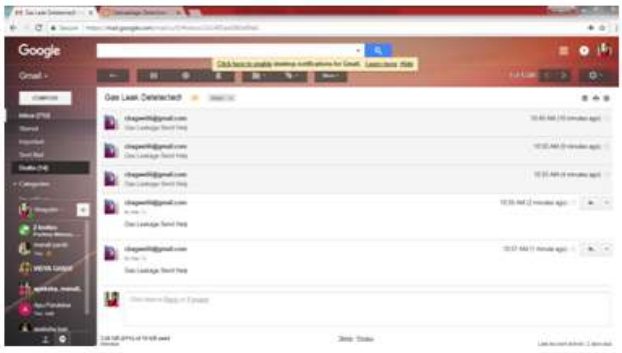

Figure 8

Figure 9

Figure 8 and Figure 9 shows the Email and Text Message sent to the users when gas leak has been detected.

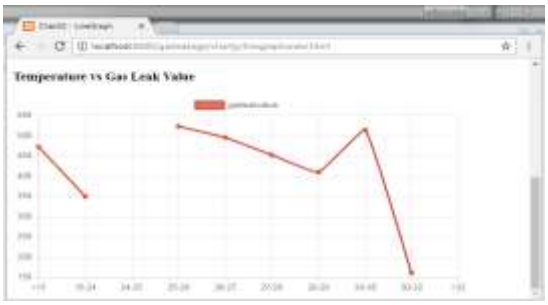

Figure 10

Figure 10 represents the Graph Gas Leak value Vs Temperature which shows maximum gas leakage value recorded for a particular range.

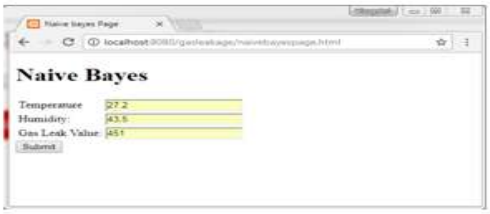

Figure 11

Figure 12

Figure 11 shows a basic form that accepts values of temperature, humidity and gas leakage which further is used for predicting whether alarm will be ON or OFF for given values.

Figure 12 shows a webpage which displays the result of prediction performed on values accepted through the form.

VI. Conclusion

The system provides constant monitoring and detection of gas leakage along with storage of data in database for predictions and analysis. The IOT components used helps in making the system much more cost effective in comparison with traditional Gas detector systems. The system alerts and responds quickly in case of gas leakage with the help of alerting mechanism and by sending SMS and Email to user or concerned authority. The system also allows user to perform analysis and prediction.

VII. Future Scope

1. A Mobile Application can be created for this system which can give information about the concentration of gas present in the area, setting reminders to check gas level, also to predict the gas leak by giving values.
2. The use of Pressure sensor along with the system can provide an extra feature of Automatic Gas Booking. Like other sensors, the pressure sensor can constantly monitor the amount of gas present in cylinder and send a booking SMS if it reaches certain level.
3. Relay motors can be added into the system to provide more safety. These motors can switch off the Main Gas Supply and Main Power supply in case the gas concentration exceeds certain limit.

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