Detection system and security monitoring of the storage room of liquid oil gas with zoning method

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Abstract: Fires often occur due to leakage of the Liquid Petroleum Gas (LPG). Fuels in gaseous forms produce layers due to condensation with a negative effect when evaporated in free air. Fire usually starts with a small spark before inflaming largely. The frequent fires in homes and industrial sites that use LPG gas leads to huge losses of material and life. Therefore, cellular communication technology helps to facilitate the provision of information associated with the fire quickly. Communication is through voice and video calls, as well as via chats using the Telegram application, which provides bot system features from various cellular devices. With the zoning method, each signal sample of the communication is converted and characterized into a data vector with a fast calculation process. The result showed that the input data in the form of captured signals, extracted and processed, produces an output in the form of a warning or notification. Therefore, the application is expected to minimize the occurrence of fires.

1. Introduction
Cellular communication technology is a communication technology that has become part of human’s communication today. Almost 90% of people have this cellular communication tool. The communication is done either by using voice, video call, or a chat through telegram application. The chat communication is reachable, and it has the service of system feature from all kinds of cellular communication device.

Gas as a supporting tool for household needs, restaurant, and hotel. If a leak occurs onto the gas, it will give a serious problem \cite{1}. Therefore, it needs more extra handling, so that it will not cause a big loss to the users\cite{2}. The gas sensor is a device that can detect a leak of the gas. Explosion caused by the leak of the gas can be anticipated by turning on the exhaust system to minimize the gas condensation. The existent of this incident can provide a warning alarm and a notification to the users. As we know that the fire comes from the triangle of flame (fuel, oxygen, and fire) \cite{3}, from here, it can be detected from one of the triangles of flame, that is fuel or gas. Arduino Uno based gas leak detector with a GSM modem and buzzer as a notification\cite{4}, which can detect when a leak occurred, and can activate the handling system, and provide information to the users, so that fire can be anticipated as soon as possible \cite{1}\cite{5}. This research is aimed to design and realize a device that can detect the leak in the LPG tube, provide early warning of the danger of the leak in the LPG tube, reduce the loss caused by the leak in the LPG tube.

2. Research Methods
System design and modeling is done to anticipate the occurrence of warehouse fires, in addition to providing information on gas leakage followed by a countermeasure / anticipation system, for example exsous system to reduce gas condensation or by activating a chimney pump to dump condensation of gas into the warehouse / free air at the top of the warehouse. The features of the LPG gas storage room detection and monitoring system are:

a. Detects fire in LPG storage room.
b. Detects the gas content in the LPG storage room.
c. Detects temperature and humidity in the LPG storage room.
d. Detects movement in the LPG storage room.
e. Detects vibrations in the LPG storage room.
f. Provides fire prevention by buzzers, exsous motors and water.
g. Sending monitoring data on the state of the gas storage room to the website and telegram.

Based on the predetermined features, the LPG gas storage and detection system is developed as follows:

![Flowchart detection system](image)

**Figure 1.** Flowchart detection system

2.1. Inputs needed
   1. The MQ-2 sensor is a gas sensor
   2. Sensor KY-015 DHT-1 is a temperature and humidity sensor

2.2. Output required
   1. Buzzer is a warning sign
   2. Relay activator exsous device and water pump

2.3. System integrator / minimum system
   Arduino UNO

2.4. System programming
   The command structure in Arduino outlines consists of 2 (two) parts, namely void setup and void loop. The void setup contains commands that will be executed only once since arduino is turned on while the Void loop contains commands that will be executed repeatedly while arduino is turned on.

3. Results and Discussion
   Figure 2. follows the use case diagram that shows the function of the application made, in the picture there are users who can open and view the fire sensor, gas sensor, temperature sensor, humidity sensor, motion sensor, and vibration sensor by logging in first. Figure 3. below is a monitoring display
design, starting and main page when operating the program. In this monitoring page, there is a file menu that has the sub-menus of fire, gas, temperature, humidity, motion, and log out.

