Ammonia Leakage Preventive and Monitoring System

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ABSTRACT: The purpose of this project is to improve unconventional measuring method of ammonia leakage that are either handheld or mounted fixed to a wall in which limit its purpose to only measuring. The project integrates Internet-of-Things (IoT) technology which helps monitor the reading of the sensor from a safe distance and also includes a preventive system that works as a feedback that responds to the reading of the sensor that will control water pump for the containment of ammonia gas leakage. The system of the project revolves around transmission of data from the sensing unit to the broker where it is stored momentarily and is displayed into web application where user will be able to access to monitor readings from the sensor. The transmission of data is done via MQTT protocol using publish and subscribe execution. The results obtained shows the ability of the proposed prototype to correctly display the required reading.

Keywords: *Internet-of-Things; ammonia gas leakage; sensor*

1. INTRODUCTION

Ammonia gas is widely used in industrial manufacturing due to its diverse functionality. Production of medicines, pesticides and other chemicals that rely heavily on ammonia. Factories that utilises ammonia gas faces the dangers of ammonia leakage which puts nearby personnel at a risk of ammonia inhalation. Inhalation of ammonia even at non-lethal concentrations would cause several symptoms to appear. The symptoms appear may vary from difficulty in breathing, burning sensation of the eyes, nose, throat and irritation of the skin [1]. Prolonged inhalation however, leads to death. Most factories install ammonia gas sensor that are either handheld or mounted fixed to a wall to detect leakage. It is an inefficient way of handling ammonia gas leakage due to its close-proximity approach in measuring the concentration of the leaked ammonia gas. With that given, it is important for the project to be able to detect the presence of ammonia gas as shown in the work of [2-6].

However, the system should not only detect its presence but also its concentration in ppm (parts per million). To stop ammonia gas leakage from worsening, the system's countermeasures must be able to respond and neutralize ammonia gas at a certain amount of concentration of ammonia gas leakage in order to contain ammonia leakages. Other than that, the system must also be able provide access to the readings obtained from the sensor. The proposed system does not only detect ammonia gas but also with added countermeasures and system that utilises IoT for distant monitoring.

2. METHODOLOGY

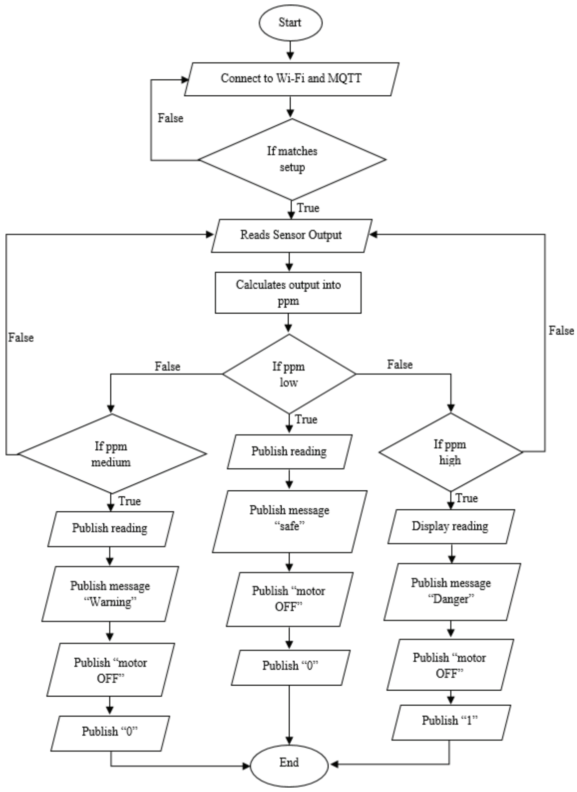

Figure 1: Flowchart of proposed system

Figure 1 show the flowchart of the proposed system. The system revolves around the sensing unit that is comprised of Node MCU and gas module. The sensing module is responsible for reading and publishing data from the gas sensors. In order for the sensing module to execute its task, it first needs to latch itself to a Wi-Fi connection where the host of node-red is also connected to it as well. The reason behind this is due to the limitation of MQTT protocol where it can only authorize publishing and subscription of data to devices if they are connected to the same Wi-Fi connection with the host. In this case, the host is set on Raspberry-Pi and is accessible by entering its IP address which varies according to the router used. Any devices with web browser installed is able to read the readings of the sensor which feeds real-time data. The preventive side of the system consist of a motor that will pump water into sprinklers. The motor will only be triggered depending on the reading of the sensors in which the threshold is set differently according to the type of sensor.

The electrical design for the system consist of three node MCU with its own gas sensor module that powered by a 9V battery. NodeMCU is used to make this system available for IoT. To store data and programs, this NodeMCU provide 128 KB RAM and 4MB flash memory. It has high processing power with in- built Wi-Fi / Bluetooth and Deep Sleep Operating features. To produce output that will trigger when the sensor give a danger state, motor pump 9V that have at most 6 liters per min is used. Raspberry Pi is connected with the motor pump to control the time for motor to pump the water. Motor pump will run until the contamination turn back to safe state after 30 seconds.

The gas sensors used are from the MQ series which are MQ-2 [7], MQ-135 [8], and MQ-137 [9] since the MQ sensor series is not limited to only one type of gas. These sensors require calibration since the output on these sensors are in ADC values [10].

The sensitivity characteristic for CO of MQ-2 sensor is 34.1075 ppm, NH_3 of MQ-137 sensor is 8.6108 ppm and CO, NH_4 and CO_2 of MQ-135 sensor are 200 ppm, 46.5954 ppm and 50.4541 ppm, respectively that will be used in this project [10]. Meanwhile, the graphical design of web is done over the Node-Red software [3] of the Raspberry Pi.

3. RESULTS AND DISCUSSION

Figure 2: System Output of the Sensors

Figure 2 shows the acquired system output. There are 2 meters for MQ-2 smoke sensor and MQ-137 ammonia sensor but only 1 meter for air quality. The reason behind this is because the MQ sensor series is not limited to only one type of gas detection. For example, the MQ-2 smoke sensor is able to detect CO (carbon monoxide) and LPG (liquefied petroleum gas). But if LPG were present, the CO meter under MQ-2 smoke sensor would increase even though calibrations were made. An ADC meter is added to detect other gases within the detection range. The graph in Figure 2 shows the reading of sensor against time. However, the graph can only store readings up to 24 hours and it will be overwritten with a new readings.

4. CONCLUSION

In conclusion, this proposed system shows the ability to correctly display the required reading. However, there are few limitations of the project, which is the system sends data in real-time and the storage is in the form of a graph and the data is stored momentarily for 24 hours at most. Hence, database is required to store previous readings and becomes retrievable for user to monitor. Besides that, another countermeasure that can be added to the project is warning alarm to warn and evacuate the factory personnel.

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