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Implementation of gas leak detection and security systems in smart homes

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ABSTRACT

Leakage of liquified petroleum gas (LPG) cylinders or devices is still one of the main causes of fires known for its flammability so that leaks in LPG are at high risk of fire. To overcome this, a tool is made to prevent crime or gas leaks that often occur to homeowners. This research was conducted to find out the security control system for homeowners and overcome if a gas leak occurs. The method used in this tool is the method of designing a tool to detect gas leaks and a security system at home when left by the owner. From the test results of the prototype that has been designed, the error percentage is 1.6% and also in the MQ2 sensor section where the distance conditions and variables used are distance, time and gas source so that if gas is detected, the fan will turn on and an sms message will appear on the smartphone.

Keywords: Buzzer; GSM module; MQ2 sensor; RTC

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INTRODUCTION

The role of liquefied petroleum gas (LPG) at this time is vital for human life both in households and in industry, and LPG gas is very cheap, so it is easier to use. However, LPG gas can hurt human health and even cause significant losses if it is not used carefully, especially if it is not known that there has been a leak from the LPG gas cylinder or storage area. Leakage of LPG cylinders or devices is still one of the main causes of fires. LPG gas that leaks has an odor so normal leaks are easy to detect. However, if the leaking gas seeps into water pipes, electrical installations, or under carpets, it will be difficult for the human sense of smell to detect. Apart from that, AC and room heaters can also cover the smell of LPG gas. LPG gas is known for its flammability nature, so leaks in LPG equipment pose a high fire risk. Due to its sensitive nature, special attention must be paid to this fuel type. So a warning system is needed to deal with gas leaks.

To prevent these leaks, a tool was created that will detect gas leaks, namely by using the MQ-2 sensor, so that fires that arise due to gas leaks can be prevented. This detection tool using MQ -2 is a tool that detects the concentration of flammable gas and also as an output for reading analog voltage [1,2]. Apart from that, people also spend a lot of time outside the house, with busy activities that make homeowners forget several things, such as locking the door of the house or checking the condition of equipment in the house whether it is off or on, even in some cases resulting in crimes occurring at home [3-5]. To overcome this problem, an automatic smart home control device based on Arduino Uno was created.

This tool will help homeowners detect strangers entering the house, whether through doors, windows, or even through holes in the wall that would unexpectedly become an entry point for criminals [6,7]. This system is also equipped with a buzzer as an alarm which will activate when an unknown object enters the house [8,9]. Apart from that, this system can also be controlled via smartphone with SMS notifications to make things easier for users. This is an effort to provide security for the house to avoid unwanted things such as theft, gas leaks, and fires in the home environment [10-12].

The way the smart home SMS system works is that first the Arduino will initialize it, set the input-output, and initialize it to connect to the SIM800L module and read data from the DS3231 RTC module. Arduino reads the gas sensor output in the form of an analog voltage which is then converted into a digital value using the ADC feature. The converted value will be compared with the reference value that has been input into the Arduino program. If the sensor reading value exceeds the reference value, the fan will activate and the Arduino will carry out the process of sending an SMS using the SIM800L module containing the message "gas detected". If the sensor reading is below the reference value, the fan will be inactive and the Arduino will carry out the process of sending an SMS using the SIM800L module containing the message "gas condition is safe". Arduino also reads the magnetic door sensor. If the magnetic door switch sensor is active, the Arduino will activate the buzzer, and if the magnetic door switch sensor is inactive, the Arduino will deactivate the buzzer [13].

LITERATURE REVIEW

A smart home is a house that connects an internet network or communications with electrical equipment that can be controlled, such as controlling lights and also the security of the house. A smart home has its benefits, such as providing better comfort, more guaranteed safety and security [14].

Security is something you need to pay attention to because it can have a very bad impact on the homeowner. High crime rate, especially theft which ends in murder. Of course, this is a very serious concern in society. Moreover, the world has become increasingly sophisticated, such as doing things that can be controlled remotely. A smart home is also a system that combines technology with services specifically used in the home environment which aims to help with daily activities at home, increasing the security, efficiency, and comfort of its occupants automatically according to user controls that have been programmed via a computer or smart home. residence so that it can be controlled anywhere [1, 15, 16].

