

“The ARFIE”

Arduino Based Fire and Garbage Volume Warning System

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Abstract

Garbage is a material that is discarded or wasted from sources resulting from human or natural activities that do not yet have economic value. Equipping of trash cans at certain points before being transported to the Final Disposal Site (TPA) is an alternative to make it easier for the community to maintain cleanliness. However, the reality is that garbage accumulates in the trash, causing pollution. Another risk is the occurrence of fires originating from the trash can if there is a fire source in the trash can, for example cigarette butts. An innovation is needed to create a trash can that gives a full garbage warning and automatic fire suppression. The research method uses the ADDIE method with the stages of Analysis, Development, Design, Implementation and Evaluation in developing fire warning bins and waste volumes. Arduino Uno R3 as a microcontroller, MQ-2 smoke sensor as a smoke detector and ultrasonic sensor HC-SR04 as a distance detector to determine the volume of waste. Sensor testing shows that the MQ-2 smoke sensor can detect smoke levels and the HC-SR04 Ultrasonic sensor can read the measured distance. The overall test results show that the tool can work well in giving warnings if there is excessive smoke levels and warnings of the volume of waste. Buzzer and LED will light up when detecting the presence of smoke levels and excessive volume of waste. The LCD screen displays the information of each working system.

Keywords: garbage, smoke, fire

1. Introduction

Maintaining cleanliness is one of the steps in an effort to live a healthy life, especially maintaining cleanliness from waste. Garbage is a material that is discarded or wasted from sources resulting from human or natural activities that do not yet have economic value (Rudi, H.2008). Equipping of trash cans at certain points before being transported to the Final Disposal Site (TPA) is an alternative to make it easier for the community to maintain cleanliness. In office spaces or homes are also given a lot of trash. In general, the trash can in the room is in the form of a tube or block with a lid. Equipping of garbage covers so that garbage is not visible or prevent the spread of odors produced by biological waste. Aesthetically, the equipping of garbage covers has a positive impact, but there are several impacts, one of which is that the existing waste is not monitored carefully, especially the type of waste and the amount.

CNN Indonesia reported that on August 22, 2020 there had been a fire at the Attorney General's Office, South Jakarta. The results of the investigation explained that the cause was a cigarette butt that was thrown away by one of the officers. Cigarette butts are a type of waste that should be thrown in the trash. However, special treatment is needed, namely turning off the cigarette butts. The

risk when cigarette butts that have not been completely extinguished are then thrown into the trash, which triggers the burning of other trash. Dry waste is very susceptible to fire if there are embers attached. Before the garbage burns, it is marked by the appearance of smoke.

An alternative is needed to prevent fires caused by cigarette butts, especially those from trash cans. Trash cans that can detect smoke or fire can be a solution to prevent fires. The warning of the amount of waste that almost exceeds the capacity of the place is a solution so that the waste is immediately disposed of in the shelter. The combination of smoke warnings and full garbage warnings is an alternative to preventing fires and keeping the environment clean. "The ARFIE" Anti-Fire Garbage Monitoring System is a trash can that is controlled automatically with the Arduino Uno R3 microcontroller which can detect the presence of burning smoke and other harmful gases. Another advantage is being able to give a warning when the trash can is full.

2. Research Method

a. Method

This research procedure uses the ADDIE development model with the following stages:

1) Analyze

Analysis is an action to identify the needs needed in an activity. In this activity, the tools needed include:

- Arduino Uno R3
As a microcontroller to regulate the work of all components
- MQ-2 Gas Sensor
As a sensor to read carbon gas from combustion and butane gas
- Ultrasonic Sensor HC-SR04
As a distance reader to determine the volume of waste
- 16x2 LCD
As a viewer of all system data
- LED Light
As an indicator light
- Buzzer
As a sound source if there is smoke or the garbage is full
- 9V Adapter
As a voltage source or can be replaced with a 9V . battery
- Software
Microcontroller programming application in the form of Arduino IDE.

2) Design

The design stage is carried out to facilitate researchers in designing the product to be made. The design stage includes making tool designs, block diagrams and flowcharts.

- Tool Design
The design is equipped with several sensors such as the MQ-2 gas sensor, HC-SR04 Ultrasonic sensor, 16x2 LCD.

