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Automated Smoke and Gas Leakage Detector with IoT Monitoring System in Rural Area

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Abstract: The majority of explosions are triggered by gas leakage that goes unnoticed in the pre-detection stage. A gas leak resulted in a tragic accident because it has optimal properties such as high heat value, less smoke, less soot, and less environmental impact, liquefied petroleum gas (LPG) or propane. The objective of this project study is to design a tool using technology and the internet of things (IoT) that functionally detects and prevents wireless threats. A device made from microcontroller Arduino UNO that controls all activity of the device alongside node WiFi module, nodemcu ESP8266 that connected and communicated using the internet to send a notification warning to users. The device's efficiency is examined in this study by running multiple trials to see how well the sensor responds to gas or smoke leaks. The system displayed a success rate of 25 out of the total of 30 repeated measurements, giving the device efficiency of 83 percent. This project demonstrates that it is able to detect and monitor gas leaks in a reasonably enclosed space. The module may be used as a household application to monitor and take appropriate control actions in various conditions.

Keywords: Automated Smoke, Gas Leakage Detector, IoT, Monitoring System

1. Introduction

Smoke and gas leaks are a severe concern in many areas nowadays, including residential structures, industrial facilities, compressed natural gas (CNG) buses, automobiles, and other vehicles. Mostly gas leaks resulted in a tragic accidents due to its optimal properties such as high heat value, less smoke, less soot, and less environmental impact, liquefied petroleum gas (LPG) or propane is used in various applications (such as houses, hotels, industry, autos, and transportation) [1]. Liquid petroleum gas (LPG) is extremely combustible and can cause a fire even if it is far from the source of the leak. This source's energy is mostly made up of propane and butane, both of which are extremely combustible compounds. These gases are easily flammable. In households, LPG is mainly used for cooking [2].

The Internet of Things (IoT) is a concept that recognizes many things/objects that are ubiquitous in the world. They can communicate with each other using wireless and wired communication and special

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communication schemes, and collaborate with other things/objects to build new applications. The realization of the Internet of Things includes smart home, smart power and smart metering, smart infrastructure, and the promotion of traffic control and supervision [3].

Based on the background, smoke and gas leakage often happens in many applications. This action needs a system that detects early leakage. Therefore, with current technology such as the internet of the things (IoT), it is possible to propose this research goal is to create a tool [4]. A tool for wireless detection and prevention system. This project is designed to detect and monitor the leak of the gases relatively in the closed places. The module can be employed as household application to supervise and apply control action on different situations accordingly [5].

In this project, we want to propose an IoT system with ability to detect smoke and Gas Leakage (like LPG leak, Butane leak, Methane leak) or any such petroleum based gaseous substance that can be detected using sensor network with Arduino UNO. In order to this device in IoT, we had developed an automated smoke and gas leakage detection monitoring by implementing the Blynk apps and ThingSpeak using ESP8266 WiFi module. Then, evaluate the system efficiency, record time it takes for the system to respond to the gas and also test the functionality and realizability of the of the smoke and gas detector which can be apply in any area of the field.

A number of research papers have been published on gas leakage detection techniques are related from alerting platform. [6-10]. One of research that related to paper is Asnor Juzairi et al proposed the GSM based gas leak monitoring system. In this paper, the system will be activated once the module detects that the gas concentration is altered, and accordingly the control action turns the alarm system alongside with air puller device ON, and sends a warning SMS to a certain recipient using GSM module [6].

2. Materials and Methods

The sensor used in this project are connect to Arduino UNO which continuously monitor the gas leakage and room temperature. With the Arduino UNO, users are able to create their own code to set how the device works. The user may control how the device functions in terms of programming language by using this. If the value of this sensor changes, the mobile application sends a notice to the server. The Nodemcu ESP8266 that act as the communication for Arduino UNO, the Blynk Server and ThingSpeak. The MQ-5 gas sensor is used to measure the LPG gas in atmosphere while the DHT22 used in this project is used to measure the temperature and humidity of the system. If the leakage is identified the presence of gas, smoke and temperature, applications gas indicator level increase to particular value. If the value is greater than threshold value then the system checks MQ5 sensor value and notify the user and turn on the exhaust fan by using the 5v relay module. The simulation software was done by simulated using the Proteus for the schematic design and also the verifying the coding into Arduino IDE.

