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LPG gas leak security system using Microcontroller based Android application

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ABSTRACT

The use of Liquid Petroleum Gas (LPG) among Indonesian people continues to increase from year to year. One of the causes of this condition is kerosene which is scarce and difficult to obtain. However, the recent increase in fires and accidents caused by leaking and exploding LPG gas cylinders has become a frightening thing for people who use this gas. LPG gas is known for its flammable nature so leaks from LPG equipment pose a high risk of fire. Due to its sensitive nature, special attention needs to be paid to this type of fuel. This research aims to produce a design for a leak detection tool for LPG gas cylinders via an Android smartphone. This research uses experimental methods to ensure the suitability of the resulting tools to the expected standards. The test results show that the results of design and testing, this microcontroller-based LPG gas leak detection tool using an Android application shows effectiveness in detecting gas leaks at dangerous levels and is able to provide early warning to users. This tool can identify various gas concentration levels through the MQ-2 sensor and send notifications to the mobile application when the gas content exceeds safe limits.

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1. INTRODUCTION

The use of Liquid Petroleum Gas (LPG) among the Indonesian people continues to increase from year to year. One of the causes of this condition is that kerosene is rare and difficult to obtain. In addition, people also feel the convenience and greater benefits of using LPG gas when compared to using kerosene. Currently, the use of LPG gas cylinders is not only in urban areas, even rural communities have generally switched to using LPG gas. LPG is widely used for various purposes needs such as in industry, commercial , and household. Most of them from the users are from household circles [1]. The increasing use of LPG gas by the community, then the gas cylinder manufacturers also experienced a decrease in quality which caused dangers due to the lack of supervision of the production of the gas cylinders. The same thing is also due to the import of gas cylinders that are handled with low quality [2]. This is proven in the field found broken cylinders, easy to rust, dented so that it is very prone to LPG gas leaks which can cause fires. Liquefied Petroleum Gas (LPG) or LPG according to Pertamina is a gas production product from refinery oil and gas refinery whose main components are propane and butane gas approximately 99% and the rest is liquefied pentane gas. Comparison The composition of propane (C3H8) and butane (C4H10) is 30:70. This LPG gas is included in the category flammable gas or flammable gas [3]. The form of LPG gas in the cylinder in the form of substance liquid and some is vapor. The ratio between the volume of gas when it evaporates and the gas in a state of liquid varies depending on composition, pressure and temperature, but is usually around 250:1 [4]. LPG gas is odorless, colorless and toxic. So that users can detect Leakage in LPG gas cylinders, PT. Pertamina added mercaptan gas as a mixture so that LPG gas has distinctive odor [5].

The recent increase in fires and accidents caused by leaks and explosions in LPG gas cylinders has become a frightening thing for people who use this gas [6]. When an LPG cylinder experiences leak, LPG liquid will leak out quickly and become a gas that is easily explosive if triggered spark fire [7]. Since the government rolled out the Kerosene Conversion Program in 2007, the number of incidents and victims of LPG explosions has continued to increase from year to year. The National Consumer Protection Agency stated that in 2007 there were 5 cases, in 2008 there were 27 cases, in 2009 there were 30 cases and in 2010 there were 33 cases with a total of 22 fatalities and 130 people injured. Explosions caused by gas leaks occur, among other things, because the safety layer on the gas cylinder is no longer correct [8] . In addition, other factors such as negligence in use gas stove and its slowness handling when it occurs Leakage is also one of the triggers for explosions [9]. LPG gas that leaks does smell so that normal leaks are easy to detect. However, if the leaking gas seeps into the water pipe, electrical installation, or under the carpet, it will be difficult to detect by the human sense of smell. LPG gas is known for its flammable nature, so that leaks of LPG equipment are at high risk of fire. Due to its sensitive nature, special attention is needed to the fuel. This type. So an early warning system is needed to deal with gas leaks. in the form of a gas detector [10]. A gas detector is a tool that can detect gas in a room. This gas cylinder leak detector is with an automatic control system that can make it easier for users to handle gas leaks [11].

