LPG Gas Leakage Safety System Prototype Using Servo Motor with MQ-2 And MQ-6 Sensors

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ABSTRACT

LPG is a trademark of LPG (Liquefied Petroleum Gas). LPG gas is a mixture of various hydrocarbons resulting from the refining of crude oil into gas form. No doubt, LPG gas is a basic need of the community because it is mainly used for cooking and many other things. However, LPG gas is sometimes also dangerous if not used properly. Among the dangers posed by LPG is flammable gas and contains poison when inhaled in large concentrations. Therefore, this research made a tool/prototype of LPG gas leak detection. This system uses the Wemos D1 module and MQ-2 and MQ-6 sensors, as well as servo motors as its main components. In addition, Buzzer and Blynk Apk are also added as indicator and monitor features in this prototype. The working system of the prototype is that if the sensor detects gas exceeding 30 minutes or gas concentration exceeding 400 ppm, the servo motor will actively open the LPG gas regulator valve. The gas concentration value can also be monitored in real-time via the internet by opening Blynk. Until this stage, the prototype is able to work well.

KEYWORDS

gas safety system; LPG gas leakage; MQ2 sensor; MQ6 sensor; blynk

1. INTRODUCTION

Human existence is changing rapidly as we enter the 21st century, particularly in the technology sphere, where numerous technologies can replace many human jobs, causing some old jobs to vanish and be replaced by new ones. The solution to the current educational challenges is higher-order thinking skills (HOTS)(Tanudjaya & Doorman, 2020). HOTS incorporate the capacity to analyze (C4), assess (C5), and create or be creative (C6) (Suprapto et al., 2020). When someone practices HOTS, they take new knowledge, retain it, and expand it to search for connections, leading to achieving goals or discovering answers after experiencing perplexity (Hubers, 2022). Based on the comes about of the PISA national report in 2018, a few Indonesian understudies were as it were able to choose the most excellent logical clarification for information displayed in a common setting, whereas the rest were at a lower level (Pusat Penilaian Pendidikan Balitbang Kemendikbud, 2019).

HOTS and physics are connected to moved forward learning results (Kahar et al., 2021). Physics will aid students in developing their critical thinking abilities, as they will need to figure out HOTS. Teachers should also encourage students to use educational materials like the HOTS, which the HOTS instrument can enhance (Widyaningsih et al., 2021).

HOTS can be measured by reasoning multiple-choice questions, which has become common as two-tier multiple choice (TTMC) (Istiyono et al., 2020). The first tier of the TTMC focuses on concepts, whereas the second level (tier II) explains why the level I answer is correct. The second tier will help enhance HOTS since it involves more complex thinking and won't directly ask about the concepts being tested (Andriyatno et al., 2023). TTMC level 1 study presents problem-based questions related to physics concepts.

HOTS training activities benefit students, including increasing their readiness to face a developing and challenging era and improving their ability to socialize with the community. Students who successfully use HOTS can be seen from their explanations and decisions to solve problems or choose existing options (Ramadhan et al., 2019). Therefore, developing two-tier multiple-choice questions is done by presenting problem-based questions to find solutions.

2. METHODOLOGY

Research Design. This research uses case study and experiment models. In the case study, at first the researchers formulated a solution to household problems, such as the many cases of fire due to the explosion of 3 kg LPG cylinder gas. Then the researcher raises the problem and provides a solution by designing a safety device/prototype of a gas leak that causes a fire. The method in designing this prototype is based on sensor and actuator testing experiments.

Tools or Instruments Used. This prototype has several main components which include Wemos as a data processor, MQ-2 and MQ-6 sensors as gas leak detection sensors, buzzer as an alarm indicator, servo motor as a gas regulator valve opener, and Blynk apk for remote monitoring system. There are 3 stages carried out in making this prototype, namely:

2.1 Design Scheme

In the design, the first thing to do is to design an electronic scheme related to the prototype to be made. Figure 1 shows the electronic scheme design of the LPG gas detection prototype