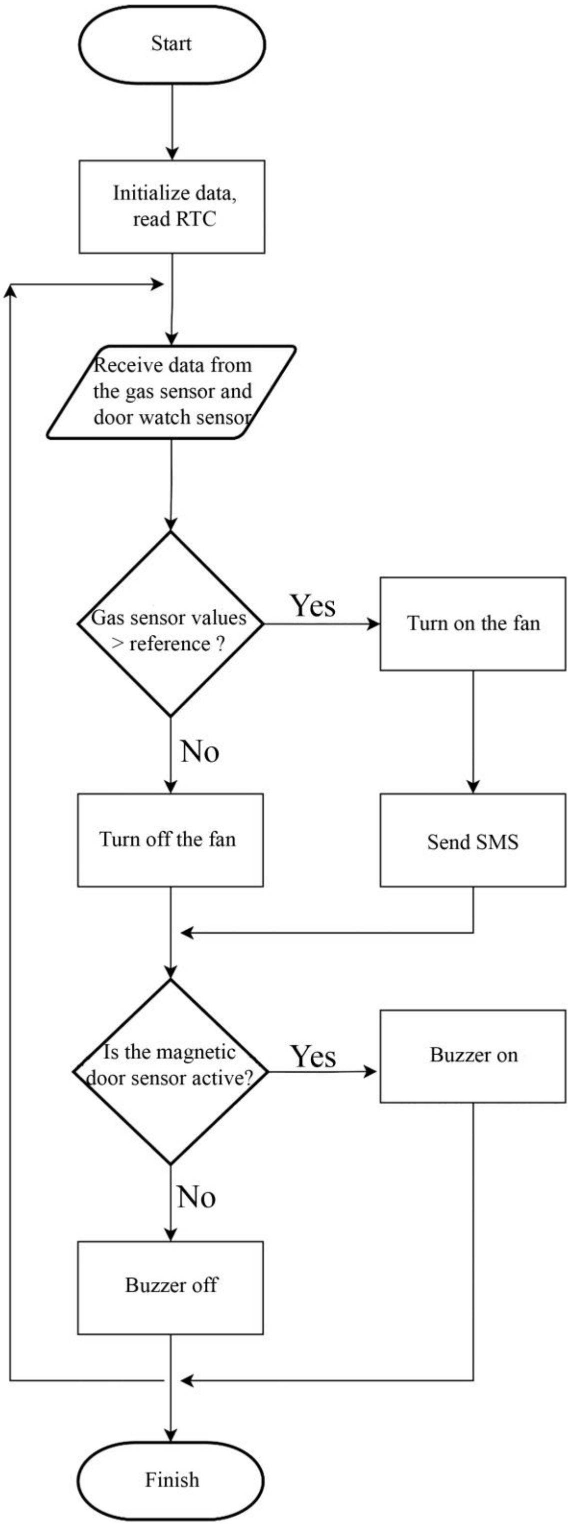

Figure 1. Prototype flowchart.

The parameters that will be controlled in this research are gas leak detection with an MQ2 sensor and a magnetic door sensor as security for the house. In this system software and hardware such as sensors and other devices will be used to control and automate it.

A flow diagram is a graphic depiction of the steps and sequence of procedures of a program to explain the stages of the research process from start to finish. This flow diagram will make it easier for readers to understand the research methodology used.

RESEARCH METHODS

This research was carried out using quantitative methods. The tools used in this research include laptops, smartphones, SMS, and lighters. The main materials used in this research include Arduino Uno, SIM800L GSM module, MQ2 sensor, buzzer, magnetic sensor, DS3231 RTC module, LM2596 stepdown, adapter, liquid crystal display (LCD).