2.1 Materials

a) Hardware Equipment

- MQ-5 sensor

In this project, MQ-5 that shown in Figure 1 is very useful for gas leakage detecting. It can detect LPG, i-butane, methane, Alcohol, Hydrogen, smoke and so on [9]. Due to its properties MQ-5 is most sensitive to LPG. The sensitivity can be adjusted using the on-board potentiometer, and used this sensor by reading the analog pin to which it is connected. The sensor is also supported with Arduino product which the main reason why Arduino UNO is being used as the microcontrollers for this project.

Figure 1: MQ-5 sensor

- Temperature sensor (DHT22)

With a single wire digital interface, the DHT22 that shown in Figure 2 is a low-cost digital temperature and humidity sensor [10]. It measures the ambient air with a capacitive humidity sensor and a thermistor and outputs a digital signal on the data pin (no analogue input pins needed). It uses a proprietary digital signal collection approach as well as humidity sensing technology to ensure its dependability and stability. The sensor is calibrated and requires no additional components, so you can start monitoring relative humidity and temperature straight away. It's simple to use, but data collection necessitates precise timing. It can only provide you knew info every two seconds.

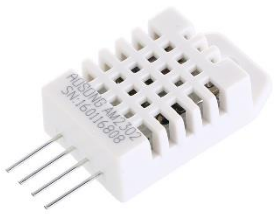

Figure 2: DHT22

- Arduino UNO

Microcontroller used in this project is Arduino UNO like in Figure 3. The Arduino Uno is an open-source microcontroller board dependent on the Microchip ATmega328P microcontroller and created by Arduino [12]. The board is outfitted with sets of computerized and simple information/yield (I/O) sticks that might be interfaced with different extension sheets (shields) and other circuits. The board has 14 advanced I/O pins (six equipped for PWM yield), 6 simple I/O sticks, and is programmable with the Arduino IDE (Integrated Development Environment), through a sort B USB cable. It can be fueled by the USB link or by an outer 9-volt battery; however, it acknowledges voltages somewhere in the range of 7 and 20 volts. It is additionally like the Arduino Nano and Leonardo.

Figure 3: Arduino UNO

- NodeMcu ESP8266

NodeMCU is a minimal-cost IoT free software platform that shown in Figure 4. It originally included firmware running on the Espress if Systems, and hardware premised on theESP-12 module. Later, assistance for the ESP32 32-bit MCU was managed to add. The programming paradigm of

NodeMCU is identical to that of Node.js, except in Lua. Its bidirectional and incident-driven. Thus, many processes have callback parameters [1]. The module has a built-in USB connector and abundant pin outputs. Using a micro USB cable, you can connect the NodeMCU devkit to your laptop and flash it in easily, just like an Arduino. It is also immediately friendly to the breadboard

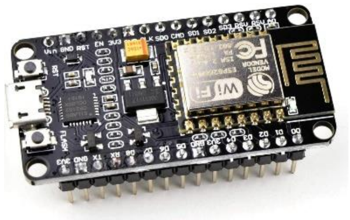

Figure 4: NodeMCU ESP8266

b) Software equipment

In this project, the software that used are the Proteus 8 professional that function to design and simulated the project before implementing into the prototype. Next, Arduino UNO ide that function as verification coding for device Arduino UNO and nodemcu ESP8266. Then, for the communication platform used the Blynk and Thingspeak as IOT system.

