

Making an Arduino-Based Trash Disposal Game

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Abstract— The problem that will be solved is the activity of throwing away rubbish, which will use Arduino as the basis for making a game of throwing rubbish with the aim of making the activity of throwing rubbish more fun. In this research, the waterfall method will be used because the scope of the research to be carried out is not large and a lot of testing is required in the part of the game being created. Overall, in writing this thesis, it is hoped that the Arduino-based waste disposal game will make the activity of throwing waste more fun.

Keywords: Arduino, Game, Sensor, Servo , Trash

I. INTRODUCTION

1.1. Background

The problem that often occurs according to the words of Zickermann and Cunningham is the lack of interest and motivation of the community to learn. If given a choice, many people will choose to play games compared to reading literature or observing the environment. Based on Presky's statement "Good education is an education that has the right mix of values as we talk about good books, good movies, and good games, these things can last for a long time." Apart from that Zickerman also said that there is no specific recipe for perfect education, it all depends on how one can mix education and entertainment according to what is needed.

Based on what was revealed by Prensky, in the education system, games can be used as an additional medium of entertainment to attract people's desire to learn where when there are games in an education system, people will have more enthusiasm to learn because the education provided is interesting and quite fun to learn.[1].

One of the functions of games that can be done is to use a game to attract people to throw the trash in its place.

Trash is solid trash material from human activities both at home, schools, offices, restaurants, shops, public places, markets and so on. The amount of trash generated from an area is influenced by the socio-economic level of the community, the higher the economy owned by the community, the higher the level of community consumption which will have an impact on the amount of landfill trash produced [2].

Trash is generated from various human activities, but trash problems always occur where the amount and variety of trash in the environment is increasing in the near future. [3].

Based on the World Bank report entitled "What a Waste: A Global Review of Solid Trash Management", the increase in the amount of solid trash by 70% by 2025 from 1.3 billion tonnes per year to 2.2 tonnes per year. With a population of 237 million people, this makes Indonesia the fourth largest country in the world. The amount of trash produced reaches 130,000 tons per day, this is because the population is always increasing. Indonesia's population with poor sanitation is 72,500,000 people, with 240 cities having problems with trash management. [2]

In Indonesia, trash management is considered less than optimal. Trash management is not optimal due to lack of public awareness or knowledge in managing trash. An increase in the amount of trash consumption that is not matched by good trash management will lead to accumulation of trash. Trash accumulation can cause environmental pollution which will have an

impact on a wider aspect. Most people still don't have the awareness to dispose of trash in its place or minimize the amount of trash produced [8].

Making games with the theme of throwing trash is one of the forms of educational games. The game itself has the meaning of activities to solve problems, with a pleasant attitude, the game can also be interpreted as something that can make players find pleasure in playing it [4]. According to Hoe, games enable students to gain knowledge, hone skills and cultivate positive traits through games that are built specifically for learning purposes. In other words, gamification in learning activities is a student-centered process [5].

As for educational games themselves, they have the following meanings:

Educational games according to Novaliendry are games that have been prepared with the aim of directing students (players) to the material that has been selected.

According to Reigeluth and Merrill, the reasons for using games for learning were put forward, such as that games connect actions and thoughts. A well-designed game can provide authentic practice in thinking and working in specific roles and contexts [6]

Educational games can also be used as appropriate learning media to stimulate student activity. This is in accordance with Miarso in Kariman & Mulia that using appropriate and varied learning media can overcome the passive attitude of students [7] From the data and problems above, games can be integrated with the problem of littering through various media, one of which is Arduino.

Arduino is an opensource tool that is easy to use both hardware and software. With a price that is not expensive and can be used easily by beginners, Arduino is one of the right media in the development of a technology [9].

Arduino can also be interpreted as an electronic development board consisting of open source. Electronic circuits with a microcontroller on a single board

programmed by a computer and designed to make the process of using interactive electronics in multidisciplinary projects easier. Arduino is usually used in designing interactive electronics projects or projects targeting building environmental sensors. [10]

Arduino is not only useful as a teaching tool but also a useful skill. Anyone who learns Arduino will have the ability to design and/or prototype what they want and can eliminate the need to rely too heavily on tools that are usually expensive. [9]

With Arduino, a technology can be made by using a sensor in a trash can where the trash will open when the trash approaches the sensor and the person throwing it will get points if the trash gets in. With this point system, it is hoped that people will be more interested in disposing of trash in its place.

