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Design and Manufacture of LPG Gas Leak Detection Based on Arduino Uno Using MQ-2 Sensor

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To design and manufacture LPG gas leak detection tool that is more efficient, relatively cheaper and can be carried because it has a smaller shape and size compared to tools on the market
Study Design: Design of LPG gas leak detection based on Arduino Uno using MQ-2 sensor.
Place and Duration of Study: Physics Study Program, Faculty of Mathematics and Natural Sciences, Universitas Udayana, from June 2023 to October 2023.
Methodology: The trial and error method is used to calibrate the designed tool with standard tools. Calibration is done by comparing the distances value of the LPG gas leak detection using MQ-2 sensor and the calibration standard tool. The relationship between the measurement values of the design tool and the standard tool is determined using linear regression method to obtain a correction equation.

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Results: LPG gas leak detection based on Arduino Uno using MQ-2 sensor have been produced. The measurement accuracy obtained 97.97%. The accuracy value indicates that the resulting tool has a good level of accuracy to the standard tool.
Conclusion: In this research, has been produced LPG gas leak detection more efficient, relatively cheaper and can be carried because it has a smaller shape and size, low-cost with high accuracy.

Keywords: Arduino uno; MQ-2 sensors; LPG; gas leak.

1. INTRODUCTION

The role of Liquid Petroleum Gas (LPG) is currently very important for human life, both in households and industry. The use of gas can have positive and negative impacts, the positive impact is that burning gas is cleaner and reduces the level of pollution in the air, and the negative impact is that gas has flammable properties which can cause explosions which have a negative impact on humans and the environment [1]. Currently, many people use gas fuel in the form of Liquid Petroleum Gas (LPG) due to the influence of the government program which converts kerosene into LPG gas, as fuel for the stoves used. Since the government launched the conversion from kerosene to gas in 2005, people who had previously used kerosene have started using gas. Many people know LPG gas as a fuel that is not a luxury item that is only owned by urban communities, but even people in remote villages have now switched to using LPG gas. With the large use of LPG gas by the public, gas cylinder manufacturers in producing gas cylinders experience a decline in quality, which can cause danger due to lack of supervision of gas cylinder production. Production of cylinders with reduced quality causes gas leaks, thus causing fires [2]. Regarding the problem of gas cylinder leaks, we need a tool that is able to detect gas leaks, so that we can anticipate gas leaks early [3]. Based on the description above, an LPG gas leak detection device based on Arduino Uno with an MQ - 2 sensor will be designed.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Liquid Petroleum Gas (LPG)

Liquid Petroleum Gas (LPG) is a mixture of hydrocarbon elements that come from nature. By increasing the pressure and decreasing the temperature, the gas turns into liquid. The components are dominated by propane and butane [1,4]. One of the risks of using LPG gas is a leak in the gas cylinder or installation so that if exposed to fire it can cause an explosion. Initially, LPG gas has no smell, but if so it will be difficult to detect if there is a leak in the gas cylinder. Pertamina by adding mercaptan gas to LPG is very useful and very helpful for early detection if a gas cylinder leak occurs [1,5].

2.1.2 Sensor MQ-2

The MQ-2 sensor is a sensor for detecting gas concentration. The MQ-2 gas sensor can be adjusted by turning the trimpot. This sensor is often used to detect gas leaks both in industry and in households. Detected gases include alcohol, LPG, smoke and hydrogen. This sensor can detect the concentration of flammable gases in the air and smoke. This sensor can measure flammable gas concentrations from 300 to 10,000 ppm, operates at a temperature range of 20°C to 50°C and uses less than 150 mA at 5 V [3].

2.1.3 Arduino Uno R3

Arduino Uno R3 is a microcontroller board that uses the ATMega microcontroller produced by Atmel Corporation. Different Arduino boards use different types of ATMega depending on their specifications. The microcontroller used by the Arduino Uno is the ATMega328 type. Arduino Uno is an integrated device consisting of various electronic components. With Arduino Uno you can create a system or physical device using software and hardware that is interactive, that is, it can respond to stimuli from the environment and respond back. Arduino is said to be open source because it is a physical computing platform. The platform here is a combined tool of programming language, hardware and IDE (Integrated Development Environment). IDE is a software that functions in writing programs, compiling them into binary code and uploading them into microcontroller memory [2].

2.1.4 LCD 12C

LCD 12C is an LCD module that is controlled serially with the Inter Integrated Circuit (I2C/IIC) or Two Wire Interface (TWI) protocol. LCD modules are normally controlled in parallel for both data and control lines. However, the parallel groove will take up a lot of pins on the controller side. You will need at least 6 or 7 pins to control an LCD module. Thus, for a controller that has to control a lot of I/O, using parallel paths is an inappropriate solution [6].