By using a detection sensor LPG gas leaks connected to the Arduino Nano microcontroller are expected to improve awareness public will the dangers of LPG gas and how it can help prevent the occurrence fire or explosion caused by LPG gas leaks, so it is hoped that this can be minimized. risks that may occur [12]. The use of sensors can detect the content of propane, butane, and LNG (liquefied gas) in LPG and can also detect the concentration of gas in the air [13]. Devices for detecting the occurrence LPG gas leaks and fires using gas sensors and fire sensors. Message notifications are displayed on the Liquid crystal display (LCD) installed in the gas storage area [14].

Referring to previous research on Design and Construction of LPG Leakage Safety and Monitoring System Based on Internet Of Things (IOT) which discusses LPG gas leak detectors using Arduino microcontrollers. The results of this study produced a gas detector system. A comparison between the tool made by the author and the previous tool shows that the previous tool has a construction in the form of a panel box that takes up a lot of space. This makes it difficult to apply in everyday life [15]. Therefore, this study was designed to be more efficient in terms of space, making it easier to use in daily activities. The previous tool was designed to prevent sparks due to short circuits when there is an LPG gas leak. While the tool created in this study aims to prevent the spread of leaking LPG gas by closing the gas line using a solenoid. Based on the background above , the author is interested in making a gas leak detection tool by using a microcontroller that can monitor gas leaks that can be observed directly via an Android smartphone. The microcontroller used is based on ATMEGA328, the MQ- 2 sensor as a special sensor module for LPG gas and the DHT 11 sensor as a special sensor module for temperature Because temperature can affect the working system of the MQ-2 gas sensor and the Arduino Ethernet Shield module and ESP 8266 as a data transfer medium from the microcontroller to the Android smartphone via the internet network. This system is equipped with a buzzer as a siren and analog data information that will later appear on the Android smartphone.

2. METHOD

This research is an experimental research type, where the research variables have been determined in advance. The sample used in this study was leaking LPG gas with predetermined variations . This research was conducted to ensure the suitability of the resulting tool with the expected standards. The initial stage in making this tool involves designing both hardware and software. The first step before making a tool is to plan the tool by making a block diagram. The goal is to visually understand the components involved in input, process, and output. By using a block diagram, the tool making process becomes more structured and easier to understand because it refers to the picture provided by the diagram. The system that has been planned for this device consists of three main components. First, there is an input system that includes one gas sensor (MQ-2) and one temperature sensor (DHT11). Second, a control system consisting of Arduino Nano and Nodemcu ESP8266. And third, an output system that includes an LCD screen and an Android smartphone application, namely WhatsApp as a platform for presenting the output results. In addition, there is a buzzer that works as a marker if it is detected a gas leak. The block diagram can be seen in Figure 1.

Based on Figure 1, the block diagram consists of several components which each have their own function, namely: 1) the MQ-2 gas sensor functions to detect the presence of gas if a leak occurs, 2) the MQ-2 gas sensor functions to detect the presence of gas if a leak occurs, 3) the MQ-2 gas sensor functions to detect the presence of gas if a leak occurs, 4) the MQ-2 gas sensor functions to detect the presence of gas if a leak occurs, 5) the MQ-2 gas sensor functions to detect the presence of gas if a leak occurs, 6) the MQ-2 gas sensor functions to detect the presence of gas if a leak occurs, 7) the MQ-2 gas sensor functions to detect the

presence of gas if a leak occurs, 8) the MQ-2 gas sensor functions to detect the presence of gas if a leak occurs, 9) the MQ-2 gas sensor functions to detect the presence of gas if a leak occurs, 10) the MQ-2 gas sensor functions to detect the presence of gas if a leak occurs, 11) the MQ-2 gas sensor functions s temperature (DHT11) functions to detect level ambient room temperature, 3) power The supply functions to provide power to each connected device, 4) the step down function is to reduce the voltage from 12 Volts to 5 Volts, 5) the Arduino Nano functions as the core of the microcontroller which acts as a control center and data processing, and sends data to the output, 6) the NodeMCU ESP 8266 functions as a connector to the internet network for the Android application, namely WhatsApp, 7) the LCD functions as an output and displays the results from gas and temperature detector in the form of text and numbers, 8) buzzer functions as an indicator to indicate existence gas leak detected on the device, 9) light indicator serves as a marker a the state or condition of the surroundings whether they are safe (Green), alert or careful (Yellow) and dangerous (Red), 10) WhatsApp function as a provider notification when it occurs LPG gas leak.