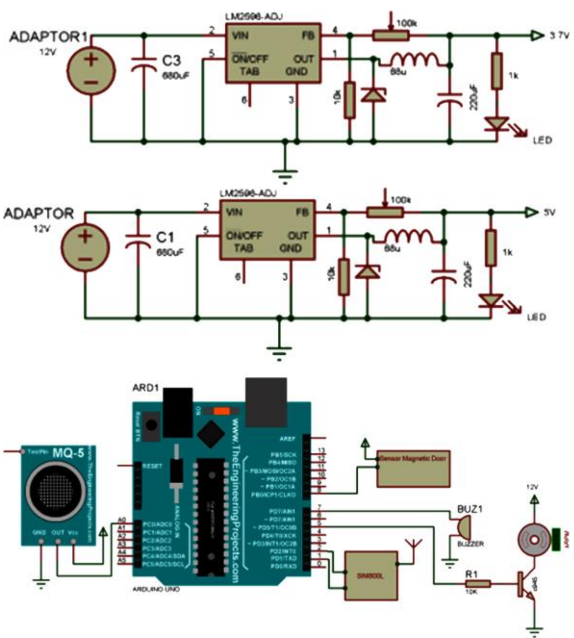

Figure 2. Research series.

The research was carried out by assembling all the materials in an electronic circuit. All components are assembled to produce a circuit that can work according to commands that have been input into the Arduino IDE software.

The method used in this tool is a tool design method for detecting gas leaks and a security system for the house when it is left by the owner. So from these results, if a gas leak occurs in the LPG cylinder and the ADC value is above 700, the fan will automatically turn on and the GSM module will send an SMS to the smartphone with the message "Gas detected" and if the ADC value is below 700 then the fan will turn off and then the GSM module will send a message to the Smartphone with the SMS "Gas is safe". And for the security part of the house, that is by using a magnetic door sensor which is placed on the door, then the real time clock (RTC) module is set according to the clock on the smartphone, if the door is opened then the buzzer will sound, and if the door is opened outside of the RTC setting time then the house in a safe condition. The design of a gas leak detection tool and security system for a smart home with SMS notifications can be seen in Figure 3.

Figure 3. Results of a series of tools.

RESULTS AND DISCUSSION

Testing On Power Supplies

Testing the power supply which functions to reduce the LM2596 Stepdown voltage. Where in this research 2 LM2596 stepdown's were used, for the first stepdown it was used to reduce the voltage from 12 volts to 5 volts which will later be connected to the Arduino, and for the second stepdown it was used to reduce the voltage from 12 volts to 3 volts which will later be connected to the SIM800L GSM Module. Then 3 adapter tests were carried out using a power supply where the initial voltage and final voltage were % error and the average error was obtained, namely 1.6%. The test results on the power supply system can be seen in Table 1.

Table 1. Power supply test results.

Testing	Initial voltage (V)	Rated voltage (V)	Voltage difference (V)	Errors (%)
1	12	12.3	0.4	2.5
2	12	12.1	0.2	0.8
3	12	12.2	0.1	1.6

Gas Sensor Testing

Gas sensor testing, namely response time, fan condition, status, and also the ADC reference value on the LCD. If the gas is brought close to the MQ2 sensor, the display on the LCD is the ADC value, whereas if the ADC value is above 700 then the fan will be on and the GSMSIM800L module will send a gateway SMS to the smartphone with the status "gas detected", and if the ADC value is below 700 then the fan is not on and the message on the SMS is "Gas is safe".

Table 2. Power supply test results.

Response time (s)	Fan condition	Status	ADC value
10	On	Gas detected	700
30	Off	Safe gas	300
16	On	Gas detected	723
40	Off	Safe gas	280
50	On	Gas detected	740

From the results of the Table 2, the response time starts from the fastest, namely 10 seconds, and the longest response time is 50 seconds.

DS3231 RTC Module Testing

The RTC on this tool functions as a continuous time count. This test serves to compare the time on the RTC with the time on the smartphone. So this RTC is a timer for the magnetic door which is placed on the door and the buzzer is the alarm. When the RTC time is set, for example from 12 pm to 5 am, if the door is opened between 12 pm to 5 am, the magnetic door will respond and the buzzer will sound. If the door opens outside the hours set on the RTC, the door condition is safe. In the table above is the RTC test as the difference between the clock on the smartphone and the clock on the RTC. After testing, the highest difference obtained was 10 seconds, this was due to the difference in the IC chip embedded in the laptop using CMOS, while the DS3231 IC chip was used in the RTC, as well as the transfer speed of the Arduino code.

SIM800L GSM Module Testing

The GSM SIM800L module is an electronic device that can be installed with a SIM card, which can connect to the GSM network and can also connect to all networks with GPRS starting from 2G, 3G, or others. At this testing stage, it is based on the length of time sent via a smartphone that was previously connected to the Arduino, then the Arduino will carry out the SMS-sending process using the GSM module. Where the SMS says "gas detected" with the sim card used in this research being an XL card which then sends an SMS to the Telkomsel network.