1.2. Problem

- How to formulate Arduino-based game scenarios to attract people to dispose of trash properly?
- How can the sensors in the Arduino be utilized in making trash disposal games?
- How does Arduino work and can be used as a basis for making trash disposal games?

II. METHODS

In developing Arduino-based trash disposal games, the SDLC (System Development Life Cycle) system will be used with a waterfall model.

This study uses the waterfall model SDLC system due to several factors, namely:

- The system to be developed for the trash disposal game is not big
- The development of this game will be suitable if it is developed in a structured and sequential process
- This method is carried out sequentially where when each stage is finished to be

carried out a review will be carried out so that errors do not occur and according to what the author wants. When during the review there are some that do not meet or there are errors, then these errors will be resolved first before proceeding to the next stage

In general, the SDLC system is divided into several sections, namely Requirement Gathering and Analysis, Design, Code Generation, Testing and Support

III. RESULT

3.1 Requirement Gathering and Analysis

3.1.1 Problem Identification

The activity of disposing of trash indoors is actually a simple activity, namely opening the lid of the trash can and putting the trash in it. However, we often delay taking out the trash and just putting it around us. So that trash is often everywhere outside the trash bins provided. A strategy formulation is needed so that disposing of trash can be interesting and enjoyable. For that, it is necessary to have a game that is integrated with the trash. Every time we take out the trash, there is a value given when it manages to get into the trash.

3.1.2 Problem Solving

To solve the problem, there is a suggestion to make a trash disposal game where in the future trash cans don't need to be manually stepped on or opened by hand and every time there is trash that is entered the points will increase.

3.1.3 Software Requirement

To realize the problem solving that the author has thought of, some software is needed to support the idea. One of the software that is estimated to be appropriate in meeting the expectations of the proposed non-manual trash can is Arduino. Arduino is a device that consists of various features

that can be used to support the completion of the game Baung Trash where Arduino has servos, sensors, LCD, and various other features.

3.2. Design

3.2.1 Flowchart

For the design, first a flowchart is made regarding the research flow so that when the research is carried out there are no elements that are lacking or left behind.

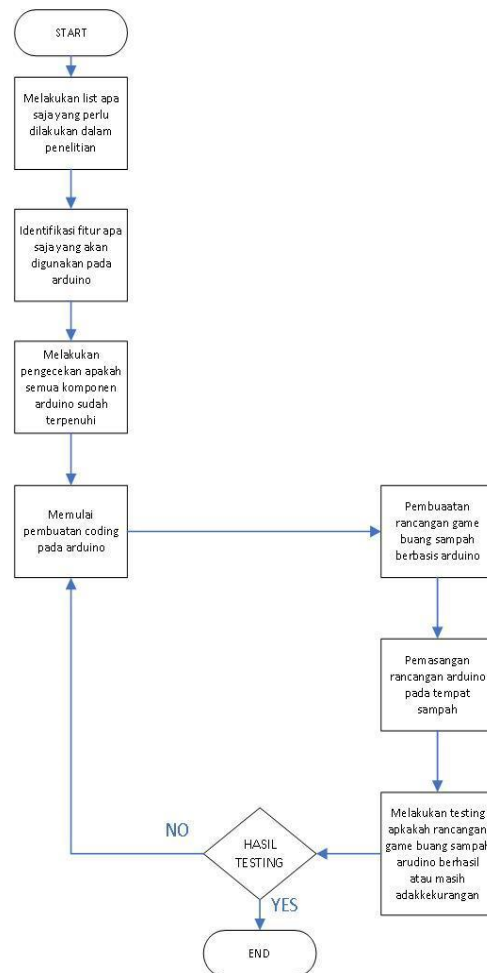


Figure 3.1 Research Flow in Making a Trash Disposal Game

Overall, various stages will be carried out, starting from making a list of what is needed in making the Arduino trash disposal game, then coding in Arduino, followed by making a design that is adjusted to the coding made before, and finally, installing the design in the trash and testing whether the game has been running smoothly or there are still problems.

3.2.2 Game Logic

The workings of the prototype will begin with the preparation of the Arduino starting from the LCD, servo and ultrasonic sensor.

After Arduino is on, the sensor will scan whether there is an object in front of the sensor or not, if there is an object when the sensor scans, the servo will rotate, if there are no objects when the sensor scans, the trash can will not open. The score will increase when trash gets inside.

When the trash can is open, within a few seconds the trash can will be closed again and will open again when there is an object in front of the sensor.