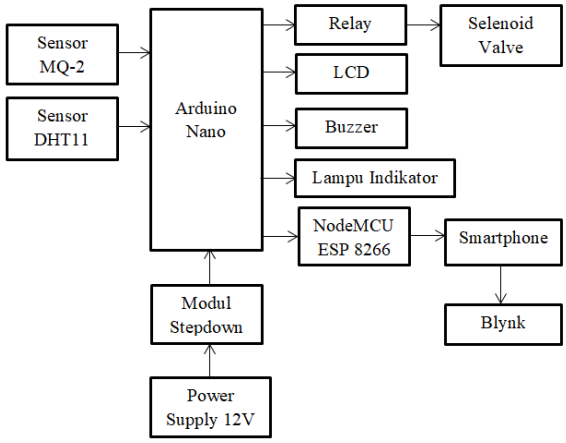

Figure 1Block diagram

Work principle This tool is first to connect the device to the 220 VAC PLN supply, then activate the power button so that the entire system will be active and the device will start the port initiation and WiFi signal connection. This tool uses three sensors, namely two MQ-2 gas sensors and one DHT11 sensor to detect gas and temperature around. When it happens gas leak, the MQ-2 sensor will detect it. The device will send a signal to the microcontroller to be processed and recorded. gas levels and temperature is in a state safe, caution or danger. If the gas level detected exceed mark predetermined standards then the relay will activate solenoid valve so that gas leakage does not increase. Data collected by the microcontroller will be displayed on the LCD screen and WhatsApp application. On the LCD screen and the WhatsApp application will be displayed notification of gas levels and temperature and the surrounding conditions after detection LPG gas leak .

Designing a tool for detection gas leaks using the MQ-2 sensor include hardware preparation, electronic circuit design, and program creation. Hardware designer aiming to simplify the process and reduce the risk of errors, so that it can produce optimal hardware according to needs. Through this stage, hardware design and direct testing of the system are carried out, to ensure whether the device works according to the initial design or not. This hardware design includes the design of the detection tool LPG gas leaks and its electronic circuits which can be seen in Figure 2.

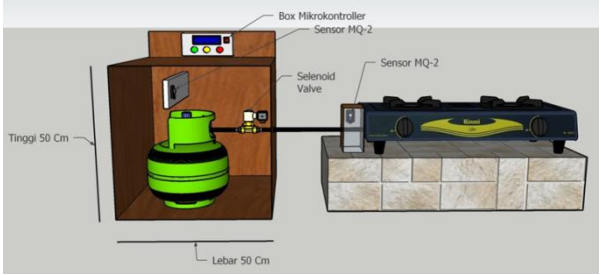

Figure 2Hardware Design

Hardware design includes the development of electronic circuits that support the manufacture of tools. The entire electronic circuit can be seen in Figure 3. In the figure, all component paths are arranged in such a way that they are interconnected, allowing the component circuits to interact optimally in carrying out their respective functions. The main role of the MQ-2 sensor in this arrangement is to detect the presence a gas around. The information obtained from the sensor is then forwarded to the microcontroller. The microcontroller will process the received data and send the appropriate output, either via LCD or software. smartphone namely WhatsApp.

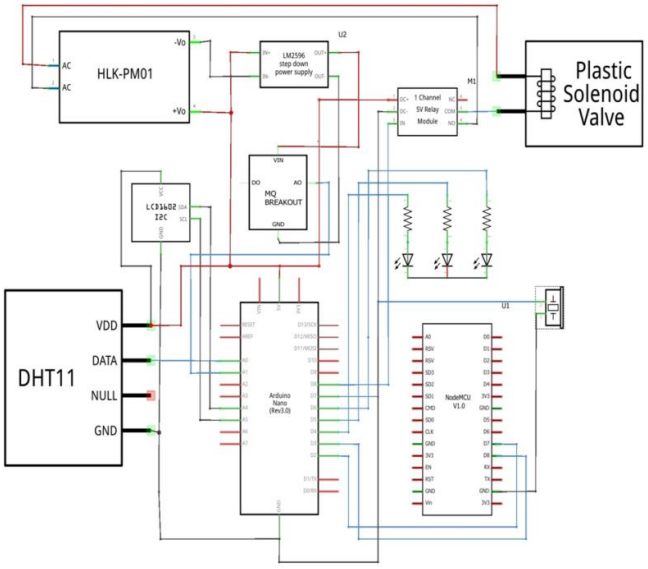

Figure 3. Electronic Circuit Design

The main purpose of making a flowchart is to simplify the understanding of a process or system. The flowchart in this study can be seen in Figure 4.