![Use case diagram analysis](image)

**Figure 2.** Use case diagram analysis

![Detection and display monitoring](image)

**Figure 3.** Detection and display monitoring

3.3. Database design
The database is very needed in making the detection and monitoring system security system for LPG gas storage room for storing the data. The following is a database design needed in the making of the LPG gas storage room security and detection system program.

3.4. Calculate sensor coverage
LPG warehouse is a place to store and unload LPG gas cylinders. Standard warehouse requirements are a minimum area of 400 m² built from non-flammable material. The way to determine the distance covered by the sensor can be used APAR calculations, as in the equation below: [6]
- Sensor name = (Building Size (m^2)) / (Minimum Protected Area (m^2))
- The hc-sr501 pir sensor has a limited range, which is a maximum of approximately 10 meters.
- Pir hc-sr501 motion sensor = (400)m^2 / (10 m) = 40 m.

Based on the above calculation, the motion sensor can reach an area of 40 m. The Mq-2 gas sensor calculates the measurement distance by the amount of gas detected.

**Measurement range:**
- 200 - 5000 ppm for LPG, propane
- 300 - 5000 ppm for butane
- 5000 - 20000 ppm for methane
- 300 - 5000 ppm for Hydrogen
- 100 - 2000 ppm for alcohol
- Ky-015 dht-11 sensor has a maximum range of approximately 20 meters.
- Pir hc-sr501 motion sensor = (400)m^2 / (20 m) = 20 m
- Vibration sensor measurement with the amount of vibration.
- Robodyn ir fire sensor detects the presence of fire or other infrared sources (fire or light source wavelengths in the range of 760 nm to 1100 nm can be detected)

3.5. Sensor Testing

3.5.1. Mq-2 sensor
In gas sensors, time is influential because the gas required is very large, therefore the distance needed is close so that the gas sensor can detect gas. Except if the remote position of the gas produced is very small with a long time the gas sensor will not be active. Shown in Table 1. at a distance of 4 cm the sensor is inactive.

| Distance (cm) | Time (Second) | Condition |
|---------------|--------------|-----------|
| 1 cm          | 10 Second    | Active    |
| 2 cm          | 10 Second    | Active    |
| 3 cm          | 10 Second    | Active    |
| 4 cm          | 10 Second    | In-active |

Table 2. Position obtaining gas

| Distance (cm) | Time (Second) | Condition |
|---------------|--------------|-----------|
| 1 cm          | 10 Second    | Active    |
| 2 cm          | 10 Second    | Active    |
| 3 cm          | 10 Second    | Active    |
| 4 cm          | 10 Second    | In-Active |

3.5.2. Trials
To find out the work of the tools and websites that have been made and find out the response time of all sensors used in this tool.

3.5.3. Mq-2 sensor
In gas sensors, time is influential because the gas required is very large, therefore the distance needed is close so that the gas sensor can detect gas. Unless the remote position of the gas produced is very small with a long time the gas sensor will not be active, it is seen in Table 2. Obtaining gas position.
3.5.4. **Robotdyn ir infrared fire sensor**
In the fire sensor, the time is affected because the fire required is very large, therefore the distance needed is close so that the fire sensor can detect fire. except if the remote position of the fire produced is very small with a long time the fire sensor will not be active. As in the table Table 3. Data position obtain fire

3.5.5. **Temperature sensor ky-015 dht-11**
From the results of testing the DHT11 temperature sensor as an input module integrated into the Arduino Uno Microcontroller as a data processor when the temperature exceeds 35 degrees, it will output fan output and an active buzzer. As in table Table 4. Testing Temperature Sensor ky-015 dht-11.

| Distance (cm) | Time (Second) | Condition |
|---------------|---------------|-----------|
| 8 cm | 6 Second | Active |
| 12.5 cm | 6 Second | Active |
| 22 cm | 6 Second | Active |
| 30 cm | 6 Second | Active |
| 40 cm | 6 Second | In-active |