3.2.3 Rules of The Game

In Arduino Based Trash Disposal Game, the rules that exist when playing are:

- Players first scan objects in front of the Arduino sensor.
- The trash can lid will open and the player will put the trash in
- Points will be added when trash has been put in the trash.
- When the points reach a multiple of 50 then the level will increase where the distance from the trash can to the object will be increased.
- After a while, the lid of the trash can will be closed again and the player will repeat the process from the beginning

```
#include <Servo.h>
Servo servo;
int angle = 10;
int level = 1;
// defines pins numbers
const int trigPin = 12;
const int echoPin = 11;
const int trigPin2 = 10;
const int echoPin2 = 9;
// defines variables
long duration;
long duration2;
int distance;
int distance2;
int skorakhir = 0;
int skor = 0;
int sensor = 0;
#include <LiquidCrystal_I2C.h> //Library LCD
i2c
//inisialisasi nomor pin LCD
LiquidCrystal_I2C lcd(0x27, 16, 4);

void setup() {

  servo.attach(8);
  servo.write(angle);
  pinMode(trigPin, OUTPUT); // Sets the
  trigPin as an Output
  pinMode(echoPin, INPUT); // Sets the
  echoPin as an Input
  pinMode(trigPin2, OUTPUT); // Sets the
  trigPin as an Output
  pinMode(echoPin2, INPUT); // Sets the
  echoPin as an Input
  Serial.begin(9600); // Starts the serial
  communication
  servo.write(90);
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0); //set kolom dan baris
  lcd.print("SMART TRASH BIN"); //
  tampilkan kata
  lcd.setCursor(0, 1); //set kolom dan baris
  lcd.print("18.N2.0012 IVAN"); // tampilkan
  kata
  /*lcd.setCursor(-4, 3); //set kolom dan baris
  lcd.print("TERIMA KASIH"); // tampilkan
  kata*/
}
```

```

void loop() {
  //sensor1
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  // Sets the trigPin on HIGH state for 10
  micro seconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  // Reads the echoPin, returns the sound
  wave travel time in microseconds
  duration = pulseIn(echoPin, HIGH);
  // Calculating the distance
  distance = duration * 0.034 / 2;
  Serial.print("Distance: ");
  Serial.println(distance);
  // Prints the distance on the Serial Monitor

  //sensor2
  digitalWrite(trigPin2, LOW);
  delayMicroseconds(2);
  // Sets the trigPin on HIGH state for 10
  micro seconds
  digitalWrite(trigPin2, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin2, LOW);
  // Reads the echoPin, returns the sound
  wave travel time in microseconds
  duration2 = pulseIn(echoPin2, HIGH);
  // Calculating the distance
  distance2 = duration2 * 0.034 / 2;
  Serial.print("Distance2: ");
  Serial.println(distance2);
  if (level == 1) {
    if ((distance < 20 && distance > 10 ||
    distance2 < 20 && distance2 > 10) &&
    sensor == 0)
    {
      Serial.println("Pntu Sampah Terbuka");
      sensor = 1;
      servo.write(10);

      skor++;

      skorakhir = skor * 10;

      String txtlevel = String(level);

      lcd.setCursor(-4, 2); //set kolom dan
      baris

```

```

      lcd.setCursor(-4, 3); //set kolom dan
      baris
      lcd.print("SKOR : " + txtskor); //tampilkan
      kata
      if (skorakhir % 50 == 0) {
        level=2;
        lcd.setCursor(-4, 2); //set kolom dan
        baris
        lcd.print("LEVEL : " + txtlevel); // tampilkan
        a
      }
      delay(4000);
      Serial.println("Pntu Sampah Tertutup");
    }
    else
    {
      sensor = 0;
      servo.write(90);
    }
  }
}
}

```

In Arduino coding, in the early stages several variables will be used such as declarations from the Arduino sensor, servo, LCD, and other variables that will be used in the Arduino-based waste disposal game. The variables that have been declared previously will be used in the process when the Arduino-Based garbage disposal game starts where there is a distance variable that is used as an indicator from the sensor. When the sensor has caught the appropriate distance from the object, the servo will be moved and the trash can will open, when the trash can is opened, the score on the LCD will increase and every multiple of 50 levels will increase where the minimum distance from the object to the sensor will increase. After a few moments the trash can lid opens, the servo will move again and close the trash can lid again followed by

the process being repeated from the beginning.