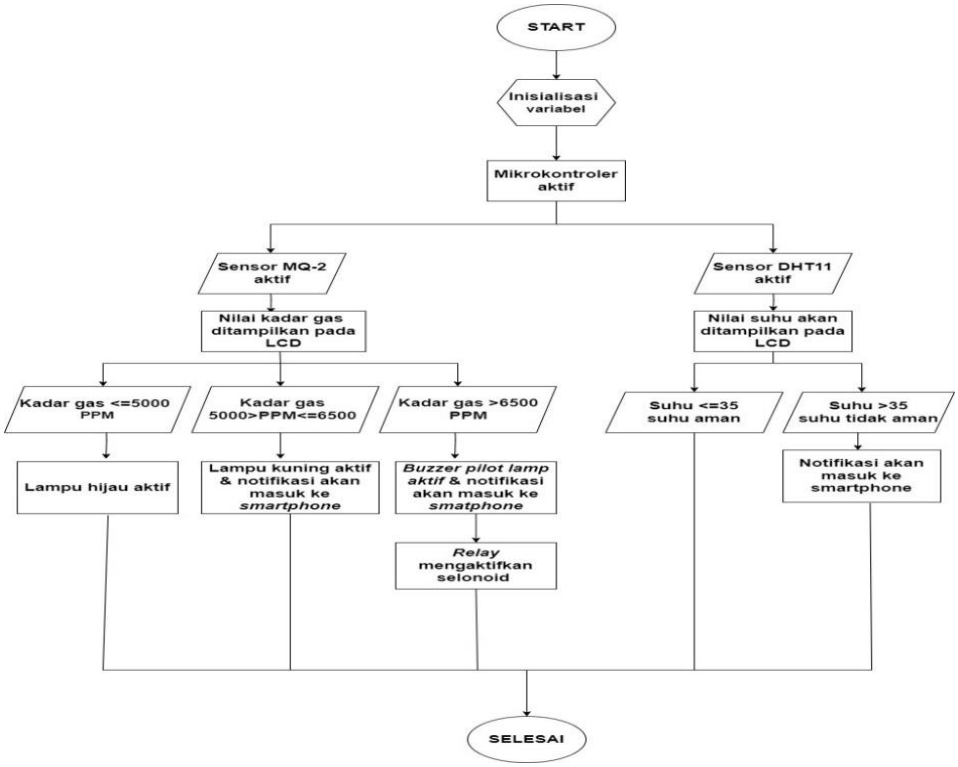

Figure 3. Program Flowchart

3. RESULTS AND DISCUSSION

The results of the tool testing are used to determine how the device works and analyze the level of reliability, weaknesses and limitations of the functional specifications of the system that has been created. In addition, this test is also carried out for conditioning so that this tool can function optimally. Software testing is done to find out whether the application device is connected to the microcontroller or not and also provides information in the form of notifications and a history of gas leak detection. The first step is to connect smartphone devices with microcontrollers. When the device connected to a power source, microcontroller NodeMCU ESP8266 automatically will connect to the internet using the module WiFi default. The connection process devices to the internet via WiFi requires a valid SSID and password programmed into the device. Network WiFi with different SSID and password will not be able to connect with NodeMCU ESP8266 .

Creation of a detection system This LPG gas leak occurs through several sources manufacturing stage. Starting with preparing the materials and tools used. Such as preparing the box and assembling the Arduino mainboard with the Arduino Ethernet Shield. The purpose of making the box is to place the input and output components or as a container of this tool system in order to facilitate and adjust the system in its use. The design of the LPG gas leak detector is seen in the Figure 5.