2.1.5 HC-SR04 sensor

HC-SR04 sensor an ultrasonic sensor is a sensor that functions to convert physical quantities (sound) into electrical quantities and vice versa. The way this sensor works is based on the principle of the reflection of a sound wave so that it can be used to interpret the existence (distance) of an object with a certain frequency. It is called an ultrasonic sensor because this sensor uses ultrasonic waves (ultrasonic sound) [7]. This sensor is a ready-to-use ultrasonic sensor, a tool that functions as a sender, receiver and controller of ultrasonic waves. This tool is usually used to measure distances from objects from 2cm - 4m with an accuracy of 3mm. This sensor has 4 pins, namely VCC, GND, Trigger, and Echo.

2.1.6 Buzzer

buzzer is an electronic component that functions to convert electrical energy into sound. The buzzer consists of a coil that is fed by current and the coil will move forward or backward. Every back and forth movement of the coil will make the air vibrate, thus producing sound [8].

2.2 Methods

2.2.1 Design of system

The design used is shown in Fig. 2. This design tool uses MQ-2 sensor as input. The Arduino Uno R3 microcontroller is the center of processing input and output sensor reading data. The HC-SR04 sensor is a sensor that functions to measure distance. The HC-SR04 there are 4 pins, namely the ground pin which will connect to the Arduino ground. There are two outputs of design tool, namely display media LCD 12C and buzzer.

2.2.2 Calibration methods

Calibration is the application of observation equipment by comparing the designation of the measuring instrument with known and traceable standard values [9]. Data collection for calibration is carried out by observing the output distance of gas leak detection and distance standard tool.

3. RESULTs AND DISCUSSION

3.1 Results

Research on the design and manufacture of LPG gas leak detection based on arduino uno using MQ-2 sensor, was carried out at the Electronics and Instrumentation Laboratory of the Physics Study Program, Udayana University, from July 2023 to October 2023. The design and manufacture of LPG gas leak detection based on arduino uno using MQ-2 sensor are shown in Fig. 1 and the schematic design is shown in Fig. 2.

3.2 Discussion

The calibration data shows that the MQ-2 sensor is only able to detect LPG gas leaks up to a distance of 24 cm (indicator on). This is because when the calibration data was collected there was the influence of the wind so that the gas coming out of the LPG cylinder was swept away by the wind before being detected by the MQ-2 sensor. The calibration data in Table 1 are plotted into a linear test graph as shown in Fig. 3. In this graph, the level of linearity between the design tool and the reference tool is very linear where the x coefficient is close to 0. The coefficient of determination (R^2) is 0.9997, indicating that the accuracy level of the design tool and the reference tool is 99.97%.

3.2.1 Testing gas levels on the MQ-2 sensor

After designing the hardware and software for the Arduino Uno-based MQ-2 gas sensor, the data collection test was carried out by determining several distances to provide a reaction to the gas released, the gas used was the gas that came out of LPG. This data collection was carried out in a closed room. Taking data in a closed room can determine how much gas is received by the MQ-2 gas sensor from a predetermined distance [5,10]. Likewise, when knowing how much voltage there is when the MQ-2 gas sensor gets the gas level reaction value. To measure

the voltage we use a digital multimeter. The results of the response value and voltage of the MQ-2 gas sensor when capturing gas levels coming out of LPG are as shown in the Table 2. Table 2 are plotted into a linear test graph as shown in Fig. 4.

Fig. 1. Result of design tool

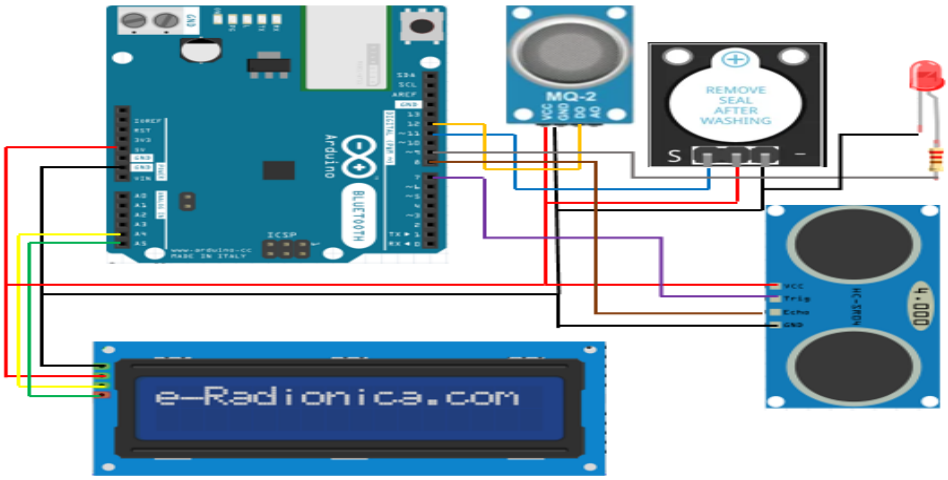

Fig. 2. Schematic design

Table 1. Calibration data of distance leak detection

No.	Standard tool distance (cm)	Design tool distance (cm)	Indicator
1.	3	2.9	On
2.	6	6.1	On
3.	9	8.8	On
4.	12	12.2	On
5.	15	14.9	On
6.	18	17.8	On
7.	21	21.2	On
8.	24	24.1	On
9.	27	26.8	Off
10.	30	29.8	Off