3.3.2 Arduino Circuit

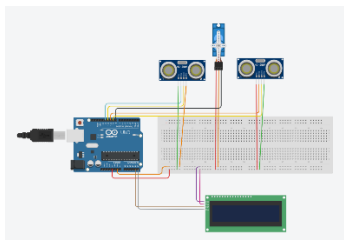


Figure 3.2 Arduino Game Disposal Trash Circuit

Component :

- Arduino Uno
- Breadboard

A board that has the function of conducting trials without soldering the circuit. Utilization of a breadboard avoids damage to the electrical components used so that they can be reused in other circuits. Breadboard is usually made of plastic with holes on it where the pattern on the holes has been adjusted to the pattern of the network connections in it. Breadboard is divided into 3 sizes, namely mini, medium and large. In this study, a large breadboard was used with 830 connection points where the connection points contained the letters A, B, C, D, E, F, G, H, I, J and the numbers 1, 5, 10, 15, 20. Letters and numbers are used as the coordinates of the electronic components.

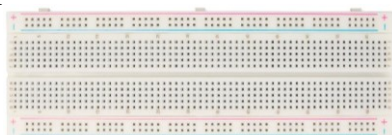


Figure 3.3 Large Breadboard

- LCD 16X4

LCD is used in Arduino applications that require monitoring output or processes that occur in the system. And also as a substitute for a serial monitor, because a serial monitor can display data when Arduino is connected to a computer.

The LCD is equipped with 16 pins that can be connected to Arduino, with their respective descriptions.

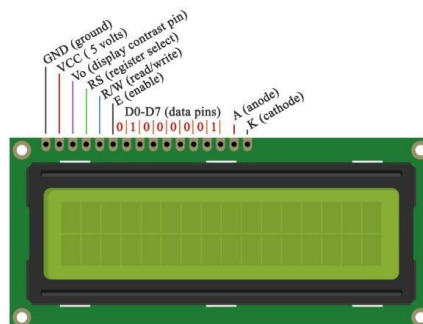


Figure 3.4 LCD 16X4

The leftmost pin labeled VSS functions as ground, it can be connected to GND on the arduino pin. Next VDD or VCC is connected to a 5-volt voltage source, it can also be connected to the 5v pin on Arduino. V0 is used to adjust the brightness or contrast of the LCD, connected to a potentiometer, you can use a value of 10K ohms. Experiments without using a potentiometer failed because the LCD was so bright that the characters could not be seen.

RS functions to send commands or data to the LCD. When RS is set to LOW, it will send commands, for example, delete the screen, turn off the screen, determine the cursor position and so on. When RS is set to HIGH it means sending data, for example sending characters to be displayed and so on. Then RW functions to read or write to the LCD, we don't really need this pin function, it is connected to ground. Next E = enable functions to write to the register.

Pins D0, D1, D2, D3, D4, D5, D6, D7 are used to send data to the LCD, there are 8 bits. In practice this time we only use 4-bit mode, so only pins D4, D5, D6 and D7 are used. The last pin is the anode (A) and cathode (K) of the LCD. The anode is connected to 5 volts, the cathode to ground.

- Servo

A servo motor is a rotary device or actuator (motor) designed with a closed loop feedback control system, so that it can ascertain and determine the angular

position of the motor output shaft. The power possessed by servo motors varies, from a few watts to hundreds of watts. Servo motors are used for various purposes such as tracking systems, machine tools and so on. Servo motors are divided into two, namely AC and DC serco motors.

Servo motors are controlled by providing Pulse Wide Modulation / PWM via control cables. The duration of the "pulse" given will determine the angular position of rotation of the servo motor shaft. The servo motor shaft will move and stay in the commanded position when the "pulse" duration has been given. The servo motor will try to withstand or fight with the amount of torsional strength it has if someone tries to rotate or change that position. The position of the servo motor will not stay still forever because the "pulse" signal must be repeated every 20 ms (milliseconds) to instruct it to stay in position.



Figure 3.5 Servo

- I2C
The need for 8 bits of data sent to the LCD is to use a 16 x 4 LCD which means it requires 8 pins to turn on the LCD on Arduino, if Arduino uses this protocol then few pins are left. The solution is to use the I2C (inter integrated circuit) interface. With the I2C interface, serial data from Arduino is converted to parallel form so that it can turn on the LCD. There are 4 pins on the I2C interface, GND, VCC, SDA, SCL. Two pins are used for communication with Arduino, the SDA pin (serial data pin) and the SCL pin (serial clock pin).

