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Kitchen Gas Leakage Control System

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Abstract: The kitchen gas leakage control system aims to give warning to user in order to avoid frequent fires in the kitchen caused by gas leakage. The objective of this study is to design, develop and test the functionality of gas leakage detection systems. The prototype development of this system is based on the Design Thinking model. The LCD display and buzzer can help users to monitor and give warning when the gas leaking happens. This gas detector uses the MQ-135 type gas detector to detect the reading value of the gas leak in percentage (%) which is already set in the software. The reading percentage of gas will be displayed on the LCD and the buzzer will produce sound if the gas reading is above 6%.Then, the DC Fan will blow the leaked gas and at the same time, the solenoid valve will automatically close the hose. The Arduino UNO is used as the controller in this system. The implementation of this project involves testing by using gas from a lighter. Expert validation has involved four experts including two lecturers, and electrical technician from the. As a result from the expert evaluation, it shows that the development of the Gas Leakage Control System in the Kitchen has data tests that have been implemented. Therefore, it can be concluded that the implication is the fire accident in the kitchen can be reduced by using this new innovation, thus can save our house from unwanted gas leakage disaster..

Keywords: Design Thinking, Gas Leakage, Gas Sensor, Arduino UNO

1. Introduction

Fire disasters are one of the most common disasters in Malaysia (Tengah, 2019). Fires often occur in forests, areas with large populations and often in the kitchen. Generally, fires often occur in densely populated areas as they are affected by short circuits and gas leaks from home kitchens (Dewi, 2017). Fire cases are most often caused by factors of human neglect and gas leaks (Joni, 2018). As a result of human negligence factors, many Malaysians have received such things as homelessness, physical injuries, and property losses. Fire can happen at any time, consciously or unconsciously. Statistics from the Jabatan Bomba Penyelamat Manusia (JPBM) have released statistics that kitchen fire cases are increasing every year (JBPM, 2016).

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Most cases of fire in the kitchen are caused by the human negligence of closing the gas stove in the kitchen (Shukrian Jef, 2016). Fire statistics from JPBM have shown that residential homes in the state of Kedah, from May 17, 2018 to June 1, 2018, have reported 10 cases of negligence in the kitchen (Zuliaty, 2018). Besides that, fire cases also occur due to exhaust fan burning in the kitchen caused by excessive smoke during cooking (Alias, 2019). Thick smoke also can be caused by gas leaks and fires in the kitchen and can spread quickly. Therefore, a kitchen gas leakage control system has been developed to warn users to avoid frequent fires in the kitchen by gas leakage.

In order to develop the kitchen gas leakage control system product in this kitchen, information search on current issues and researching existing products were done. From gas leak detection studies, it was discovered that designers used gas sensors to detect gas leaks (Drahman, 2015.) Among the studies are projects related to the construction of a wireless smoke detector system where the system is focused on the use of the PIC16F876A microprocessor which is the main alarm system (Zaki,2013). Therefore, improvements and modifications were made to develop this project. This project involved the use of gas detectors that detect LPG gas leaks occurring in the kitchen. The addition of a Buzzer to the Arduino (Maker UNO) will sound and at the same time the solenoid valve will cut off the supply of gas from the gas tube to the stove. Meanwhile, the DC Fan will inhale and emit leaking gas and the LCD display will show the percentage of the gas, the condition of the DC Fan and solenoid valve whether in an open or closed condition.

2. Methodology

The methodology used throughout the development process for the kitchen gas leakage control system product in the kitchen is the Design Thinking model, which has five phases. These include empathize phase, define phase, ideate phase, prototype phase and test phase. Therefore, this model is ideal for product development that is to be developed.

2.1 Empathy

In this initial phase, preliminary study analysis is performed to identify the problem and it is carried out to determine the direction and objectives of the research model developed. Knowledge of what users do, say and think is important to identify the problems occurring. The methods used in this phase is interviewing users with problems encountered in the context of everyday user life. Therefore, the researchers have interviewed firefighters and housewives to get information on fires caused by gas leaks in the kitchen.

2.2 Define

This phase of the research combines the findings of previous studies and observations done based on the problems faced by the users. The problem statement was identified through analysis using the 5W1H technique. Through this technique, the researchers have clearer ideas about the product features and characteristics required by the users. Table 1 shows the use of 5W1H technique in the development of this prototype device.

Table 1: Using the 5W1H technique to propose a solution

5W1H element	Question
What	What is the problem that caused the gas leak?
Who	Who should use this product?
Where	Where are the places fires often occur in the home area?
When	When will the solenoid valve block the leaking gas?

Why	Why is this product important for consumers?
How	How is the gas leak control system in this kitchen developed to prevent fire and gas leakage?

Through the 5W1H technique performed, the problem statement of the study can be identified based on the needs and problems of the user. Therefore, the researcher can find out how to solve the problem by answering the questions that arise.

