International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 06 | June 2020 www.irjet.net p-ISSN: 2395-0072

IoT Based Real Time Industrial Hazardous Gas Leakage Detection and Alerting System

Parijat Kundu[1], Vaibhav Mishra[2], Pradeep Kumar G M[3]

[1,2]Students, [3]Assistant Professor

[1-3]Dept. of Computer Science and Engineering, S.J.C. Institute of Technology, Chikkaballapur, Karnataka-562101

Abstract – *Gas leaks can be hazardous to all sentient beings and the environment. Due to the lack of real time warning systems, people staying nearby the industries can lose their lives. In this proposed system the detector(s) senses the presence of hazardous gases where they should not be present and informs the nearby people using mobile app. This proposed system includes MQ-135 gas sensor which detects NH3, NOx, Benzene respectively, it uses Arduino Yun Rev 2's on-board Wi-Fi module to send alert to the people using MQTT protocol.*

Key Words: **Internet of Things (IoT), Arduino Yun Rev 2, MQTT Broker, MQ-135 Gas Sensor, Mobile Application.**

1. INTRODUCTION

In this paper we are introducing an IoT based real time industrial hazardous gas leakage detection and Alerting system which alerts against the hazardous industrial gases and proves itself to be life saver in many situations. In this proposed method we make use of Arduino Yun Rev 2 as a controller board, MQ-135 gas sensor, Message Queuing Telemetry Transport (MQTT) broker, and a mobile app (to display the alert in real time). The output of the information captured by the sensor is sent to the particular person using Internet of Things (IoT). Internet of Things brings the ultimate connectivity of various types of devices like phones, tablets, personal computers and so on. The architecture of IoT provides great flexibility and it can improve the intelligence of homes and business models. IoT can be implemented in Home automation, Wearables, Smart cities, industries etc. In Home automation various electronic items like Air conditioners, refrigerators, fans, light etc. can be connected through the internet and can be accessed from anywhere in the world. IoT can be used to detect robberies inside the house or any place of importance. In wearables the watches are connected to the internet and the data from those watches can be used to analyze many useful things. In smart cities IoT can be very beneficial. For an example the garbage collector trucks can be informed in real time by the smart dustbins which has full of waste whenever a garbage collector truck passes by. In that case both the garbage collector truck and the dustbin should be IoT enabled. In industries like oil and gas real time information can be given to the people if any incident takes place with the help of IoT. It encapsulates a vision of a world in which billions of objects with embedded systems, communication means, and sensing and actuation capabilities connects over the IP network. Smart objects and cyber-physical systems or just "things" – are the new IoT entities the objects of everyday life , embedded with microcontrollers, optical and radio transceivers, sensors, actuators, and protocol stacks suitable for communication in constrained environments where target hardware has limited resources, allowing them to gather data from the environment and acupoint ,and giving the man interface to the physical world. The IoT objects can be worn by users or deployed in the environment. These objects are highly constrained, with limited memory and available energy storage, and they are subject to stringent low-cost requirements. Moreover, this system alerts people in real time which can play a vital role in minimizing the response time to provide rescue.

2. LITERATURE SURVEY

[1] Microcontroller based low cost gas leakage detector with SMS alert: Here, the system measures the gas leakages at permeable places. It automatically detects the gases if the concentration goes above the predetermined level. Simultaneously the LED and the buzzer are turned on and an SMS is sent via the GSM module. This system has a GSM module which is connected to a Microcontroller. If somehow the GSM module stops working the detection is affected and eventually the system fails.

[2] Gas Leakage Detection and Smart Alerting and prediction using IoT: This system deals with the leakage of harmful gases where they should not be present. Arduino UNO, Ethernet shield, GSM module, and MQ-2 gas sensor and ThingSpeak cloud platform are used for the proper functioning of the system. If the hazardous gases concentration exceeds the threshold the system sends an E-Mail to the higher authority about the hazard. The system also gives call to fire station and Ambulance. Perhaps this

system has disadvantages. Firstly, its alert services are restricted to only Higher Authorities. If the Higher authorities take longer time to respond to the alert then it could put everyone's life at stake. So, every single person should be alerted in the stipulated time. Secondly, it does not have a dedicated mobile application which every single person should have.

