MONITORING AND CONTROL SYSTEM OF IOT-BASED GAS LEAK DETECTION

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Abstract

LPG gas leaks are one of the factors causing fires in housing, this is due to gas leaks not being able to be detected from the start because the gas content is usually small and not smellable, when there is a lot of gas outside the cylinder and there is a trigger or sparks around it, the fire does not occur. it is undeniable that it will happen. So that this can be avoided, a monitoring and control system for IOT-based Gas Leak Detection is created, by detecting lpg gas leaks by operating the MQ-06 sensor reading which has been set at a set point of 1960 ppm, with a maximum sensor reading limit of 10,000 ppm based on Arduino nano 10 bit with information transmission media in the form of the NodeMcu V3 module.

The results of the MQ-06 sensor readings are processed in the Arduino program so that information is generated in the form of sound notifications generated by the buzzer, when the MQ-06 sensor detects LPG gas at a set point of 1960 ppm the sensor will send data in the form of an analog voltage sent to Arduino and converted into a digital voltage through the ADC facility to then send information, the sensor will send data to Arduino to be managed in the Arduino IDE software so that it can respond in the form of a buzzer as an alarm, displays information on the LCD and activates the exhaust fan, and this tool can also send information gas analog data to android smartphones using the Blynk platform via the internet network.

Keywords: Gas leak, Arduino, Android, MQ-06 sensor, flame detector sensor

Introduction

Smart homes have highly sophisticated automated systems. Smart smart homes appear "smart" because their daily activities use a lot of technology and are monitored by computers. A smart home[2] uses automated systems for controlling and monitoring lighting and temperature, home appliances, multimedia equipment, and security systems and many other functions. IoT [1] plays an important role in making smart homes, because through IoT almost every object of our daily life at home can be connected to the Internet, so that IoT makes it possible to monitor and control objects from anywhere and anytime. One of the objects that can be controlled in a smart home is the prevention of fires caused by leaks in LPG gas cylinders which are usually caused by the use of rubber tubes that do not match the regulator, so that the gas escapes and when exposed to fire can cause a fire.

Gas leak detection aims to avoid incidents or accidents, such as fires and explosions involving flammable gas leaks. To control these conditions, a detection system is made that uses an MQ sensor that is capable of detecting gases such as H2, LPG, CH4, CO, alcohol, Smoke and Propane [3]. The system works by detecting the gas content around the gas cylinder, if it exceeds a predetermined limit, the system will sound a buzzer as a warning and then send the results of sensor readings to be informed to the user via Android. analysis can be performed on the readings to increase the precision of the system. and with the help of IOT, users can monitor gas concentrations in ppm on their

smartphones, receive notifications and take the necessary action by turning on the exhaust remotely when a gas leak occurs.

Literature review

Control systems use sensors [4] to collect data from the environment in which they are installed, actuators to react to changes in the environment until the system reaches the expected state, and controllers are responsible for processing the data collected by the sensors, for adjusting the response of the actuators and for informing the user. regarding system status; as a simple example, it is possible to highlight the temperature control system in air conditioners and showers. [4,5,]

MQ-6 [6]is a gas sensor that can be used to detect LPG, Iso-butane, Propane with high sensitivity. However, the MQ-6 gas sensor has a weak sensitivity to alcohol and cigarette smoke. The advantage of the MQ-6 gas sensor is that it has a fairly fast response to LPG (Liquefied Petroleum Gas), is stable for long periods of time and can be used in simple control circuits [8]. The MQ-6 sensor has a detection range from 200 to 10000 ppm. The level of LPG in cylinder is also continuously monitored [9][10]

Methodology

The LPG gas leak detection system uses Arduino nano, MQ-06 Sensor, Flame detector Sensor, and NodeMCU Lolin V3 whose benefits are to provide information and early warning in the event of an LPG gas leak in a room, control the Selenoid Valve which will close the LPG gas hose valve and activate the exhaust which functions to dispose of LPG gas that leaks outside the room when there is a leak of LPG gas or a fire is detected in the room. In conditions where the LPG gas is leaking, the sensor will send an order to turn on the buzzer output which gives a warning that there has been an LPG gas leak and the LCD will display an information. The tool in this system also sends information on LPG gas leaks to an android smartphone which can be accessed via the Blynk platform application.