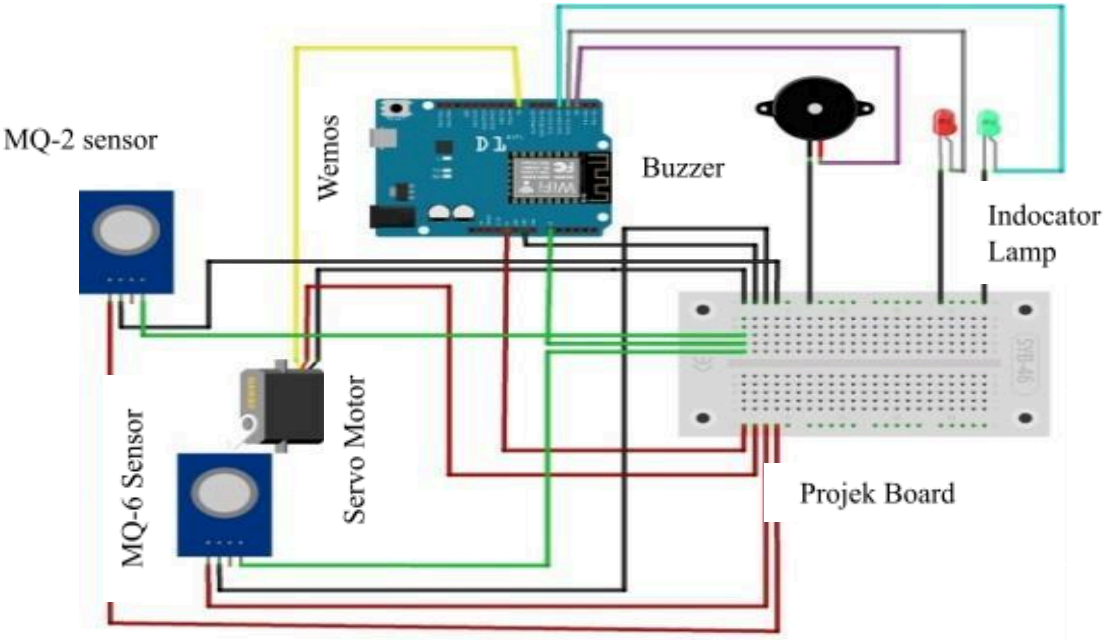

Figure 1. Electronic schematic design of LPG gas leak detection prototype

2.2 System Workflow Diagram

Figure 2 shows the workflow of the device system for easy understanding. The MQ-2 and MQ-6 sensors measure the concentration of harmful gases in the surrounding environment. Then the sensor data is received by Wemos to be processed. The processed data is then sent via the internet to be displayed on the Blynk interface. In addition, the buzzer and servo motor will activate as a danger sign if the gas concentration value exceeds the predetermined deviation/limit value.

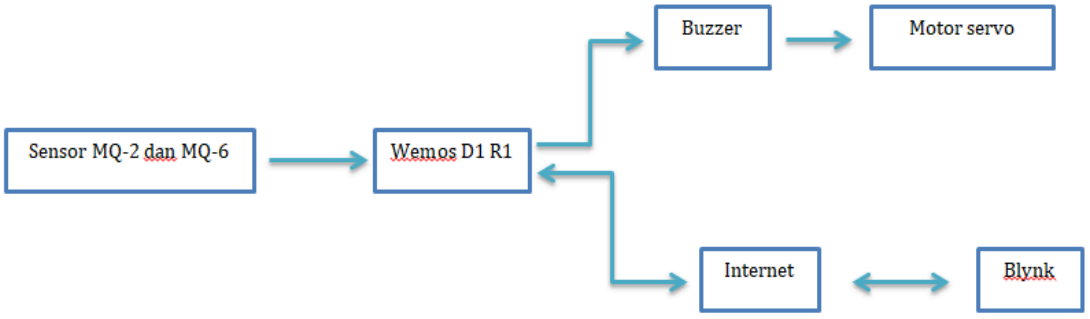

Figure 2. System workflow diagram

2.3 Flowchart of How the LPG Gas Leask Detection Prototype Works

The last design stage is to create a flowchart of how the product works so that it can be used functionally.