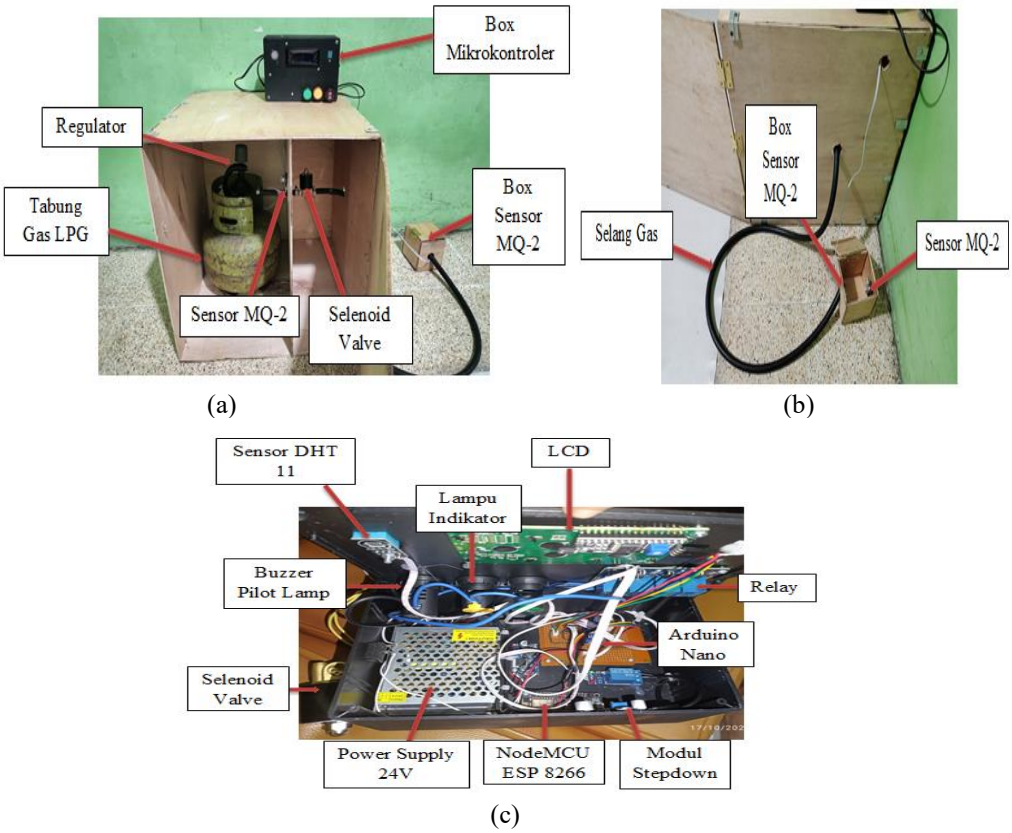

Figure 5. Tool Design Results. a) front view, b) side view, c) tool components

Based on the test results, the condition of the indicators in the LPG gas leak detection system using a microcontroller-based Android application obtained the results as in the Table 1.

Table 1. Component Condition Test Results

Component	Status	Information
Buzzer	Off	As Planned
Microcontroller	On	As Planned
LED indicator	On	As Planned
Notifications	Off	As Planned
Solenoid Valve	On	As Planned
Sensor	On	As Planned

Based on the test results, when power up, the power supply LED on the microcontroller lights up, while the buzzer does not sound, and the active sensor and indicator LED light up indicating that there is no object reading process. In addition, solenoid valve on and notification does not appear on the connected smartphone. Measurements were taken when the LPG gas content was below 5000 ppm. The results obtained can be seen in Tables 2.

Table 2. Second MQ-2 Sensor Test Results <5000 ppm

NO.	MQ-2 Sensor Reading Value	Solenoid Valve	Lights On Indicator	Buzzer Description
1.	754 PPM	Open	Green	No Sound
2.	2051 PPM	Open	Green	No Sound
3.	2595 PPM	Open	Green	No Sound

4. CONCLUSION

Based on design and testing results, the detector tool LPG gas leak based microcontroller using this android application shows effectiveness in detecting gas leak at dangerous levels as well as capable give warning early to the user. This tool can identify various level gas concentration through the MQ-2 sensor and sends notification to mobile app when gas content exceeds the safe limit. With this capability, the tool provides protection additional for users as well as potential prevent the occurrence fire or explosion consequence LPG gas leak.

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