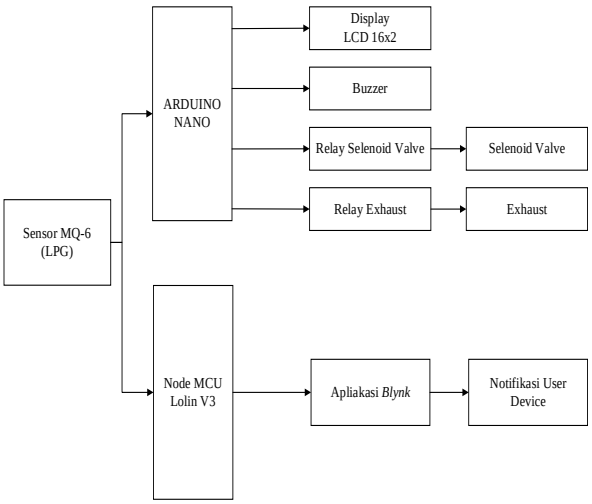

Figure 1. system works

the program is made using the Arduino IDE using the C language and it is this program that will run commands on the system and tools. Then the program that has been uploaded to Arduino using the Arduino IDE will be connected to the Blynk platform application for displays information from LPG gas leaks on android.

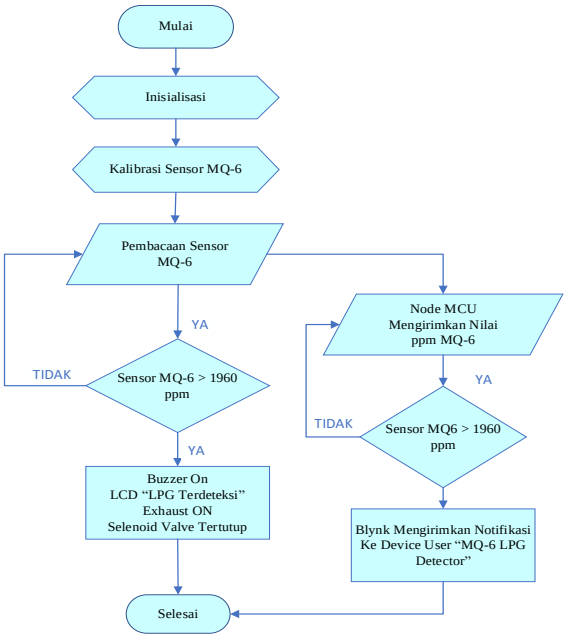

Figure 2. work of MQ-06 sensor

Creating Blynk Automation functions to determine the Automation that will be issued by the blynk application when it has touched or exceeded the set point value that has been determined. In this program, we create a set point for ppm values above 1940 ppm, then a notification will be sent to the Device User.

The MQ-6 sensor has a detection range from 200 to 10,000 ppm. The MQ-6 sensor starts to detect values from 200 ppm to 10,000 ppm which can be detected, with 200 ppm as Zero. If it is made at the percentage level then 9800 is divided by 100%, what is obtained is 0 to 98 ppm which is considered as 1 percent.

