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Development of Smart Monitoring and Gas Leakage Detector for LPG Gas

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Abstract: The main purpose of developing this project is to detect gas leakage and measure the gas level inside the tank using a load sensor. Then, Blynk mobile application will notify the consumer when the gas tank is out of gas, and the leaked gas is detected. The mobile application will also display the collected data from the sensors. People nowadays are less aware of the LPG Gas tank in their house. The leakage from the LPG tank can lead to fire accidents as the gas inside the tank is a combustible gas. Why was research needed? The main component for Smart Monitoring and Gas Leakage Detector for LPG Gas is ESP8266 NodeMCU, Load Sensor, HX711 Load Cell Amplifier and MQ-9 Gas Sensor. The accuracy and sensitivity of both sensors are measured as the consumer will monitor the collected data. Both sensors are functioning well, even though the accuracy of the sensors is not 100% accurate. This project uses ESP8266 NodeMCU to control the system and as a platform to send the collected data to mobile applications wirelessly. The project has achieved its objectives which is to detect the gas leakage and measuring the weight of the LPG tank, then notify the user through NodeMCU

Keywords: Load Sensor, HX711 Load Cell Amplifier, Gas Sensor

1.0 INTRODUCTION

LPG comprises both saturated and unsaturated hydrocarbons and is made up of commercial propane and butane. Because LPG has such a mild odour, it is good to quickly select an odourant to identify any leaking gas [1]. The main hardware for this project is NodeMCU V3 ESP8266 Wi-Fi, Load Sensor, Load Cell Amplifier HX711 and MQ-9 Gas Sensor. Blynk will be used as a mobile application that can monitor the result of the project. This project uses Arduino IDE as a platform for programming languages. Therefore. The load sensor is a measuring tool to measure the gas level in the LPG cylinder by measuring the weight. The empty LPG Gas cylinder is roughly 15-16 kg, whereas the overall weight of the LPG Gas cylinder is roughly 28-29 kg. By measuring the weight of the LPG Gas cylinder, the level of gas contained inside of the cylinder can be calculated. . The method of determining the concentration of specific gases in the environment is known as gas detection. When a chemical reaction caused by a certain gas occurs, the sensor serves as a reference point and scale, allowing for the measurement of an electric current. Early sensors can only detect one gas at a time, but currently, they can detect multiple gases at once, particularly oxygen (O2), flammable gases (LEL), hydrogen sulfide (H2S), and Carbon monoxide (CO). By using an MQ-9 gas sensor, only carbon monoxide (CO) and flammable gas can be sensed.

2.0 METHODOLOGY

I. BLOCK DIAGRAM

The details of methodology in developing Smart Monitoring and Gas Leakage Detector is included. This methodology explains the overall block diagram of the project, as shown below.

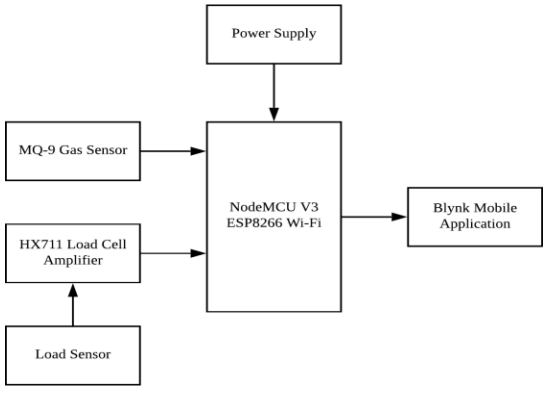

Figure 2-1: Block Diagram of the project

The project's block diagram is shown in Figure 2-1. Smart Monitoring and gas leakage detector for LPG Gas consists of a few important components. From inputs, MQ-9 Gas Sensor is connected to NodeMCU V3 ESP8266 Wi-Fi. The gas sensor will detect the gas leakage from LPG Gas. MQ-9 Gas Sensor is suitable for detecting LPG, CO and CH4 gas. The sensitivity is high, and the response time is faster than other gas sensor modules. The load sensor measures the weight of LPG Gas, which is the force pressure applied on the load sensor. Because of the low and feeble signal strength, the HX711 Load Cell amplifier will increase and amplify the signal strength.

The processing unit is NodeMCU V3 ESP8266 Wi-Fi which is a combination of microcontroller and Wi-Fi Module. The NodeMCU must configure all the input sensors connected to it and compute the parameters to and display the output on the Blynk mobile application for monitoring the measurements taken by the sensors. The Lithium battery mounted on the battery shield and connected to NodeMCU provided 9V power, allowing the project to be portable without using a USB port or converter.