3. EXISTING SYSTEM

At present day we come across various incidents about gas leakages and industrial accidents which cost the life of the workers, people staying nearby the industry and other animals. The Bhopal gas leak incident which took the life of at least 3787 people and recently the Visakhapatnam gas leak which took the life of at least 11 people are examples of hazardous industrial gas leaks. There are many systems and methodologies for the gas detection and prevention but many of them are not efficient and are lacking the features to alert about an incident in real time

4. PROPOSED SYSTEM

With the help of the proposed system we can easily detect any sort of hazardous gas leakage around the industry and alert them in real time using a dedicated mobile application. We are not only interested to inform the local disaster management organization but also interested to let every people nearby the industry, and people in different states of a country to know about the incident. This increases the awareness in people and they are not dependent on any higher authority, they don't need to wait for their responses and they immediately can take care of themselves. We have also used a very advanced Microcontroller board i.e. Arduino Yun Rev 2, which has Ethernet and Wi-Fi connectivity. If the one fails then the other can be used to keep the system connected to the internet and keep people informed about any incident. We collect the data from the sensors and send it to the MQTT broker and later broadcast it to the dedicated mobile application. In this proposed system we have used Android application. The people nearby the industries or faraway can use the dedicated android application using which they need to subscribe to the particular alerting service.

4.1 Block Diagram

The block diagram gives an overview of all the components which are integrated and working together. Each block specifies each components and arrows specifies the integration among the various blocks.

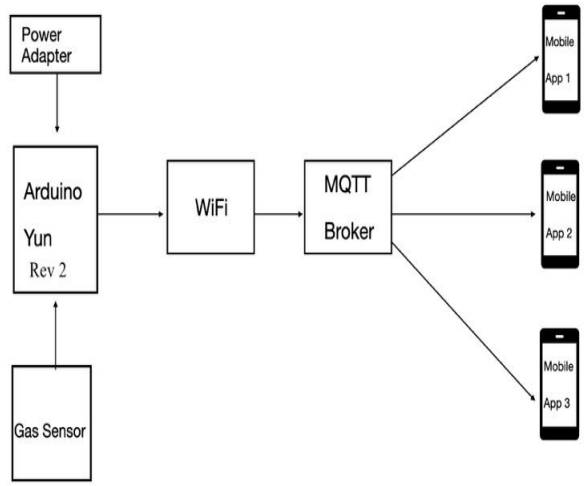

Fig-1: Block Diagram.

4.2 Working Principle

Working of this system is based on the principle of detect and alert. i.e. as soon as the gas leakage is detected an alert is send to the person.

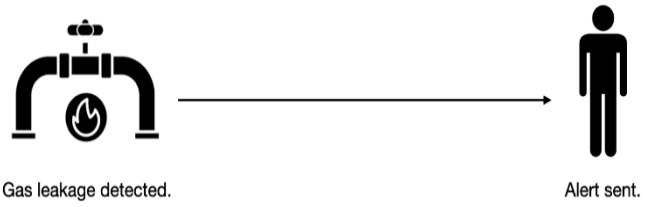

Fig-2: Working Principle.

4.3 Working

At first the Gas Sensor is kept in the sensitive area of the industry which is vulnerable to leakages. The sensor is connected to the Arduino Yun Rev 2 microcontroller in which code is pushed, the data from the sensor is processed in the microcontroller. Then the system is connected to the internet via the inbuilt Wi-Fi module of the Arduino board. If the sensor data crosses the threshold then an alert is published to the topic of the MQTT broker. The MQTT broker further sends the alert to the appropriate subscribers which had subscribed to the particular topic i.e. "Hazardous Gas Leak" on their dedicated mobile applications. The subscribers are the dedicated mobile applications which are used by the nearby people staying near the industry. If the people subscribe to the topic i.e. "Hazardous Gas Leak" then only they will get the alert. The alert is not only restricted to

the people nearby but also anyone who has subscribed to the topic staying in other states of a country. People have to install the dedicated mobile application on their mobile phones to get alerts. Then they can choose the topics about which they want to get the alert.