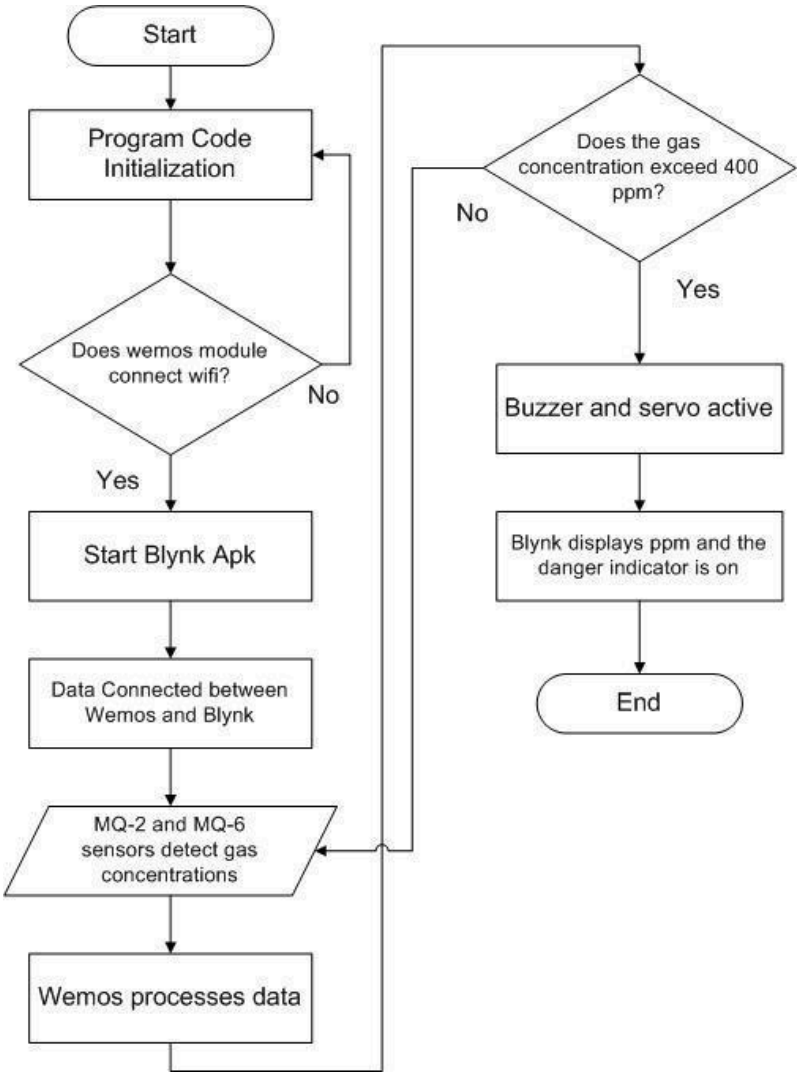

Figure 3. Flowchart of the tool's working system

The development of this LPG gas leak prototype tool includes hardware development and software development. At the hardware development stage, researchers developed prototype tool hardware by designing and modifying regulators for LPG gas cylinders. In this regulator design, 2 MQ-2 and MQ-6 sensors have been embedded which are used to measure the level/concentration of the LPG gas leak. In addition, a servo motor is also added to open the LPG gas cylinder regulator valve automatically if a gas leak occurs within a certain period of time.

As for software development, an interface/view was developed to find out the gas concentration level via the internet. The Blynk application was chosen as the interface between the prototype tool and the data display on the internet. IoT technology is also used to assist in displaying data via the internet.

Sensors Test. Tests were carried out on both MQ-2 and MQ-6 sensors and servo motors as actuators. Testing is done by pairing the regulator that has been designed on the LPG gas cylinder. Testing is done by detecting a gas leak at a predetermined time interval..

The MQ-2 sensor has the characteristic of being able to detect harmful gases with a concentration of 300-10,000 ppm. PPM stands for Parts per Million which means parts per million. PPM is a concentration unit ratio used in chemical measurements. This unit is used to indicate the content of compounds in a solution. One part per million is equal to 0.0001 percent of the solution. This is the same as one milli of other units such as milligrams per liter, milligrams per kilogram, etc. (Andriani, 2023).