2.2 Methods

The proposed method is mainly focused on processing monitoring and management by Arduino UNO and communicated to IoT system by using Nodemcu ESP8266. This system is extremely adaptable and simple to manage. It is not necessary to use manpower. Figure 5 shows a dataflow graph explaining block diagram of gas and smoke detection using Arduino UNO

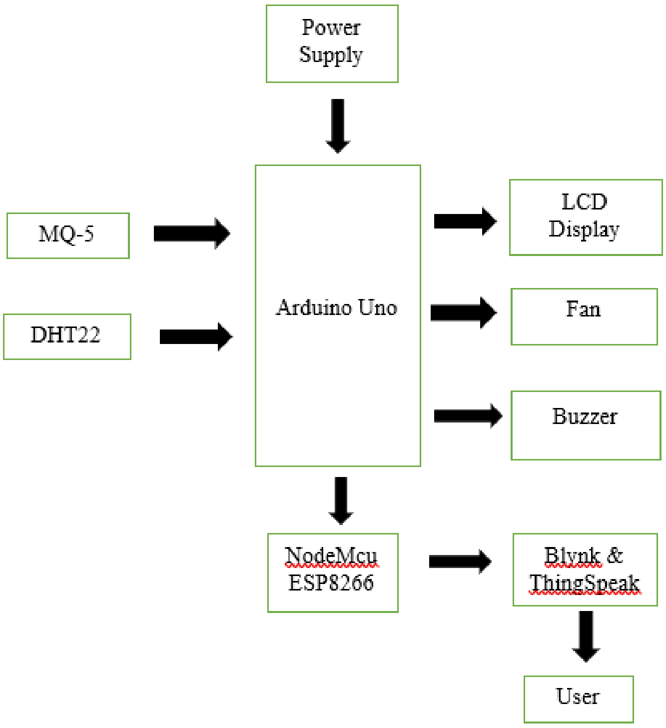

Figure 5: Block diagram of gas and smoke leak detector

Figure 6 shows the structure diagram for the purposed project. Arduino will be the main microcontroller of this project. As one of the alert platforms, the task of sending notifications to users is the Blynk module. This project will use ESP8266 NodeMCU WiFi module. The buzzer will serve as an auxiliary alarm platform for the equipment. The MQ-5 sensor will be used as a trigger to activate the device. It will detect all the liquefied petroleum gas present in its environment. LCD displays information as the third alarm platform of the device. The addition of DHT22 will respond to the temperature of gas and smoke leak that can synchronous and activate the exhaust fan.