II. FLOWCHART OF THE PROJECT

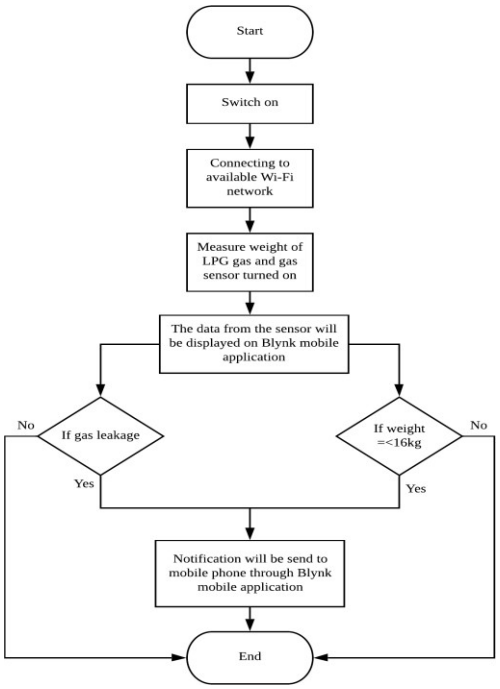

Figure 2-2: Flowchart of the project

The flowchart in Figure 2-2 shows the Smart Load Sensor and Gas Detector's working for LPG Gas. The switch will be turned on first then the NodeMCU will send the command to the load sensor and MQ-9 gas sensor. Open-source prototype board designs are available for NodeMCU, an open-source firmware. The term "NodeMCU" is a combination of the words "node" and "MCU," which stand for microcontroller and unit, respectively. The NodeMCU microcontroller can connect to the nearest accessible Wi-Fi network. The SSID and password of the selected Wi-Fi will be configured inside the NodeMCU. It will connect to the selected Wi-Fi with the correct SSID and password. Then, both equipment will measure the weight of the LPG gas tank and detect the gas of LPG. If there is gas leakage or the weight is below 16kg, the notification will be sent to Blynk mobile application through NodeMCU. On the Blynk mobile application, the data collected from the sensor will be shown.

3.0 RESULTS

3.1 Results 1: Gas Sensor Analysis

The result is collected and measuring based on the first project objective. The first objective is to detect the gas leakage of the LPG using MQ-9 Gas sensor. The butane gas from the lighter has been leaked for 10s near to the gas sensor.

Time , s	Gas Sensor Value
0	286
1	286
2	288
3	289
4	289
5	290
6	290
7	290
8	292
9	294
10	298