The calculation of the ppm value is done by converting the sensor ADC value to ppm. The equation (1) used is

$$KONVERSI\ ADC = \frac{Vin}{Vref} \times 1024 \quad (1)$$

Where :
Vout= output voltage (volt)
Vref= reference voltage (5 volt)

From Equation 1, we know that the ADC value range of the sensor ranges from 0 - 1023. The equation of the ADC value to the gas concentration that the MQ-2m sensor can detect is 10000-300 = 9700 ppm. The PPM/ADC value is 9700/1023 = 9.4819. Then the equation that can be used to get the ppm value of the MQ-2 sensor is equation (2). Figure 4 shows how to install a regulator on an LPG gas cylinder. In Figure 4 is a top-view image.

PPM = 300+(ADC*9.4819) (2)

Figure 4. Top-view of sensor and servo motor testing

Data Analysis Methods. Testing and analysis activities are carried out by experimentation with quantitative processing methods. Testing of sensors and actuators was carried out 10x and the average value was taken. The data taken is in the form of gas concentration value data in ppm units which is then measured based on a certain time interval. In this case, researchers set the measurement period from 0 seconds to 60 seconds with an interval of 5 seconds. By analyzing, it can be concluded that the tool is able to work properly or not.

3. RESULTS AND DISCUSSION

After the LPG gas leak prototype tool has been designed and made, the next step is to test the tool. Figure 5 and Figure 6 show the tools that have been made. There are 2 main

components in this prototype tool, namely the main prototype tool shown in a white box in which there is a Wemos D1 as a data processor and the second tool is a prototype in the form of a regulator that can be used for LPG gas cylinders.

Figure 5. Main prototype of LPG gas leak monitor

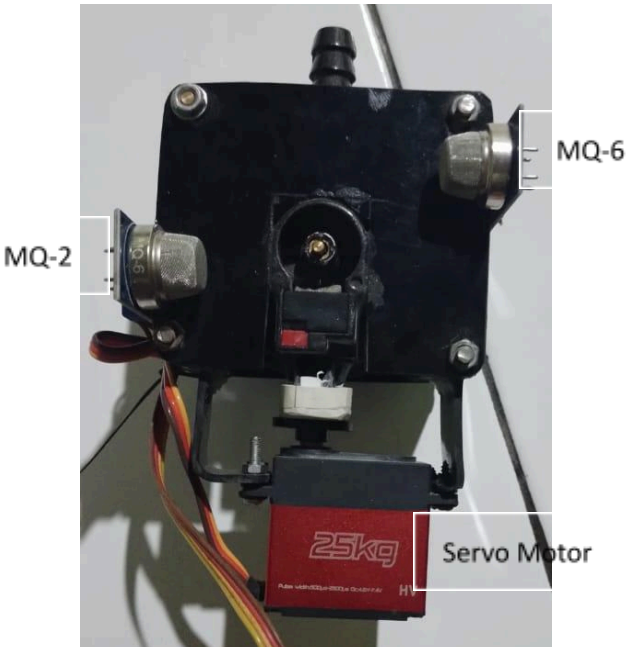

Figure 6. Prototipe regulator

Figure 5 is the main component of the LPG gas leak prototype. In this prototype tool there is a Wemos D1 as a data processor and connects data to the Blynk internet. In this tool there is also a buzzer and LED indicator of LPG gas monitoring. The buzzer will activate when the sensor indicates an LPG gas leak with a leak concentration of 400 ppm accompanied by an indicator LED that lights up. Figure 6 shows the prototype of the regulator that has been designed. In this regulator there are 2 sensors namely MQ-2 and MQ-6 which are used to detect LPG gas leaks. Then there is a servo motor that is connected

to the LPG gas regulator valve. In principle, the servo motor will move and open the gas valve if the sensor detects a gas leak at a certain level. The reference of the servo motor moves based on the combined average value between detection MQ-2 sensor and MQ-6 sensor, as shown in Table 1. The author determines the safe limit of gas leakage for the first 30 seconds and is adjusted to the gas concentration received by the sensor. Furthermore, if a gas leak occurs for more than 30 seconds, the servo motor will activate to rotate/open the LPG gas valve, thus preventing a fire.