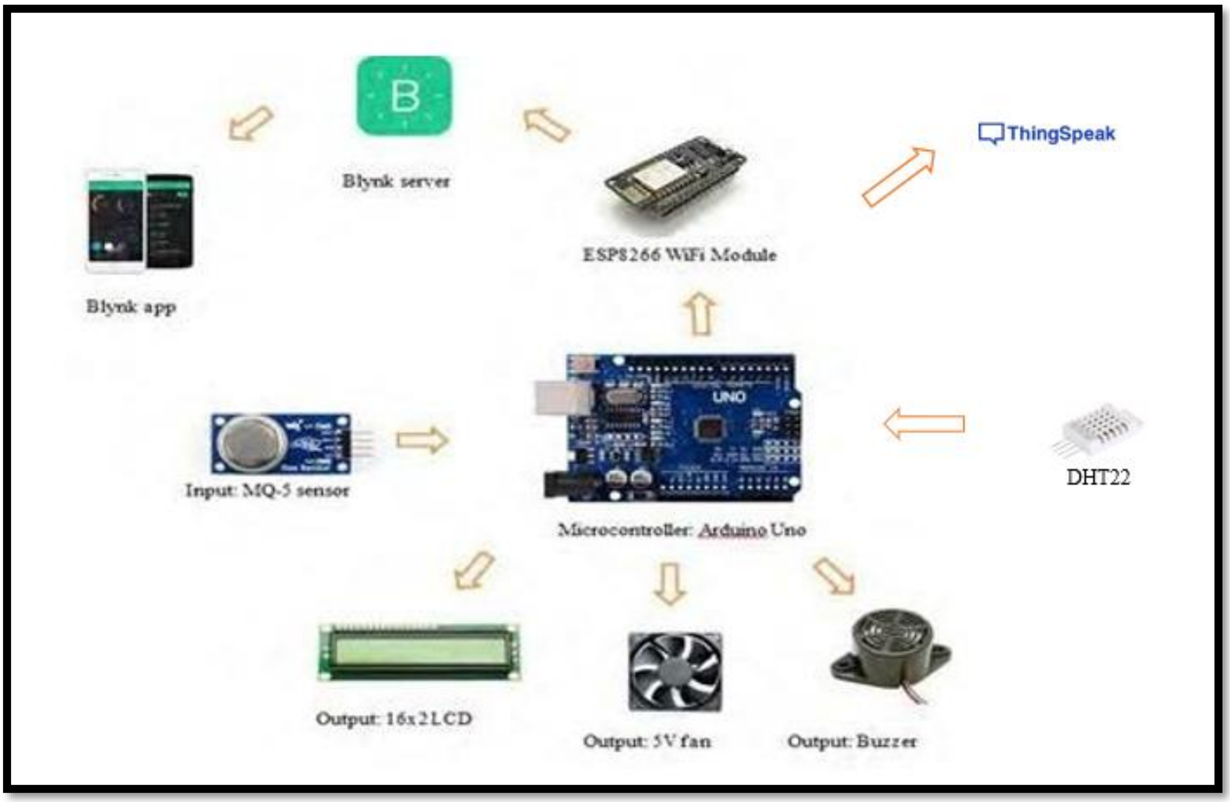

Figure 6: Structure diagram of purposed system

According to Figure 7, the operation of the proposed project can be explained in the form of a flowchart. The first step of the operation is to turn on the device that receives power from the 9v battery unit. Then the device will enter standby mode, if the sensor detects any smoke and gas, the buzzer will light up, the LCD display will display "Smoke and gas detected", and finally the ESP8266 module will send data to the user's smartphone through the following method Blynk the server notifies the user that a leak has occurred. ThingSpeak server also received the data of gas and smoke leak into the web server. When all the alarm systems have completed their work, the LCD will return to normal by clearing the screen, and the entire system will re-check whether there is a leak.

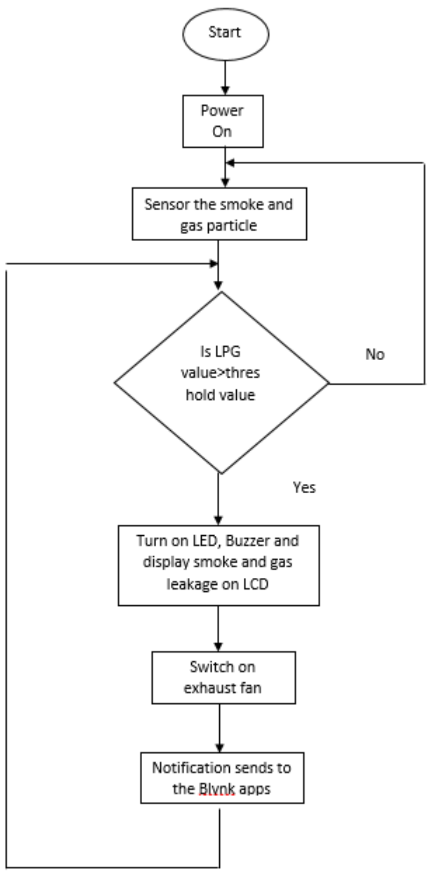

Figure 7: Flowchart of design project

2.3 System Efficiency

A formula for efficiency will be used to estimate the device efficiency based on the results obtained in Table 3.1, while the average time required will be computed to obtain the total time taken for the device to react to the sensor

$$efficiency = \frac{successfull\ of\ trial}{total\ number\ of\ trial} \times 100\% \qquad Eq.(1)$$

$$\eta = \frac{Wout}{Win} \times 100\%$$

η = (25/30) x 100

= 83%

According to the calculations, the device's effectiveness is 83%. The formula utilized for this computation is the number of trials completed divided by the total trial time. According to the figures, the number of successful trials was 25, with a total of 30 trials

3. Results and Discussion

The result and discussion section are very important for the researcher to make sure that project development process run smoothly and goes through better low of process. Next, the result was measured completely with kind of experiment for this device such as the tested of sensor efficiency, the range test of sensor and the configuration of the IoT system for this project.

