Automatic regulator design for Liquified Petroleum Gas

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Abstract. In Indonesia, cases of explosions due to gas cylinder leakage have begun to become the attention of the government and the development company. If a leakage happens when there are no people around it this can be dangerous because no one open the regulator on the LPG tube. To handle this, we design a system to detect leakage and release regulators if a gas leakage is detected. We build the automatic regulator system, we use several equipment including Arduino Nano, MQ-2 sensor and servo motor. The MQ-2 sensor is used as an input for gas leakage detection when the servo motor is used as a control output to open the regulator knob. Arduino Nano is used as a control device to read sensor signal input and control the output in the servo motor. Based on the results of the tests have been carried out the automatic regulator work well when a gas leakage happens by opening the regulator knob and the gas does not flow continuously. From the test results obtained an average response time to open the knob after the detected gas is 1,796 seconds.

1. Introduction
Fuel is one of the most important needs for humans. The fuel divided into two, oil and natural gas. The petroleum fuel will be processed into gasoline, diesel and kerosene. Meanwhile, natural gas can be processed into LNG (Liquified Natural Gas) and LPG (Liquified Petroleum Gas). In Indonesia before, mothers use kerosene as a fuel for household needs. With the decreasing supply of natural petroleum, in 2007 the Indonesian government establishes a policy to switch LPG as a fuel for household needs [1]. However, this LPG is airborne, allowing leakage causing dangerous explosions.
In Indonesia cases of explosions due to gas cylinder leakage began to become the concern of the government and the development company. Actually, leakage known by humans when they are near the LPG location because LPG has a special typical odour. If a leakage is known then we simply release the regulator and the LPG tube will be closed. However, if a leakage happens when there are no people around, this can be dangerous because no one will open the regulator on the LPG tube. To handle this, we propose to create an automatic regulator to release regulators in the event of a gas leakage.
This study was conducted based on the literature of several previous studies on LPG leakage. Previously there have been several studies to detect LPG using sensors [2–4]. There are also several studies to make safeguard against LPG leakage [5–7]. Based on some of these studies we designed a system to detect leakage and release the regulator if a leakage is detected.

2. Method
2.1. Material Collection
To build the automatic regulator system we use several equipment including Arduino Nano, MQ-2 sensor and servo motor. Arduino Nano is used as a control device to read sensor signal input and control the output in the servo motor. The selection of Arduino Nano is due to small size and low price in terms
of the control board. Arduino widely used in building control or monitoring systems[8–11]. The Arduino Nano board can be seen in Figure 1.

![Arduino Nano](image1)

**Figure 1.** Arduino Nano

The MQ-2 sensor is used as an input for monitoring when the servo motor is used as a control output. The MQ-2 sensor is useful for detecting gas leakage (at home and industry) and it is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane[12]. Because of its high sensitivity and fast response time, measurements can be made as soon as possible. Sensor sensitivity can be adjusted using a potentiometer. Sensor MQ-2 can be seen in figure 2. Servo motor is a DC motor with a close feedback system where the rotor position will be informed back to the control circuit in the servo motor[13]. This motor consists of a DC motor, a series of gears, a potentiometer, and a control circuit. Servo motors can be seen in figure 3. In addition, we also use the buzzer as a marker sound when a gas leakage happens.

![MQ-2 Sensor](image2)

**Figure 2.** MQ-2 Sensor

![Motor Servo](image3)

**Figure 3.** Motor Servo
2.2. System Design
In the system design, the system is made according to system block diagram in Figure 4.

![System Block Diagram](image)

**Figure 4.** System Block Diagram
Based on Figure 4, the working principle of the system being built is:
1. When a gas leakage happens, the MQ-2 sensor detects a gas leakage in the tube due to changes in conductivity on the sensor.
2. The sensor sends a signal to the Arduino Nano Microcontroller.
3. Arduino Nano Microcontroller receives the signal and processing the signal.
4. The signal is sent to the buzzer and sounds an alarm.
5. After a few seconds, the Microcontroller also sends a signal to the servo motor to open the regulator knob.

3. Result and discussion
From the design results obtained an automatic regulator prototype as shown in Figure 5.

![Prototype System](image)

**Figure 5.** Prototype System
Furthermore, a functionally tested prototype test work well or not. Testing is done by calculating the response time needed to open the regulator knob when a gas leakage is detected. The results of the test can be seen in Table 1.
Table 1: Test Results of Automatic Regulator Time Response

| No | Testing | Response Time (s) |
|----|---------|------------------|
| 1  | First   | 3.34             |
| 2  | Second  | 1.32             |
| 3  | Third   | 3.47             |
| 4  | Fourth  | 1.57             |
| 5  | Fifth   | 1.33             |
| 6  | Sixth   | 0.99             |
| 7  | Seventh | 1.63             |
| 8  | Eighth  | 1.77             |
| 9  | Ninth   | 1.23             |
| 10 | Tenth   | 1.31             |

Based on the results of testing in Table 1, it can be calculated the average time required as follows:

\[
\bar{t} = \frac{\sum_{i=1}^{n} t_i}{n}
\]

\[
\bar{t} = \frac{17.96\text{s}}{10} = 1.796 \text{ s}
\]

4. Conclusion

Based on the results of the tests it can be seen that the automatic regulator work well when a gas leakage happens by opening the regulator knob and the gas does not flow continuously. From the test results obtained an average response time to open the knob after the detected gas is 1,796 seconds. For further work, development will be carried out by adding a communication module and LPG leakage can be monitored remotely.

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