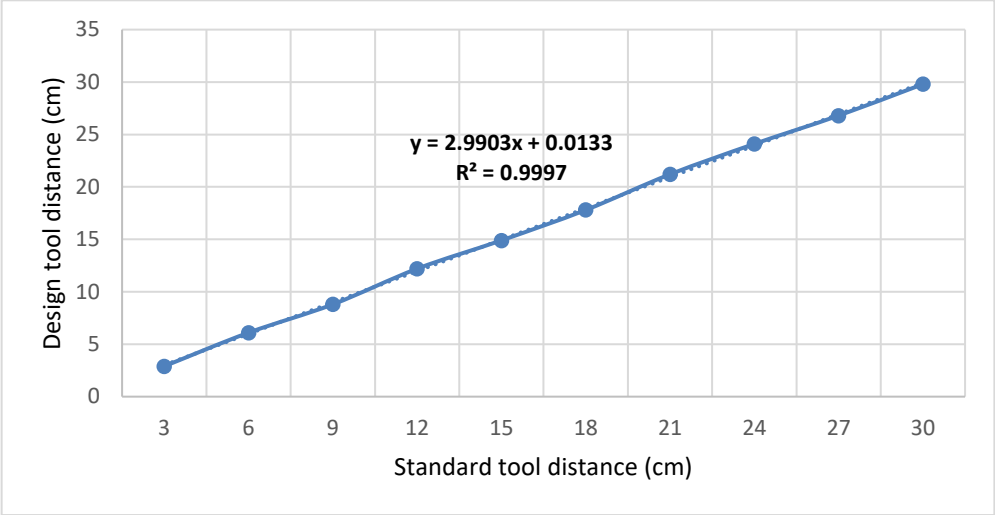

Fig. 3. Graph of standard tool distance vs design tool distance

Table 2. Testing gas levels on the MQ-2 sensor

No	Detection distance (cm)	Gas content value (ppm)	Input (Volt)	Output (Volt)
1.	3	475	5	3,75
2.	6	465	5	3,73
3.	9	450	5	3,70
4.	12	430	5	3,62
5.	15	420	5	3,60
6.	18	410	5	3,60
7.	21	393	5	3,59
8.	24	385	5	3,59
9.	27	378	5	3,57
10	30	370	5	3,57

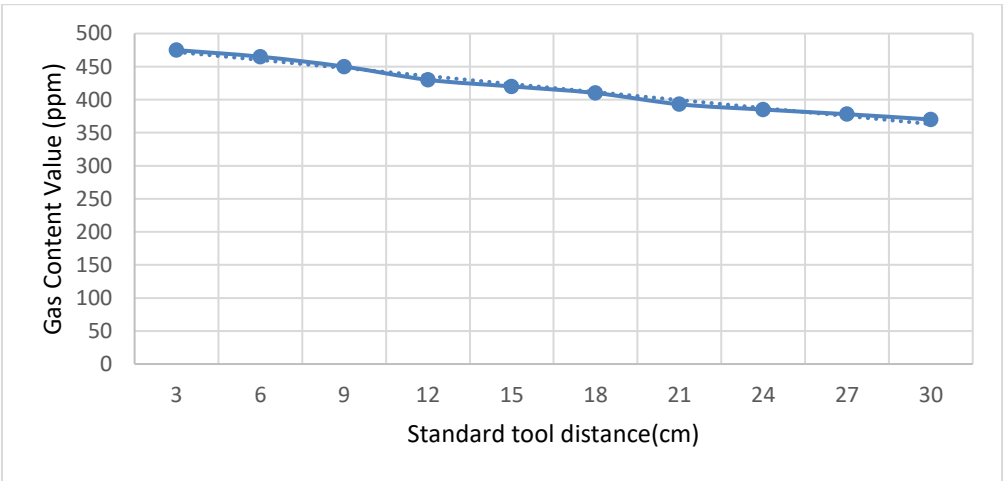

Fig. 4. Graph of standard tool distance vs gas content value

From Fig. 4, it can be explained that when the distance of the gas is farther from the MQ-2 sensor, the resulting read output will also be smaller, because the value of the gas content captured by the MQ-2 sensor is getting smaller. Fig. 4., shows a graph of the relationship between the output voltage and the detection distance of the design tool. The graph shows that even though the input voltage provided is the same, the output detection read on the tool gets

smaller along with the detection distance, meaning that the farther the detection distance, the harder the tool works so that the output voltage read gets smaller.

4. CONCLUSION

Design and Manufacture of LPG Gas Leak Detection Based on Arduino Uno Using MQ-2 Sensor has been produced in this study. The study concludes that Design and manufacture LPG gas leak detection has been produced more efficient, relatively cheaper and can be carried because it has a smaller shape and size, low-cost with high accuracy.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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