Testing of sensors and servo motors is done to determine the performance of sensors (Aulia and Munasir, 2022). Testing was carried out as many as 10x. The time used in testing each sensor uses multiples of 5 seconds. LPG gas leakage is calculated based on gas concentration in ppm units. Table 1 shows the results of sensor testing which shows the average value at each multiple of time.

Table 1. Test results of sensor and servo motor functions

Time (second)	Average LPG gas concentration reading (ppm)			Motor servo
	MQ-2	MQ-6	MQ-2 + MQ-6	
0 – 5	315	305	310	OFF
0 – 10	330	325	327	OFF
0 – 15	367	344	355	OFF
0 – 20	375	368	371	OFF
0 – 25	390	389	389	OFF
0 – 30	399	394	396	OFF
0 – 35	426	405	415	ON
0 – 40	448	407	427	ON
0 – 45	469	426	447	ON
0 – 50	489	437	463	ON
0 – 55	510	456	483	ON
0 – 60	525	466	495	ON

By looking at Table 1, the servo motor will activate if there is an LPG gas leak for more than 30 seconds with a measured gas concentration value of more than 400 ppm. Gas leaks below 400 ppm or less than 30 seconds are still considered safe and do not have the potential to cause a fire because at this stage, the leaked gas still binds to the free air around it. This ppm value will appear on the Blynk interface sent via the internet. In this interface, there is a ppm value that is monitored in real time and indicators such as safe and dangerous.

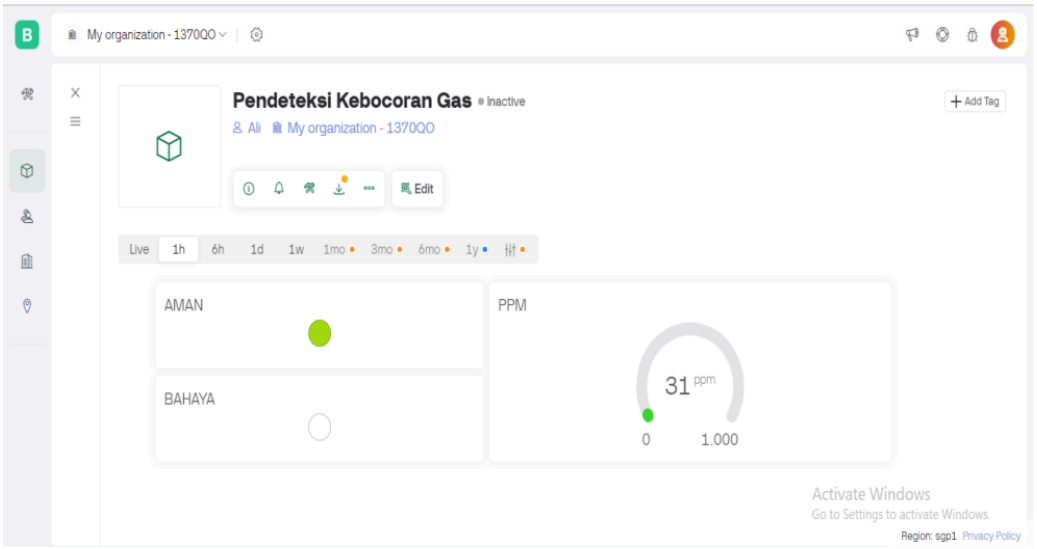

Figure 7. Blynk Apk design for LPG gas leak monitoring

Figure 7 shows the Blynk interface that has been designed for gas leak monitoring. The safe indicator will light up when the gas concentration value is below 400 ppm. While the dangerous indicator will light up if the ppm value is above 400 ppm. Until this stage, the device can work well in detecting LPG gas leaks. And the Blynk interface can read the ppm value in real time.

4. CONCLUSION

The tool that has been made successfully detects LPG gas leaks properly. The servo will activate when the detected gas ppm value shows more than 400 ppm. The servo will open the LPG cylinder gas regulator valve so that the situation becomes safe from fire.

Suggestions for further research are to redesign a regulator that is more suitable for gas cylinder valves. The regulator that is currently made is still loose. Then it is better to use only one sensor rather than two sensors at once because the data obtained is less stable when using two sensors.

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