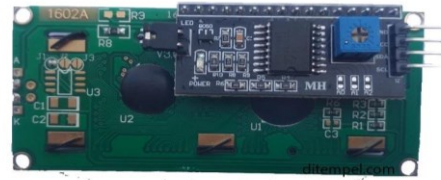


Figure 3.6 I2C

- Male Female Jumper Cable
Used as a connecting cable between features on Arduino, namely LCD, servo, and sensor
- Ultrasonic Sensor
Ultrasonic sensor is a sensor that functions to convert physical quantities (sound) into electrical quantities and vice versa. The way this sensor works is based on the principle of the reflection of a sound wave so that it can be used to interpret the existence (distance) of an object with a certain frequency. Called an ultrasonic sensor because this sensor uses ultrasonic waves (ultrasound sound). This sensor is a ready-to-use ultrasonic sensor, a device that functions as a sender, receiver and controller of ultrasonic waves. This tool can be used to measure the distance of objects from 2 cm – 4 m with an accuracy of 3 mm. This tool has 4 pins, pin Vcc, Gnd, Trigger, and Echo. Vcc pin for positive electricity and Gnd for ground. The Trigger pin is used to trigger a signal from the sensor and the Echo pin is used to capture reflected signals from objects. This sensor consists of a series of ultrasonic transmitters called transmitters and ultrasonic receivers called receivers. The distances that can be handled range from 2 cm to 400 cm, with a precision level of 0.3 cm. handleable detection angle is no more than 15°. The required current is not more than 2mA and the required voltage is +5V
 - o The concept of the HC-SR04 sensor
 - The signal is emitted by an ultrasonic transmitter with a certain frequency and for a certain duration. The signal has a frequency above 20 kHz. To measure the distance of objects (proximity sensor), the commonly used frequency is 40 kHz.

- The transmitted signal will propagate as a sound wave with a speed of about 340 m/s. When it hits an object, the signal will be reflected by the object.
- After the reflected wave arrives at the receiving device, the signal will be processed to calculate the object's distance. The object distance is calculated based on the formula: $S = 340.t/2$ Where S is the distance between the ultrasonic sensor and the object (reflective plane), and in this case, t is the travel time from when the ultrasonic signal is emitted until it returns. Please note the speed of sound is 343m/s. The principle of signal sending by trig and reception by Echo is as follows: a. Trig must be HIGH for at least 10 microseconds b. The ultrasonic module will also send square waves with a frequency of 40 KHz c. The sent waves will be monitored automatically by the ultrasonic module. In this case, the time taken from sending the signal to receiving it back is T. at that time the Echo pin will be HIGH. This T time can be obtained by giving commands on the Arduino. $T = \text{pulseIn}(\text{PIN_ECHO}, \text{HIGH})$; d. Since T has been obtained, the distance is calculated using the formula: Distance = speed of sound * T/2 (2) The divisor of 2 is necessary because T is the time it takes to travel from the sensor to the object and from the object to the sensor. With a value of the speed of sound of 343 m/s or 343000 cm/s, the distance can be obtained by the equation: Distance = $343000 * (T/10^{-6}) / 2 \text{ cm} = 0.0343 * T/2 \text{ cm}$ Figure 2 shows how the sensor illustration ultrasonic works, start the signal sent by the Trig pin until it is received again by the Echo pin

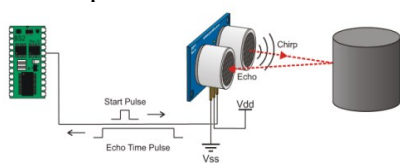


Figure 3.7 Ultrasonic Sensor

3.4 Testing

3.4.1 Prototype Appearance

The Arduino-based trash disposal game has a prototype display as follows:



Figure 3.8 Prototype appearance when it got turned on

In the initial process of the game, Arduino will display the name and “NIM” as well as the smart trash bin. In this initial process the servo, lcd and sensor will be prepared to start the game.



Figure 3.9 Prototype appearance when it scanned the object in front of the sensor

When starting the game, the player will place the object in the example of using the hand as an object, when the sensor detects an object, the trash can lid will open and the score on the LCD will increase



Figure 3.10 Prototype appearance when it closed after predetermined time

After the object is detected by the sensor, after a while the trash can lid will close again and the process returns to the initial process. When making the prototype, several stages were passed, starting from making the design of the prototype, making the design of the prototype, implementing the design and design of the prototype and testing the prototype. In the testing phase, the prototype will be tested with various factors described in the following table:

3.4.2 Prototype Concept

The Arduino-Based Trash Disposal Game Prototype begins with the reflection of ultrasonic waves from the sensor so that the sensor catches a signal which is then connected to the servo. Servo after receiving a signal from the sensor will move the degree of the servo so that the trash can lid can be opened and the display on the LCD will change to level and point where the level is determined when the point reaches above 50 where the level determines the distance from the sensor to the object. and points will increase when the trash can lid opens, After a while, the trash can lid will close again and the process repeats again from the beginning of the game.