Then if compared with the maximum output voltage from the sensor which is 5 Volts with a tolerance of 5%, the maximum output voltage value of the sensor can be up to the Input Voltage, from the results of the information above, the following equation can be made:

$$Vout=Presentation/100 \times Vin$$

From the equation above, if there is 20% concentration of LPG gas or 1,960 ppm of LPG gas content, the sensor will output a voltage of 1V. The sensor output voltage of 1V will be converted into digital data with the ADC facility on Arduino, which will then activate the Selenoid Valve and Exhaust Fan Blower, as actuators for closing LPG gas hoses and blowers intended to exhaust LPG gas out of the room. This information will also be sent via IoT with the NodeMCU device, and will be received by the Blynk application on the user's Smartphone. The buzzer in the tool design will be controlled by Arduino nano via Digital 2 (D2) port which will be active when LPG gas or fire is detected.

Making Blynk Automation functions to determine the Automation that will be issued by the blynk application when it has touched or exceeded the set point value that has been determined. In this program, we create a set point for ppm values above 1940 ppm, then a notification will be sent to the Device User.

Results and discussions

Testing of the MQ-06 Gas sensor was carried out using a Gas lighter as a substitute for LPG Gas and measured at the Analog Output Pin to the GND pin. As a result, the LCD displays "LPG detected" and the measurement shows the output voltage of the MQ-06 Sensor

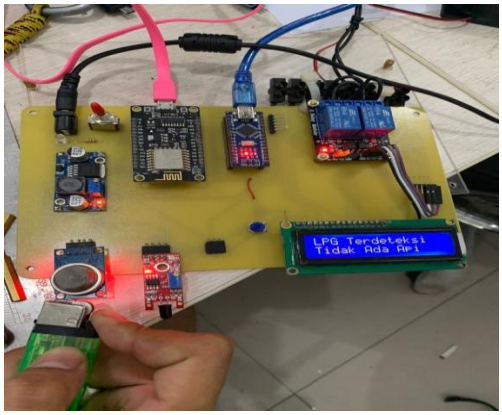

Figure 3. system testing

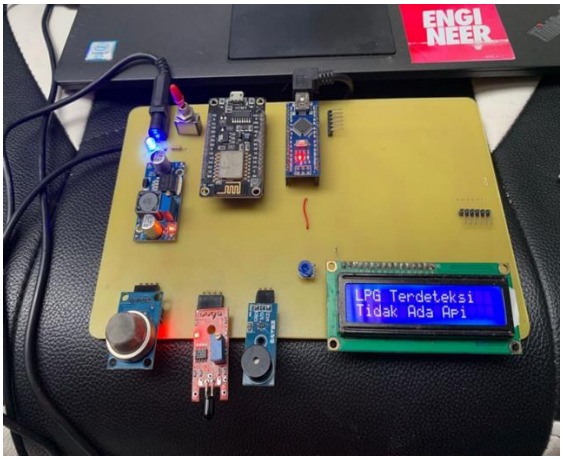

Figure 4. Equipment testing when LPG is detected and fire is not detected.

Figure 5. Equipment testing when a fire is detected and LPG is not detected

Figure 6. Notifications on Device Users when the Blynk application sends notifications that there is an LPG Gas leak

System Testing

Based on the picture above, that the 12 V 5 A Power Supply Voltage and the Step Down Dc-Dc Converter as the main power supply in the circuit will be indicated by a 3mm LED when it is an indication that the power supply is active, with input from the 12 V 5A Power Supply which then Step down by the DC-Dc Module step down to the Arduino Nano working voltage, MCU node, Flame Detector sensor, MQ-6 sensor, 16x2 LCD, Buzzer, and 2 Channel Relay, while for the Selenoid Valve and Exhaust power supply directly use 12V from Power Supply without being stepped down by the Step Down Dc-Dc Module.

System testing is carried out by bringing the tool closer to LPG gas and fire, then the program will read the flame detector sensor and the MQ-6 sensor. After the reading process is complete, the program will provide information on LPG gas leaks and the presence of hotspots (fires), as well as sending information to the Blynk application on Smartphones.

When fire is detected, gas is detected or fire and gas are detected, then Arduino nano will order according to the syntax to activate the relay, which then the relay will activate the Selenoid valve and exhaust with a 12V voltage. Whereas in conditions where it does not detect gas or fire, the Arduino Output Pin will provide Logic 1 or 5VDC Voltage to the Relay pin control input so that the Relay is not active, as well as the Exhaust and Selenoid Valve will not get 12V voltage to be active.