3.1 Results

3.1.1 Sensor functionality test based on time

Figure 8 shows the results of the circuit's efficiency testing. The table illustrates how long it took the sensor to detect and respond to the gas. The sensitivity of the sensor and the concentration of the gas discharged determined the outcome of this experiment. The experiment was completed successfully with no errors in the remaining trials, resulting in 5 failed trials out of a total of 30.

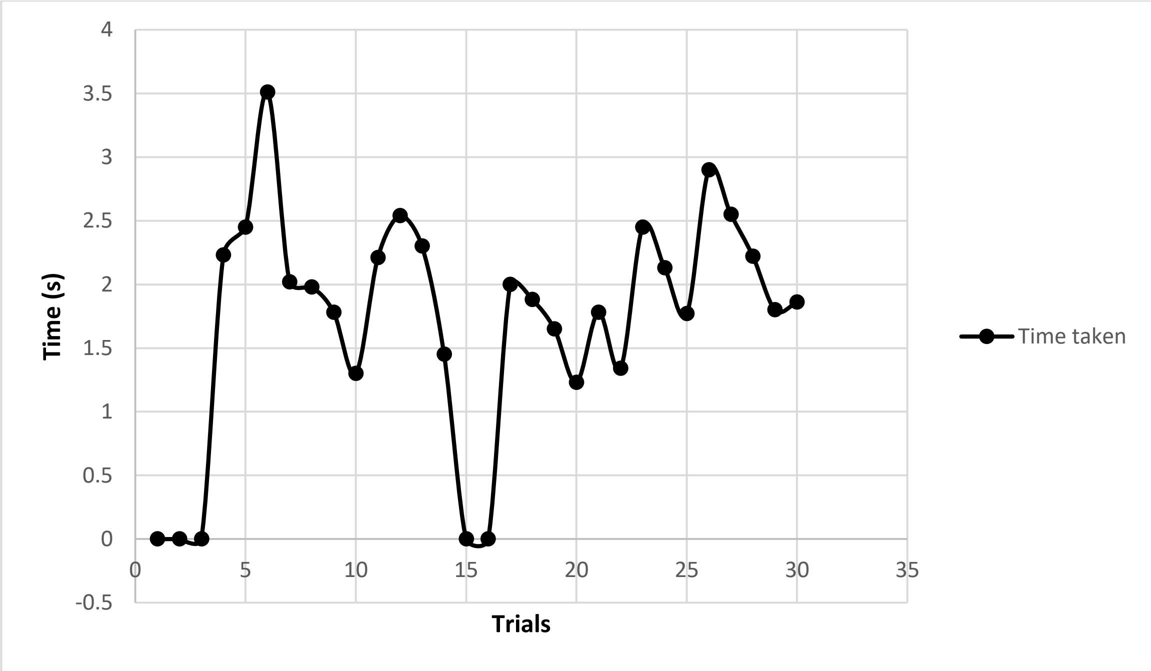

Figure 8: Time taken data of trial gas leakage detector

The graph in Figure 8 depicts an inconsistency in the time it takes the sensor to respond to LPG. This was owing to the gas release's concentration inside the box. The heating coil within the sensor must be triggered by at least 0.05mg/L of gas, which explains why the sensor takes so long to respond to the gas.

3.1.2 Sensor functionality test based on distance

A testing to assess the range of the sensor capable of detecting the gas was also crucial, in addition to an efficiency test. A total of ten readings ranging from 1cm to 10cm were obtained as part of the experiment.