Table 3-1: Gas Sensor Value for 10 second

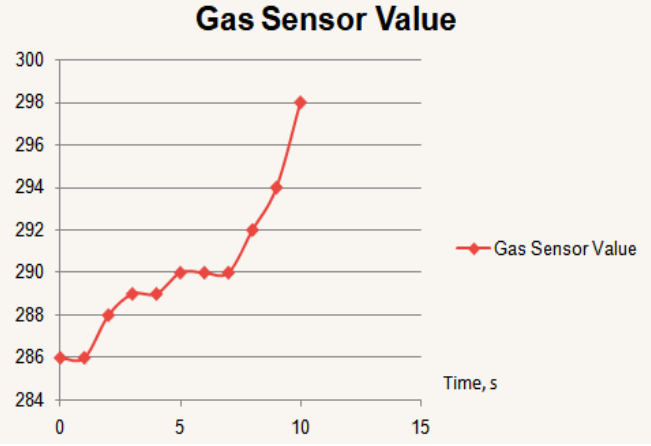

Figure 3-2 : Graph of Gas Sensor Value for 10 second

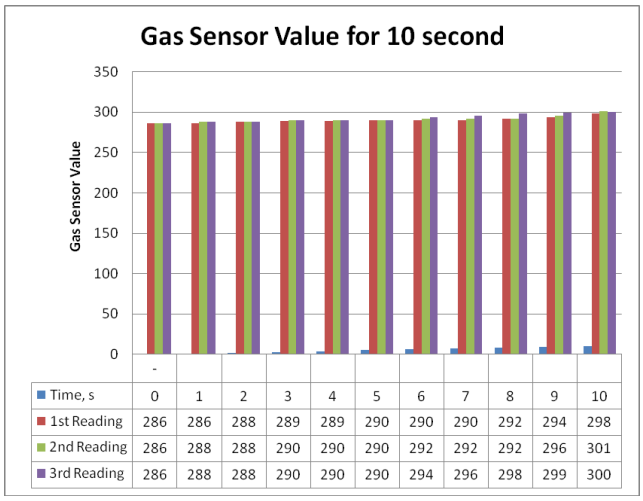

Figure 3-3 : 3 reading of gas sensor value for 10 second

Table 3-1 shows that the butane and propane gas from the lighter leaked near the gas sensor is recorded. The experiment is done to test the sensitivity and gas sensor's accuracy. The recorded gas sensor value is collected from Blynk mobile applications. The gas sensor detects the gas leakage and sends the data to the mobile application through NodeMCU. The initial value for this experiment is 286. Then the value increases to 298 for 10 seconds; the value increases by 12 in 10 seconds. It can be said that the MQ-9 Gas Sensor's sensitivity towards butane and propane gas is high.

Based on Figure 3-2, the graph of leaked gas value for 10 seconds has been plotted. The graph showed that the value is increasing faster. MQ-9 Gas Sensor's sensitivity towards Combustible gas and Carbon Monoxide gas is high. The experiment is conducted three times to make sure that the result will become more efficient. Below is the table of all data collected.

Based on Table 4-3, the initial reading of the project testing is fixed, which is 286. Then, all the data collected will be compared to check the sensitivity and efficiency of the gas sensor. The data collected shows that the gas sensor does increase from 286 to 298 for the first reading. For the second reading, the value increases from 286 to 301. Lastly, the third reading's value increases from 286 to 300. This concludes that the gas sensor can detect the gas leakage efficiently and with higher sensitivity toward gas.

3.2 Result 2: Load Sensor Analysis

The load sensor will be tested with the plate's 5kg, 15kg and 20kg weight, and the accuracy of the data collected will be calculated. The weight plate will replace the LPG Gas tank.

Weight of the Plate	Weight Displayed on the Blynk mobile application	Accuracy of the load sensor
5kg	4.96kg	99.2%
15kg	15.38kg	99.97%
20kg	19.51kg	97.55%

Table 3-4 : Weight displayed on mobile application and the accuracy

The accuracy of 5kg plate is 99.2%, 15kg plate is 99.97% and the 20kg plate is 97.55%. That's mean the accuracy error of the reading is 0.8%, 0.03% and 2.45% respectively. The material used to develop the base for weight plate is one of the factors that will affect the accuracy. The size and position of the base will also affect the accuracy.

The weight measured by using load sensor will be displayed on the mobile application. The time for the value to appear on the mobile application is slow and the value is less accurate. This is because the internet connection's speed is not faster enough to transfer the data collected from the NodeMCU. However, the accuracy's error of the load sensor is still acceptable as the value is almost accurate with the actual value.

The accuracy of the load sensor will be calculated by using this formula:

$$= \frac{Weight\ displayed\ on\ mobile\ application}{Actual\ weight\ of\ the\ plate} \times 100\%$$

4.0 DISCUSSION

Development of Smart Monitoring and Gas Leakage Detector for LPG Gas is done and both sensor's value were displayed on the Blynk mobile application. The accuracy and sensitivity for both sensors is measured to determine the efficiency of this project. The MQ-9 gas sensor does functioning-well as it can sense the gas leakage with high sensitivity. Then, the load sensor can measure the weight of LPG gas tank. However, the accuracy is 100% accurate as there will be a few factors that will affect the accuracy. Last but not least, Blynk mobile application will be the platform for this project display or send notification to the consumer. There will be two type of condition in this project which is when the gas sensor value is more than 300 and the weight value is less than 16.5kg. The Blynk mobile application is one of the best options for developing an IoT project.

5.0 CONCLUSION

In conclusion, the Smart Monitoring and Gas Leakage Detector for LPG Gas has met the intended objective and solved the problem in this study. The project has achieved its objectives: to detect the gas leakage, measure the LPG tank's weight, and then notify the user through NodeMCU. The gas sensor functions well as it can detect the leaked gas from the regular lighter with higher sensitivity. The gas was leaked for 10 seconds near the gas sensor to test functionality and observe the efficiency of the gas sensor value. The data collected then will be displayed on the mobile application. Next, the load sensor can measure the weight of the LPG tank with high accuracy. The HX711 Load Cell Amplifier will amplify the load sensor. The reason for using the HX711 Load Cell Amplifier is because the signal from the load sensor is too weak to read. So, the load cell amplifier will increase the signal power, and the ESP8266 NodeMCU will collect the data. The reading of the load sensor's accuracy will be affected by few factors, such as the material used to create the base for the load sensor and the position of the load sensor.

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