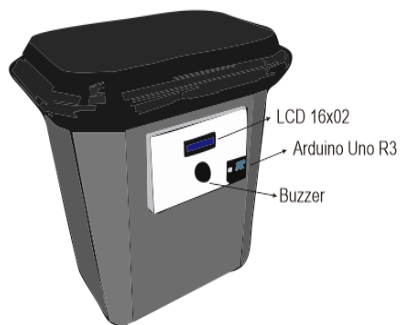


Figure 1. Tool Design (Private Doc, 2021)

b) Block Diagram

Block diagram is a diagram to describe the working principle of the tool to made

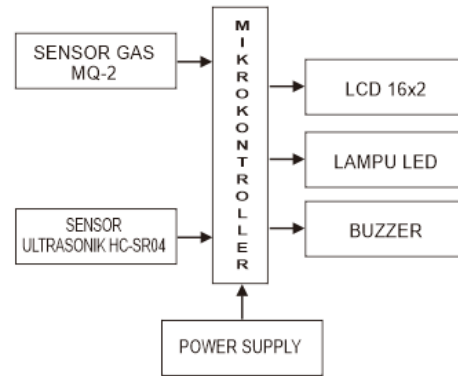


Figure 2. Block Diagram

c) Flowchart

Flowchart is a diagram that describes the work steps from start to finish

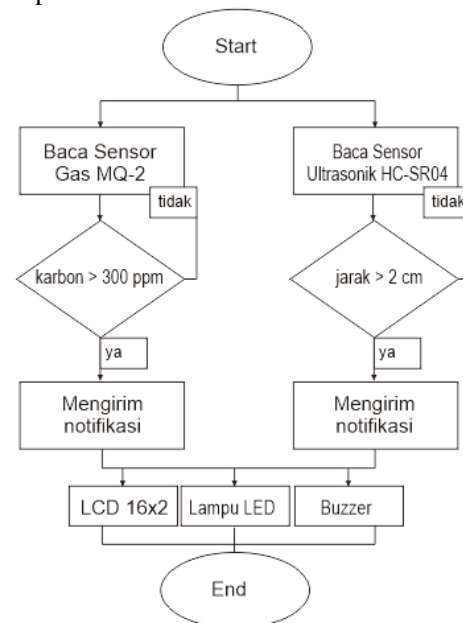


Figure 3. Flowchart / Diagram Alir.

d) Electronic circuit

The electronic circuit is drawn in advance to facilitate the assembly of tools. The image was created using the fritzing app.

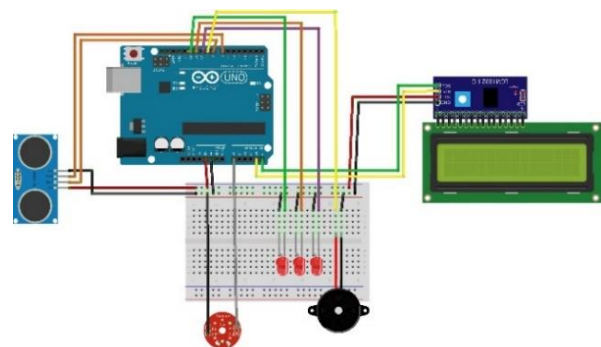


Figure 4. Circuit Design

3) Development

The development stage is an advanced stage to realize the product design that has been made in the design stage to become a product. The final result of this stage is a product that will be tested. The following are the stages in the manufacture of the product:

- a) Prepare tools and materials needed in the manufacture of products.
- b) Assembling the components based on the designs that have been made.
- c) Installing components that have been assembled on the panel box.
- d) Program the automatic system of the tool according to the function so that it can be tested.
- e) Carry out functional testing of all components.

4) Implementation

The implementation stage is to implement and realize the product in real terms. During the trial, the researcher made notes about the shortcomings and constraints that occurred when the product was implemented.