Table 1: Sensor range measurement

Distance (cm)	Times (seconds)
1	1.26
2	1.65
3	3.3
4	4.20
5	6.55
6	8.12
7	-
8	-
9	-
10	-

According to Table 1, the time it takes for the sensor to detect gas presences is proportional to the distance between the sensor and the gas sources. It also displayed the sensor's maximum detection range, which is 6cm. The sensor limited to range 6 cm because the gas leak used in this experiment is lighter that give short ranged for sensor devices.

3.1.3 IoT system

The blynk testing shown in Figure 9 is done in the same way that a notice from the blynk server is sent to a smart phone. The gas data is then used to trigger the sensor on the MQ-5, resulting in a rise in gas percentage. The sensor and the Blynk applications had a proportionate connection, which meant that if the sensor didn't function, the module wouldn't work either. Based on the Figure 10, the additional server cloud like ThingSpeak web server will be the alternatives for the Blynk apps. Furthermore, the Thingspeak was operated the collected and stored the data of gas leakage, temperature and humidity into server. This web server also can be monitored which more detail information about the any of gas leakage and the temperature and humidity.

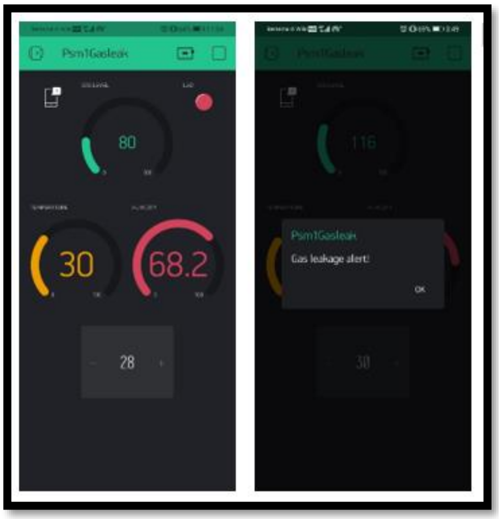

Figure 9: Testing Blynk apps for gas detector

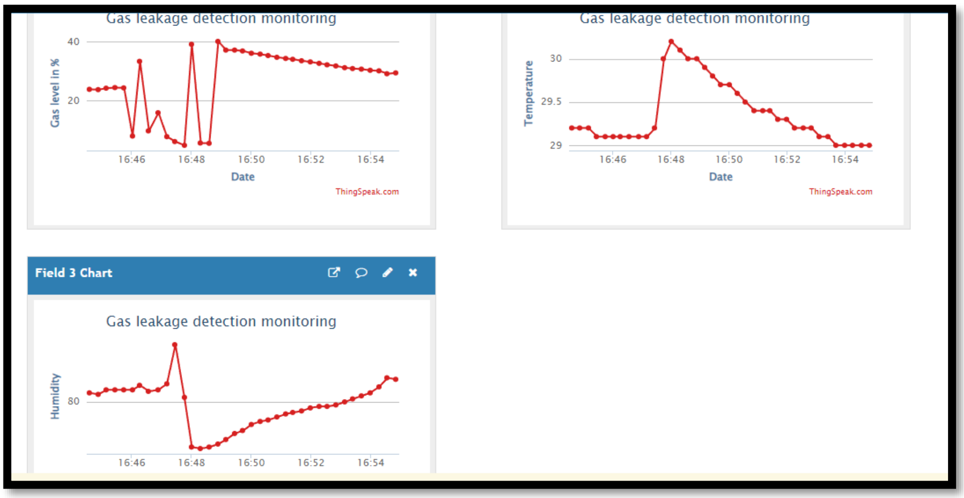

Figure 10: ThingSpeak data collection from gas leak detector

3.2 Discussions

The validity of the coding and hardware connection is very important in verification of software that make sure there will be no error occurred during the hardware simulation. The researcher on the previous other project gave the advantages on the current project in term of software or hardware. As a result, the validity of all pin connections and coding has been established, and it will be incorporated into hardware. In terms of the expected results, the project's conclusion may change from the original design due to the installation of another sensor, but the function will remain the same as stated in the proposal. A circuit having the same function as the simulated circuit was developed based on the simulation. The device's efficiency is examined in this study by running multiple trials to see how well the sensor responds to gas and smoke leaks. The testing was 25 percent successful, with a total of 30 trials, giving the gadget an efficiency of 83 percent. Testing on the apps Blynk and ThingSpeak proved effective in terms of adding IOT to the device. As long as the smart phone has an internet connection, it can get notifications from the Blynk server. The data collected by ThingSpeak may be seen by users in an easy-to-use format. The device can detect gas leakage up to 6cm from the gas source, according to the different area tests.