2.3 Ideate

This phase of the researcher uses brainstorming's method of brainstorming creative and creative ideas in developing a new product that meets the needs of users based on the information gained in the Define phase. This phase takes quite a while because a lot of things need to be taken into account and considered.

In this phase, the flow of the system is designed, after considering the inputs from the sensors and the expected output. The description of this prototype device consists of three main sections: the circuitry hardware, the software, and the project overview. Several aspects of the consumer needs are taken into consideration such as safety, functionality and usability. The circuit operational is presented in Figure 1.

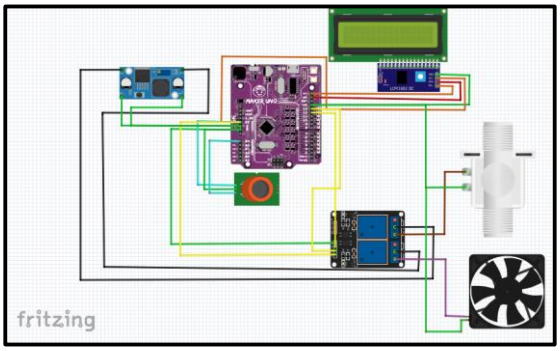

Figure 1. Circuit of operational control

2.4 Prototype

In this phase, the researcher has made product sketches, built project circuits, developed programs, product and the product model of a gas leakage control system in the kitchen. Through this sketch drawing, the researcher can identify the disadvantages and advantages of the design of the product and the researcher can determine the suitable size of the product. The choice of suitable materials and sizes are also considered in producing the design of the product. The preliminary sketches used to design this product was drafted using Sketch Up software. The researcher used this software because it is easy to handle with portraying the product design that resembles the actual model that has been developed. The front view sketch of product, right side view of product and sketch of the circuit box are presented in Figure 2, 3 and 4.

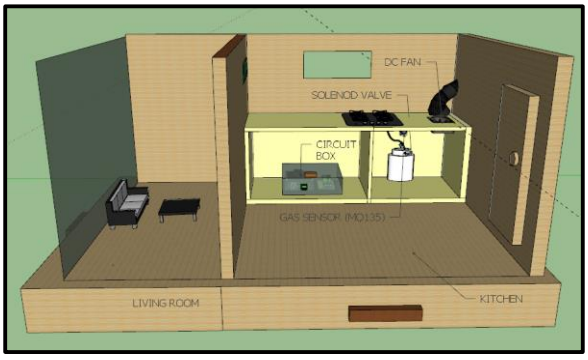

Figure 2: Front view sketch of product

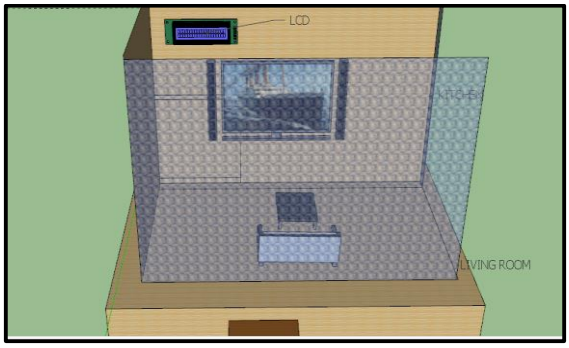

Figure 3: Right side view of product

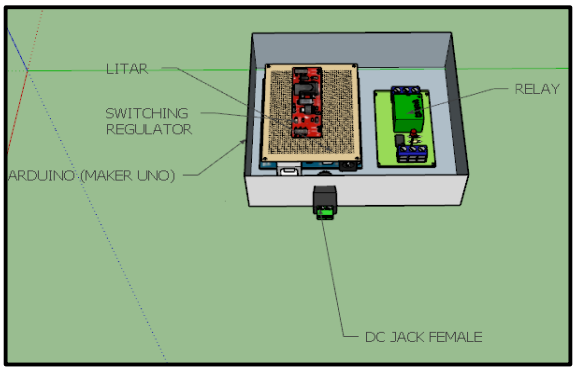

Figure 4: Sketch of the circuit box

2.5 Testing

The testing process is done to test the product's functionality to ensure that the objectives of this product development are achieved. In this phase, the test is carried out using two methods which are the test on the built-in components and users' acceptance test. Each unit involved in the development of this system is combined to form a complete circuit to achieve the project's goals and objectives. The test is also conducted to ensure that the system is controlled as planned. Expert verification has been done to strengthen more the implementation of this project. Four experts in electronics and electrical area were selected to evaluate this prototype.

3. Results and Discussion

The test process performed after completing the prototype phase was conducted to test the product produced, that is the input for the MQ-135 gas sensor. MQ-135 gas detector is an important component in the formation of kitchen gas leakage control system because it is a component that will detect the LPG cooking gas leakage in the kitchen. The researchers chose the MQ-135 detector because of the efficiency and the short time for the detector to detect the leakage of LPG gas. Testing was performed using a lighter in an enclosed space.