5) Evaluation

The evaluation stage is carried out to analyze the product there are still obstacles or not, if there are no more obstacles, then the product is feasible to use.

b. Research subject

The subject of this research is an electronic device capable of monitoring and warning the presence of carbon gas (smoke) resulting from combustion and the volume of waste.

c. Data collection technique

The data collected in this study is data reading of the variables that support the growth of corn plants. The input data is a reading from the MQ-2 gas sensor, ultrasonic sensor HC-SR04.

d. Data Analysis Plan

The data analysis technique used descriptive analysis. The data analyzed in the form of readings of carbon gas levels from the MQ-2 gas sensor, distance readings to determine the volume of waste using an ultrasonic sensor HC-SR04. In descriptive research, data analysis activities include steps to process data, analyze data and find results. Quantitative data in the form of numbers is processed using descriptive statistics. Based on the analysis of the data then displayed in the form of a table as the findings of the research.

3. Results and Discussion

The ARFIE is a trash can equipped with combustion smoke detection and waste volume

warning. The data that is read includes data on the capacity of Carbon or Butane gas in the trash and data on the volume of waste. If excessive carbon or butane gas is detected by the MQ 2 gas sensor, the system will give a warning in the form of an LED light and a buzzer. The greater the capacity of carbon and butane gas, the more the led will glow and the buzzer will sound. Ultrasonic Sensor HC-SR04 reads the distance of the trash from the top side. If it is detected that there is garbage up to the top, the system will give a warning on the 16x2 LCD and buzzer.

Each sensor is tested and calibrated to ensure the function of each component can work optimally. The test results of each component are as follows:

a. MQ-2 . Gas sensor testing

The MQ-2 sensor is one of the sensors that is sensitive to cigarette smoke. The main material of this sensor is SnO_2 with low conductivity in clean air.

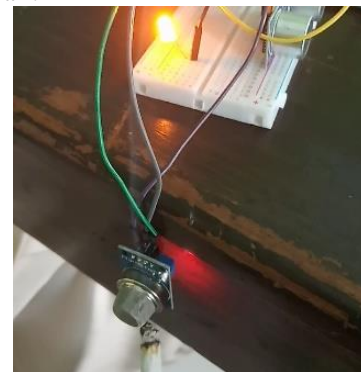


Figure 5. Gas sensor testing used The MQ-2

If there is a gas leak, the sensor's conductivity becomes higher, every increase in gas concentration, the sensor's conductivity also increases. The following is a measurement table for the MQ-2 . gas sensor

No	Treatment	Rated gas
1	No smoke	598
2	With smoke	697
3	With Butane gas	789

Based on the measured data, the MQ-2 gas sensor functions well to detect the presence of gas levels, especially combustion smoke.

b. Ultrasonic Sensor HC- SR04

Ultrasonic sensor HC-SR04 is a sensor that can measure distance or height from 2 cm to 400 cm. This sensor accepts input voltages ranging from 1 V to 5 V. The output of this ultrasonic sensor is as input for the microcontroller in the form of analog data which will be processed into actual distance or height values by the microcontroller. When measuring, comparisons were made in measuring distances using an ultrasonic sensor and a 30 cm ruler.

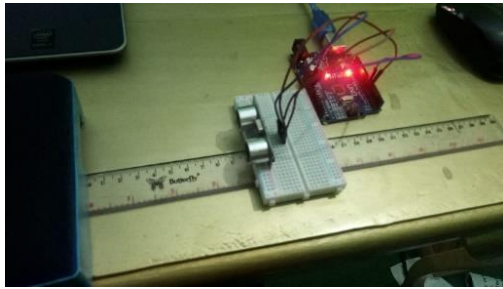


Figure 6. Sensor Testing HC-SR04

The following table shows the measurement results of the HC-SR04 ultrasonic sensor and the ruler

No	Mistar rated (cm)	HC- SR04 rated (cm)	Error (%)
1	2	2	0
2	5	5	0
3	10	9	0,1
4	20	21	0,05
5	30	31	0,03
average			0,036

Based on the distance measurement trial using the ultrasonic sensor HC-SR04, the measurement error was 0.036%. Based on these data, the HC-SR04 sensor can be used to read the distance.

c. LCD Test

LCD testing is done by displaying the data read by the ultrasonic sensor HC-SR04. This test is carried out to check whether the LCD can function properly or not.



Figure 7. LCD Test 16x2

From the results obtained in the test, the LCD can function properly and can display data according to a predetermined program.

d. Buzzer Test

Buzzer testing is done by giving current to the buzzer so that the buzzer sounds and is not flowing or the buzzer does not sound. Measurements were made using a Digital Multimeter.