3.4.3 Prototype Rules of The Game

Within the game rules of the prototype, there was a change to the game rules in the design. This can change because the Arduino results show that the trash can cannot scan fast moving objects. This changes the rules of the game as follows:

- The player places an object in front of the Arduino sensor
- The trash can lid will open
- Points will increase when the trash can lid is opened and the level will increase in multiples of 50 points
- After a while, the trash can lid will be closed again and the process will be repeated.

Changes to the rules of the game lie in the initial design section where points increase

when the trash can enters where in the prototype the points will increase when the trash can lid opens

3.4.4 Prototype Testing

A. Testing the Workings of the Prototype

- Servo

Table 4.1 Servo Function

	90 degrees before the bin lid opens	10 degrees when opening the bin	90 degrees when the bin lid is closed
Servo Degree	Servo work correctly	Servo work correctly	Servo work correctly

- LCD

Table 4.2 LCD Function

	LCD First Display	Change Score and Level
LCD 16X4 I2C	Servo doing well	Servo doing well

- Sensor

Table 4.3 Sensor Function

	Left Sensor	Middle Sensor	Right Sensor
Sensor 1	*	*	*
Sensor 2	*	*	*

B. Testing the Game Level of the Prototype

Table 4.4 Game Level Testing

	0	10	20	30	>30					
Sensor	1	2	1	2	1	2	1	2	1	2
Level 1	X	X	*	*	*	*	X	X	X	X
Level 2	X	X	X	X	X	X	*	*	*	*

Information :

* = sensor detects object

X = sensor does not detect objects

The sensor at a distance of 0 cm will not detect objects because level 1 in the Arduino-Based Garbage Disposal Game starts with a distance of 10-20 cm so that at level 1 the sensor can detect objects and is somewhat different from level 2 where the minimum distance from the sensor to the object has been increased to more from 20cm- 30cm. The sensor also

will not detect objects that are at a distance of more than 30cm.

C. Endurance

For the Arduino-Based Trash Disposal Game prototype, in the endurance test a 10000 mah power bank was used to test the prototype can survive a certain period of time. The result obtained is that the Arduino can last more than 12 hours where in the endurance test the Arduino remains on without turning it off unless an error occurs such as a power bank that suddenly disconnects the power and releases the connecting cable.

3.4.5 Final Result

In the Arduino-Based Trash Disposal Game, several changes were made to the game rules, this has a reason because the ultrasonic sensor on the Arduino cannot catch fast moving objects. In the manufacture of the device, there were several model changes which caused the servo used in the study to lack the strength to open the lid of the trash can and the circular shape made installing the tool in the trash can quite problematic

IV. CONCLUSION

After carrying out various tests and changes to the Arduino-Based trash can, conclusions are drawn which are divided into several points as follows:

In designing a series of Arduino-Based trash cans, the user will get a score if the trash goes into the trash can and when the value reaches 60 levels it will increase so that the minimum distance of the object from the string will increase. Values will be totaled until the power is removed.

Arduino uno is needed as the brain of the circuit to run the input and output of the trash from the servo, LCD, and ultrasonic sensor. The ports used on Arduino are port 8 which is used to adjust the position of the servo so that it can open the trash can

The sensor used is an ultrasonic sensor used as an indicator for changes to the servo and LCD. This sensor is attached to ports 11 and

12 on Arduino where port 11 is the echopin and port 12 is the trigger pin. This ultrasonic sensor will capture objects that are in front of it at a certain distance.

As a whole, this Arduino-Based Trash Disposal Game starts with an object that will be captured by the ultrasonic sensor where when there is an object, the servo will rotate and the points on the LCD will increase. Within a predetermined time, the trash can will be closed again and the process will return to the beginning where the sensor needs to capture an object.

The game element offered in this series is where players earn points when the trash can lid opens.

V. SUGGESTION

The following are suggestions for further research based on the research that has been done:

Added a sound effect when trash goes into the bin and gauges user interest.

Adding sensors to select types of trash, for example plastic trash and iron trash.

Use of a larger trash can so it can contain more trash on the inside

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