4.4 Flowchart

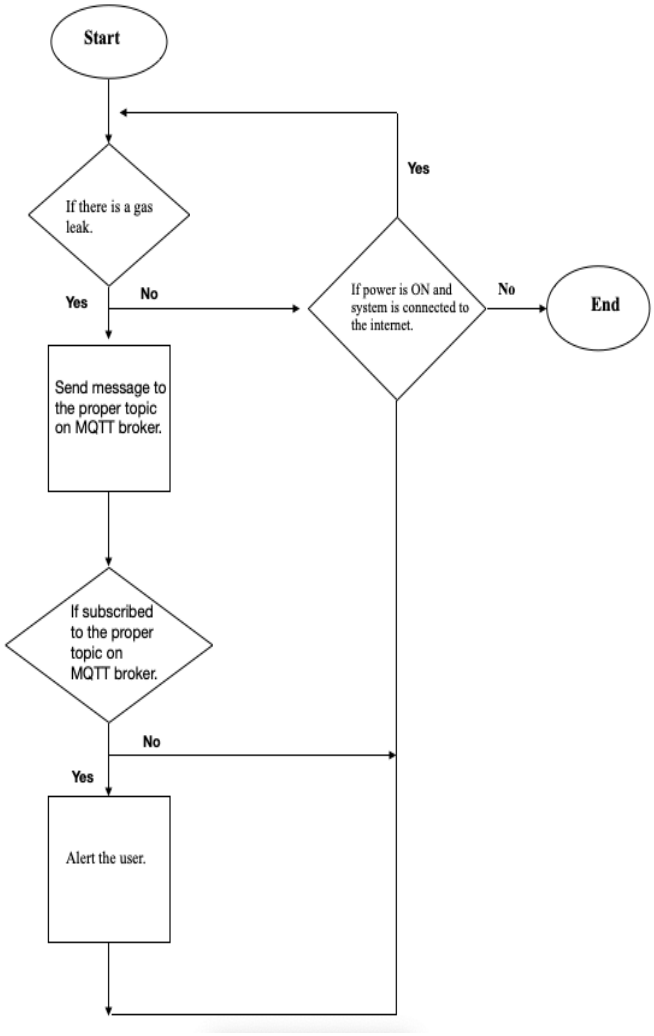

Fig-3: Flow chart.

4.5 Steps for Android Application

For designing the application, we will be using android studio, it's an all platform, freeware IDE by google used to develop Android apps.

I. Create an Android studio project

II. Screen Layout

Next step after setting the activity customization screen to design the screen layout. This includes setting the screen layout according to the device and application by considering all the aspects related to the display.

III. Screen Logic

Next, we have to add logic to the screen that will make it dynamic and create notification when new message is received from the sensor.

1. There will be three methods autogenerated by Android Studio to manipulate stacks and Menu related options in the app.

2. We have to add two methods:

    1. The first method is used to update the screen with the new messages form the sensor

    2. The second method will create a real time notification on phone or tablet to alert the user.

So as soon as the message from the sensor is received the app will notify it in real time.

IV. MQTT client

The final piece of the app will be MQTT client. This client will connect to the MQTT server and subscribe to the related topics, in this scenario its hazardous gas leak. Necessary MQTT libraries must be downloaded and included in the app module. Next step will be to connect it to the MQTT server and subscribe to the topic(s). And in last a buffer should be created to handle the notification messages from the server.

4.6 Result.

On Detection of the hazardous gas the mobile application gives an alert with the name of the industry from where the gas leaked. So, if people get any alert about a gas leak, they will see the name of the industry and the place where it is situated. If the people find the industry nearby them then they can move away from that place and get to a safer place.

Fig- 4: Android Application Output.

5. COMPONENTS

5.1 Arduino Yun Rev 2

The Arduino Yun Rev 2 is a microcontroller board. It has built-in Wi-Fi and Ethernet support, a USB-A port, micro SD card slot, 20 digital input/output pins etc. The Yun Rev 2 has the ability to communicate with the Linux distribution onboard. In addition to Linux commands we can write our own shell and python scripts. The main advantage of using this board is that it has onboard Wi-Fi and Ethernet support in order to connect to the internet. While few boards don't have any internet, connectivity supports. Another plus point to use Arduino microcontroller boards is that every element of the platform hardware, software and documentation is easily available and is open source. An Arduino IDE is required to write code and push the code into this Arduino board.

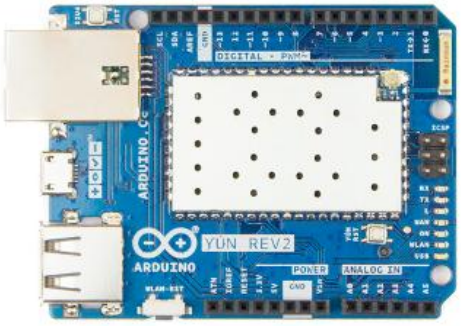

Fig- 5: Arduino Yun Rev 2.

5.2 MQTT Broker

MQTT broker implements MQTT protocol which is a light weight protocol used over the TCP/IP protocol. MQTT is very simple to design and implement. The above-mentioned properties make it ideal for Machine to Server(M2S), Server to Server(S2S), Machine to Machine (M2M) connections and also in the context of Internet of Things (IOT). It follows the publish subscribe model. The MQTT broker uses a concept of topic to notify all the subscribers about the relevant data. A topic is similar to the newsfeed in which you subscribe to certain topics on which you want to receive the news. In our proposed system the topic could be "Hazardous gas Leak". Here, publisher could be a sensor attached to an Arduino device and subscriber could be mobile applications, Websites, or other devices Figure 6 Provides an overview about MQTT broker.