4. Conclusion

Gas leaks cause serious accidents that result in property damage and human injuries. The major causes of gas leaks are poor equipment maintenance and a lack of public awareness. As a result, LPG leaks detector is critical for avoiding accidents and saving human lives. We talked about the ways for detecting leaks and immediately opening the exhaust fan, which can save a lot of lives. This strategy provides real-time data to the user, allowing them to be informed at any moment.

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Appendix A (Optional)

Table 2: Efficiency time taken of trial MQ-5

Trial of MQ-5 sensor	Time taken respond (s)
1	No data
2	No data
3	No data
4	2.23
5	2.45
6	3.51
7	2.02
8	1.98
9	1.78
10	1.30
11	2.21
12	2.54
13	2.30
14	1.45
15	No data
16	No data
17	2.00
18	1.88
19	1.65
20	1.23
21	1.78
22	1.34
23	2.45
24	2.13
25	1.77
26	2.90
27	2.55
28	2.22
29	1.80
30	1.86

References

[1] Khan, M. M. (2020). Sensor-Based Gas Leakage Detector System. In *Engineering Proceedings* (Vol. 2, No. 1, p. 28). Multidisciplinary Digital Publishing Institute

[2] Soundarya, T., Anchitaalagammai, J. V., Priya, G. D., & Kumar, S. K. (2014). C-leakage: Cylinder LPG Gas leakage Detection for home safety. *IOSR Journal of Electronics and Communication (IOSR-JECE)*, *9*(1), 53-58

[3] Amutha, B., Rajeshbabu, C., Neehar, C., & Sumanth, E. (2020). GAS AND SMOKE DETECTION IN INDUSTRIES USING NodeMCU. *Journal of Critical Reviews*, *7*(8), 1504-1507

[4] Dewi, L., & Somantri, Y. (2018, July). Wireless Sensor Network on LPG Gas Leak Detection and Automatic Gas Regulator System Using Arduino. In IOP Conference Series: Materials Science and Engineering (Vol. 384, No. 1, p. 012064). IOP Publishing

[5] Sharulzaman, N, A, (2009). Automated Safety System for Gas Leakage Detector

[6] Mahmood, S. N., Ishak, A. J., & Hussain, S. T. (2019). GSM based gas leak monitoring system. Periodicals of Engineering and Natural Sciences, 7(2), 670-678.

[7] Briant, A. (2000). Smoke alarm project. Journal of Community Nursing, 14(12).

[8] Kumar, G. A., Rajasekhar, K., Satyanarayana, B. V. V., & Murthy, K. S. (2012). Implementation of Real time Detection of Gas leakage in Industries using ARM7 and Zigbee. IEEE International Journal of Engineering Research & Technology.

[9] Pandey, R. C., Verma, M., Sahu, L. K., & Deshmukh, S. (2017). Internet of Things (IOT) Based Gas Leakage Monitoring and Alerting System with MQ-2 Sensor. International Journal of Engineering Development and Research, 5(2), 2135-2137

[10] Falohun, A. S., Oke, A. O., Abolaji, B. M., & Oladejo, O. E. (2016). Dangerous gas detection using an integrated circuit and MQ-9. International Journal of Computer Applications, 135(7)