The distance between the GSM module is not a problem as long as there is still a GSM network available and it is also ensured that everything is connected correctly and that there is a GSM network. On the GSM module, there is an LED which will later determine whether the GSM module is active or inactive. If the LED lights up three times then the module is active, however, if the LED flashes more quickly three times it means the GSM module is not active. The results in the table above show that each test has a different time because it depends on the network and the fastest delivery is 10 seconds and the longest is 50 seconds.

Door Magnetic Sensor Testing

Testing on the magnetic door is carried out to see whether the sensor can read the condition of the door being closed or not and this test is also carried out by adjusting the time that is changed on the RTC module. If the magnet coincides with the sensor, the system will judge that the door is closed and has been regulated according to the provisions in the RTC. If it doesn't match, the buzzer will automatically sound.

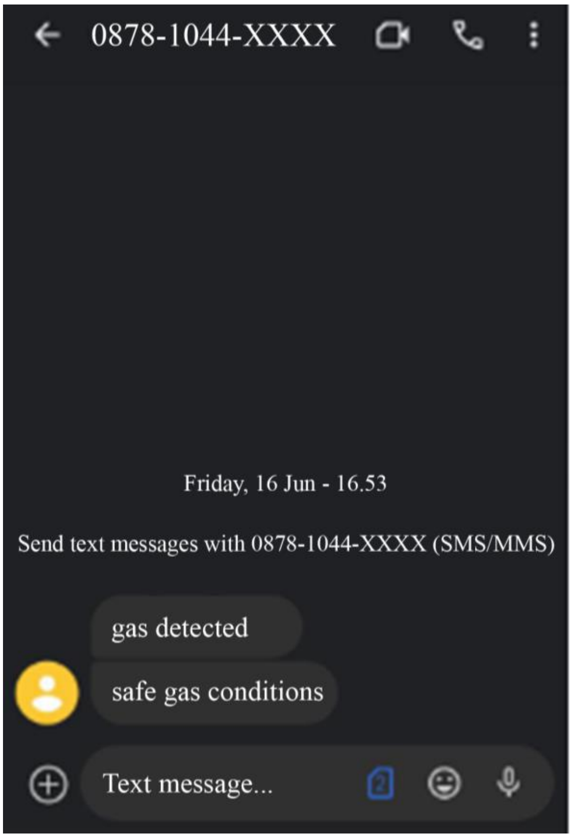

Figure 4. Display of SMS.

This tool is also equipped with an SMS system which is used as a smart home condition monitoring system. SMS (ShortMessage Service) is an application used to send and receive SMS. This SMS can also be sent via telephone in just a few seconds as long as it is within the GSM service range. In this research, SMS is used as a notification if a gas leak occurs. If the value on the sensor reader exceeds the reference value, the fan will activate and the Arduino will carry out the process of sending an SMS using the SIM800L GSM module containing the message "gas detected". If the sensor reader is below the reference value, the fan will be deactivated and the Arduino will carry out the process of sending an SMS using the GSM Module containing "safe gas conditions".

The result of the smart home being designed is a technological concept that must be developed so that it can be implemented in everyday human life. The definition of a smart home here is an electronic network technology that is integrated between electronic devices and household appliances so that they can be monitored and controlled. Examples include gas leak systems and home security. Based on the background above, this research designed an automatic tool that will be linked to a smart home because it can be done with a technological concept. The parameters that will be controlled in this research are gas leak detection with an MQ2 sensor and a magnetic door sensor as security for the house. In this system, software and hardware such as sensors and other devices will be used to control and automate other home activities and also have their benefits such as providing better comfort.

CONCLUSION

Based on the results of the prototype testing that has been carried out, the conclusion is that this prototype test is a home security control system on a smart home prototype that has been designed, using sensors and modules that can run well so that it makes it easier for users to monitor using SMS and has been equipped with a security system. which has been connected to the smartphone. The prototype has been designed using an MQ2 sensor with variable conditions used, namely distance and time of the gas source. So if gas is detected, the fan will turn on and an SMS message will appear on the smartphone.

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