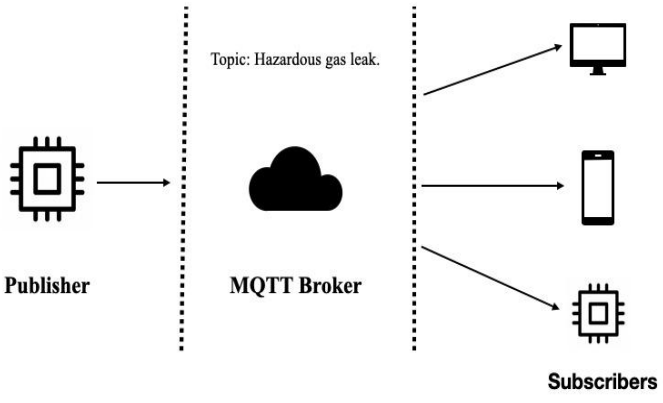

Fig-6: MQTT Broker.

5.3 MQ-135 Gas Sensor

Our proposed system uses sensor to sense its surroundings which are vulnerable to gas leakages. In our proposed system we are using MQ-135 gas sensor, any other gas sensor can be used depending upon usage and type of gas to

be detected. MQ-135 is a sensor module which is suitable for detecting and measuring of NH3, NOx, Benzene, Smoke etc. The sensor comes with the digital pin which make the sensor to operate even without the microcontroller and proves efficient when tries to detect one particular gas. One can use the MQ-135 sensor in both analog and digital pins. The MQ-135 sensor has a lot of features including wide detecting scope, fast response, high sensitivity, stability, long life etc. The operating voltage is 5V. Its analog output voltage range is from 0V to 5V, and the digital output voltage range is from 0V to 5V (TTL Logic). The gas sensor acts as a MQTT publisher that is connected to a Wi-Fi enabled Arduino board (in our proposed system it is Arduino Yun Rev 2) or other gateway like Ethernet shield, ESP8266 in order to connect us to the MQTT broker. The MQTT broker has topics and the subscriber sends the message to the particular topic. After that the MQTT broker does the needful by sending the message to the subscribers who has subscribed to the topic.

Fig- 7: MQ-135 sensor.

5.4 Mobile Application

Now we require a stand-alone mobile application to which the alert can be pushed in real time. The mobile application can be an android application or an iOS application based on user's choice. The mobile application acts like a MQTT subscriber which subscribes to a particular topic example "Hazardous Gas Leak". There might be many topics but the user might choose the appropriate ones. The application will retrieve the data from the server and will show it to the end users. i.e. in the time of emergency, the alert will be published on the application interface by which the people around the place of incident can be alerted in real time.

Fig-8: An interface of subscriber application when no gas has been detected.

6. CONCLUSION AND FUTURE SCOPE

Our proposed system detects the leakage and alerts the workers working inside the industry as well as people living nearby the industry. It makes the people independent of any higher authorities help. It is also capable to inform other people staying in different cities across the country who opts the service. This system is more accurate because of the usage of Arduino Yun Rev 2 which is an advanced microcontroller board and MQTT protocol which minimizes network bandwidth for the Internet of Things (IOT). The system also has a lot of scope for improvement, Google map (APIs) can be integrated with the proposed system. This improvement would let the people know about the particular area.

7. ACKNOWLEDMENT

We thank the department of Computer Science and Engineering of S.J.C Institute of Technology Chikkaballapur, Karnataka, India for permitting us to use the computational facilities available in the center for Research and Development cell.

8. REFERENCES

[1] A. Banik, B. Aich and S. Ghosh, "Microcontroller based low cost gas leakage detector with SMS alert," 2018 Emerging Trends in Electronic Devices and Computational Techniques (EDCT), Kolkata, 2018, pp. 1-3, doi: 10.1109/EDCT.2018.8405094.

[2] A. Varma, Prabhakar S and K. Jayavel, "Gas Leakage Detection and Smart Alerting and prediction using IoT," 2017 2nd International Conference on Computing and Communications Technologies (ICCCT), Chennai, 2017, pp. 327-333, doi: 10.1109/ICCCT2.2017.7972304.

[3] M. B. Yassein, M. Q. Shatnawi, S. Aljwarneh and R. Al-Hatmi, "Internet of Things: Survey and open issues of MQTT protocol," 2017 International Conference on Engineering & MIS (ICEMIS), Monastir, 2017, pp. 1-6, doi: 10.1109/ICEMIS.2017.8273112.

[4] A. F. Oklilas, R. Zulfahmi, Ermatita and A. P. Jaya, "Temperature Monitoring System Based on Protocol Message Queue Telemetry Transport (MQTT)," 2019 International Conference on Informatics, Multimedia, Cyber and Information System (ICIMCIS), Jakarta, Indonesia, 2019, pp. 61-66, doi: 10.1109/ICIMCIS48181.2019.8985356.