3.1 Results

Table 2 shows data recorded for the test using a lighter gas consisting of distance, time to detect gas, LCD display, buzzer, solenoid valve and DC fan.

Table 2: Data recorded for the test using a lighter gas

Distance	Time to Detect Gas	LCD Display (Percent Gas)	Buzzer	Solenoid Valve	DC Fan
0.5 cm	1.61 Second	23%	On	Close-Gas were blocked	On
1.5 cm	2.66 Second	18%	On	Close-Gas were blocked	On
2.5 cm	3.84 Second	15%	On	Close-Gas were blocked	On
3.5 cm	5.47 Second	12%	On	Close-Gas were blocked	On
4.5 cm	6.10 Second	10%	On	Close-Gas were blocked	On
5.5 cm	6.78 Second	7%	On	Close-Gas were blocked	On
6.5 cm	Can't be detect	No display	Off	Open-Gas flow	Off
7.5 cm	Can't be detect	No display	Off	Open-Gas flow	Off

3.2 Discussions

In this test, the area of the enclosed space takes a short time for the gas to fill the space and detect the gas leakage that occurs in the space. The distance analyzed by the researcher is from 0.5cm to 7.5 cm. Table 2 shows the test results using lighter gas. Based on table 5.2, the MQ-135 gas detector can detect lighter gas leaks up to a distance of only 5.5. Next, after the data collection has been done and recorded in table 2. The researcher then builds a graph to make it easier for the data to be analyzed.

3.4 Figures

Figure 5 shows the graph of time versus distance when the gas leak occurred. The researcher has done this analysis by using gas from a lighter. It can be seen from the graph that when the distance to detect gas leaks increases, the slower the MQ-135 gas detector will detect the gas leaks. Meanwhile, the percentage reading of gas on the LCD display decreases as the distance of gas leak to be detected increases.

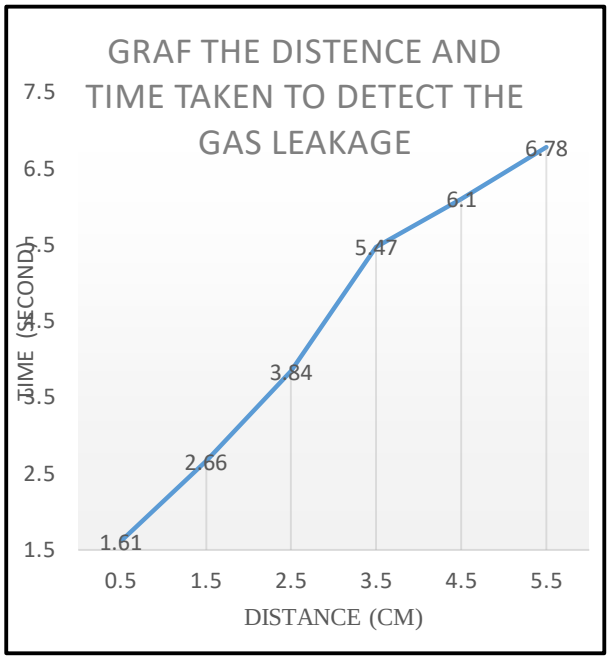

Figure 5: The graph of time taken distance to detects the gas leakage

4. Conclusion

Overall, the project has achieved its objectives. During the implementation of this project, the researcher had gained a lot of useful knowledge in the arduino programmer field especially. Although the implementation faced many obstacles and difficulties, the effort and patience of the project researcher has been successfully developed. The Kitchen Leakage Control System Product was developed using the main component, Arduino (Maker UNO). Arduino (Maker UNO) was used as a process for giving instructions and sending data to the MQ-135 gas detector to send notifications to LCD displays.

Although this system can successfully operate, there are some problems encountered during the development of this system. Among them is, the 12V power supply circuit is not functional because the arduino (Maker UNO) is not placed close to the power supply circuit and has caused the DC jack female to burn. Therefore, the researcher has devised a solution to change the DC jack female and check in more detail the power supply before connecting it to a 240 V power supply.

The software arduino (Maker UNO) used should be compatible with the components of the microcontroller circuit. Beside that, the use of appropriate programming languages is matched in software to give instructions to Arduino (Maker UNO) and some output components to act. Gas sensors also play an important role in this system because the readings to input them can only be read in analog output (AO) display. The reading value is in percentage of gas.

Overall, the researchers noted that the development of the kitchen gas leakage control system has been successful. Moreover, it can be further strengthened by the evaluation of selected expert evaluation. It is hoped that in the future studies, they will improve the design of the system and solve the problems faced by users. Therefore, the development of this system is relevant to be developed to assist users in detecting gas leaks.

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