**Table 4. Trial of temperature sensor ky-015 dht-11**

| Condition   | Output         |
|-------------|----------------|
| Under 34 deg | Fan and **Buzzer Inactive** |
| Upper 35 deg  | Fan and **Buzzer Active** |

3.5.6. **Pir hc-sr 501 motion sensor**
From the results of testing the pir hc-sr 501 motion sensor as an input module that is integrated into the Arduino Uno Microcontroller as a data processor when the movement around the sensor, the output will be active. As in table 5. pir hc-sr 501 motion sensor trial test.

3.5.7. **Vibration sensor**
From the results of vibration sensor testing as an input module that is integrated into the Arduino Uno Microcontroller as data processing when shaking around the sensor, the buzzer output will be active. As in table 6. Trial of the vibration sensor trial.

**Table 5. Testing of hc-sr 501 pir motion sensor**

| Condition   | Output         |
|-------------|----------------|
| No-Motion   | Fan-Inactive   |
| Motion      | Fan-Active     |

**Table 6. Trial of the vibration sensor**

| Condition   | Output         |
|-------------|----------------|
| No-Vibration | **Buzzer In-active** |
| Vibration   | **Buzzer Active** |

3.6. Output testing
3.6.1. **Buzzer**
The program on the microcontroller has been established that the microcontroller will issue a logic of 1 (5 Volts) only if the condition of the gas sensor, fire sensor, vibration sensor and temperature sensor detects gas leakage, fire, vibration and temperature increase and if the sensors are not detected then the output The microcontroller will be worth zero (0 Volt). When the program is run it is proven that the buzzer sounds when it is detected by the sensor. When the sensor does not detect, the buzzer will return to its original state (silent), as in table 7. Trial of the buzzer test.
3.6.2. Water motor
From the test results it can be seen that the fire sensor detects a fire, the water motor will be active. As in Table 8 Air Motor Trial.

| Table 7. Trial of buzzer |
|--------------------------|
| Input Potential (Volt)   | Information   |
| 0 v                      | **Buzzer Inactive** |
| 4.8 v                    | **Buzzer Active** |

| Table 8. Water motor trial |
|-----------------------------|
| Input Potential(Volt)       | Information       |
| 0 v                         | Water Motor Inactive |
| 12 v                        | Water Motor Active |

3.6.3. Fan
When a gas sensor, motion sensor, and temperature sensor are detected to detect a gas leak, there is movement and the temperature rises, the fan will turn on to reduce LPG gas levels in the test box. When LPG levels are not detected, the fan will stop spinning. As in table 9. Fan testing.

| Table 9. Fan testing |
|----------------------|
| Input Potential(Volt)| Information |
| 0 v                  | Fan In-active |
| 12 v                 | Fan active    |

3.7. Zoning method
Feature extraction is a process in which each signal sample will be converted into data vectors. The method to be used in the characterization process in identifying this signature is the zoning method. Like in Table 10. Zoning trial.

| Table 10. Zoning trial |
|------------------------|
| Sensor Input           | Output               |
| Gas | Motion | Temp | Fire | Shakes | Humidity | Fan | Buzzer | Water Control | Website | Telegram |
| Yes |         |      |      |        |          | Yes |        |              |         |          |
| Yes |         |      |      |        |          | Yes |        |              |         |          |
| Yes |         |      |      |        |          | Yes |        |              |         |          |
| Yes |         |      |      |        |          | Yes |        |              |         |          |

4. Conclusion
Based on the results of research, design, and testing of systems and tools, the authors obtain conclusions as follows:

1. The application as a whole is running well and the test results are in accordance with the needs to detect, activate exsous and monitor.
2. The application aims to minimize the occurrence of LPG gas leakage in terms of report information.
5. References

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