Figure 8. Voltage measurement on buzzer

The following table measures the voltage on the buzzer when it sounds and when the buzzer does not sound.

Table 3. Buzzer Test

Input (volt)	Output (volt)	Note
0	0	Passive
5	4,88	Active
5	4,88	Active
5	4,88	Active

Based on these data, the buzzer is not active when the input voltage is 0 volts. When given a high input (5 volts), the buzzer can be turned on with a voltage of 4.88 volts.

e. Indicator LED test

Led testing is done by connecting the anode to the Arduino output pin which passes through the resistor first and the cathode is connected to ground on the Arduino. Then give the program logic, namely the On-Off control program (Logic High or Logic Low). Led will be on if given a logic High and Off if given a logic low (Mulyati et al, 2019)

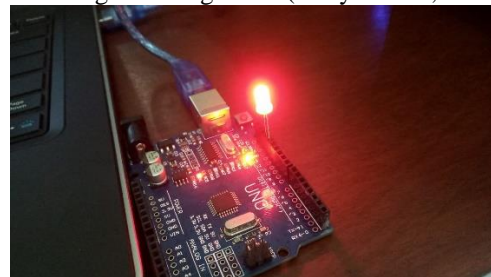


Figure 9. LED lamp Test

Based on the sensor tests that have been carried out, the "The ARFIE" Arduino-Based Fire and Waste Volume Warning System is able to provide a warning if there is smoke from burning in the trash. The test results of the MQ-2 gas sensor are sensitive to Carbon gas produced by smoke. The MQ-2 gas sensor is placed in the litter box as shown below.



Figure 9. The ARFIE' active

There are 4 (four) categories in the readings by the MQ-2 gas sensor depending on the measured gas value. The higher the measured gas level, the different warnings given. The following is a table

of warnings displayed via LED lights, Buzzer and 16x2 LCD.

No	Smoke level	L1	L2	L3	Buzzer
1	No!	On	off	off	off
2	Low	On	on	off	off
3	Middle	On	on	on	off
4	High	On	on	on	on

A comprehensive fire warning trial was carried out by putting paper waste into the trash box and cigarette butts that were still lit in the trash box. The smoke that collects inside is read by the MQ-2 gas sensor and provides a warning LED light and a description on the LCD. The denser smoke activates the buzzer to fire and warns of a fire in the trash can.



Figure 10. Warning via LCD, LED light and buzzer

Ultrasonic Sensor HC-SR04 is able to read the distance of objects. Garbage that is put in the trash can over time will fill the space. The fuller the litter box space, the shorter the readable distance. This principle is used to determine the position of the waste. The fuller the trash, the shorter the distance read by the HC-SR04 ultrasonic sensor. The sensor is set if the distance is less than or equal to 3 cm then the buzzer and the LED will be active flashing. Layar LCD akan gives a warning "THE WASTE IS FULL".



Figure 10. Position of ultrasonic and gas sensors

The trial of reading the volume of waste is carried out by adding paper waste in stages. If the position of the trash has not reached the surface, the warning has not been lit. Alerts via LED, Buzzer

and LCD light up when trash reaches the surface of the box.

Based on the trials that have been carried out, "The ARFIE" Arduino-Based Fire Warning System and Garbage Volume is effective in preventing fires and providing full waste warnings so that it is hoped that the safety and cleanliness of the residence will always be maintained.

4. Conclusion

"The ARFIE" Arduino-Based Fire and Garbage Warning System is a trash can that is able to provide warnings through the flash of a light, writing on the LCD and sound by a buzzer. The components used are the MQ-2 gas sensor to read the presence of smoke, the HC-SR04 Ultrasonic sensor to read the distance, Arduino Uno R3 as a microcontroller, 16x2 LCD, LED lights and buzzer. Power supply using a 9 volt DC adapter or 9V battery. The system is set up in a programming language using the Arduino IDE application and uploaded to the Arduino Uno R3.

The ARFIE is able to detect the presence of smoke from combustion that occurs in the garbage box. Warnings are displayed through the LED lights, buzzers and warnings that appear on the 1602 LCD. The full volume of garbage is read and gives a warning for the garbage to be disposed of immediately. The ARFIE is effective in fire prevention efforts and efforts to maintain cleanliness so that waste does not accumulate in the trash so that it is feasible to be implemented in various places, especially offices and residences.

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