Because the MQ-6 Sensor and Flame Detector Sensor use the ADC (Analo to Digital Converter) facility on the Arduino Nano which uses an internal Reference Voltage (VREF) to convert analog data into digital. When VREF is not 5V, it will affect the measurement quality and ADC value conversion.

In Figure 4.12, testing of the MQ-06 Gas sensor is carried out using a Gas lighter instead of LPG Gas and is measured at the Analog Output Pin to the GND pin. As a result, the LCD displays "LPG detected" and the measurement shows the output voltage of the MQ-06 Sensor.

Tabel 1. Testing Sensor MQ-06

No		MQ-6 Sensor Measurement		
	Time	V_o (Vdc)	PPM	Information
1	1	0.02	39.18	Not detected
2	5	0.06	116.87	Not detected
3	10	0.1	196.00	Not detected
4	15	0.31	607.54	Not detected
5	20	0.82	1607.18	Not detected
6	25	1.1	2158.11	detected
7	30	2.3	4508.00	detected
8	35	3.6	7056.00	detected
9	40	4.1	8036.00	detected
10	45	4.98	9760.72	detected

Tabel 2. Notification

No	Sensor MQ-6 (ppm)	Sensor Flame	LCD	Buzzer	Exhaust	Selenoid Valve	Notif Blynk
1	257	0	No LPG & Fire	off	off	off	No notification
2	189	1	No LPG & Fire Detected	Active	Active	Active	Fire detected in the room
3	2786	0	LPG detected & No Fire	Active	Active	Active	Gas detected in the room
4	4007	1	LPG & Fire detected	Active	Active	Active	Gas and Fire detected in the room

In testing the MQ-06 sensor, it is carried out by testing the sensitivity of the sensor based on the gas that comes out, in this case the gas used is gas from an opened lighter. The aim is to determine the level and concentration of gas by the MQ-06 sensor which is used to detect LPG gas in the room. There are 3 types of tests carried out, namely; output voltage testing, ADC calculation based on V-out and PPM conversion based on the resulting ADC value. From the test results of the MQ-06 sensor, it can be seen that gas is detected at an output voltage value of 1V according to the syntax of the MQ-06 sensor program on the Arduino IDE, and the MQ-06 sensor detects gas at a PPM value of ± 1960 PPM according to the characteristics of the MQ sensor -06 which can detect with a range of 200 – 10000 PPM.

Conclusion

Testing of the MQ-06 sensor is carried out by testing the sensitivity of the sensor based on the gas that comes out, in this case the gas used is gas from an opened lighter. The aim is to determine the level and concentration of gas by the MQ-06 sensor which is used to detect LPG gas in the room. There are 3 types of tests carried out, namely; output voltage testing, ADC calculation based on V-out and PPM conversion based on the resulting ADC value. From the test results of the MQ-06 sensor, it can be seen that gas is detected at an output voltage value of 1V according to the syntax of the MQ-06 sensor program on the Arduino IDE, and the MQ-06 sensor detects gas at a PPM value of ± 1960 PPM according to the characteristics of the MQ sensor -06 which can detect with a range of 200 – 10000 PPM.

In testing the Flame Detector sensor aims to determine the maximum distance of the fire that can be detected by the Flame Detector. From the results of table 4.4, it shows that the maximum distance for a fire detected by a Flame Detector is 90cm. This measurement is carried out by adjusting the potentiometer on the sensor, and the maximum result is 90cm. Based on the test results, it can be concluded that the Flame Detector is in good condition according to the characteristics of the sensor.

Testing for the whole tool aims to create a tool that can inform the user. Based on the test results, it can be seen that all the components of the tool work well and are in accordance with the program instructions that have been made.

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