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DESIGN AND CONSTRUCTION OF METAL AND NON-METAL WASTE SELECTING TOOLS BASED ON ARDUINO UNO

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Abstract- This Arduino-based automatic metal and non-metal waste sorting tool is designed to sort waste, making it easier to recycle waste. The main components of this tool include Arduino (as a tool control system), proximity sensor (as a metal scrap detector), servo motor (as a driver to isolate metal scrap) and LCD to display the type of metal scrap. In terms of waste sorting, the Proximity sensor will detect waste. If the waste is detected as metal waste, the servo motor will rotate to the right and direct the waste to a special metal waste bin. The LCD screen will display the type of metal waste. If the proximity sensor does not detect non-metal waste, the servo motor will rotate to the left and direct the non-metal waste to a special non-metal waste bin. This type of waste sorter is very helpful in reducing waste because it can be processed according to the type of waste.

Keywords: Arduino, Proximity Sensor, Servo Motor.

I. INTRODUCTION (*HEADING 1*)

Waste management is increasingly vital in urban environments, where improper disposal poses significant environmental and health risks. Waste, defined as material discarded by its owner, can still hold value if recycled into new products. It is classified into two main categories: organic waste, which decomposes naturally with the help of microorganisms, and inorganic waste, which includes metals (such as cans and batteries) and non-metals (like plastic and paper) that are challenging to break down.

Mini markets, popular for their seating areas and WiFi amenities, attract customers who often relax, eat, and socialize while shopping. However, these establishments face challenges in waste management. Despite the convenience of seating and socializing areas, the disposal of waste, including cans, bottles, and plastic, often ends up mixed in a single trash bin. This lack of proper waste segregation stems from low customer awareness and public ignorance about waste types, contributing to environmental degradation and health hazards.

Careless waste disposal in mini markets can lead to severe consequences such as flooding from clogged drainage systems, environmental pollution, unsightly surroundings, and air pollution. To address these issues, the author has developed an innovative solution: an Arduino-based automatic waste sorting tool. This tool aims to streamline waste management by automatically sorting metal and non-metal waste. By utilizing sensors and actuators controlled by Arduino technology, the system identifies and segregates materials based on their physical properties, promoting efficient recycling and reducing environmental impact.

In conclusion, effective waste management practices are essential for maintaining clean and sustainable urban environments. The proposed Arduino-based sorting tool represents a step forward in enhancing waste segregation at source, thereby minimizing the adverse effects of improper waste disposal in mini markets and fostering a more environmentally conscious community.

II. METHODS

2.1 Product Design

In this research, researchers will design a prototype of an Arduino Uno-based metal and non-metal waste sorting tool and use several processes to get the desired results. Apart from that, this research seeks to create a tool that makes it easier for users to detect metal and non-metal waste.

2.1.1 Block Diagrams

To make it easier to study and understand how this tool works, the design system for this tool was created based on a block diagram where each block has a specific function and way of working.

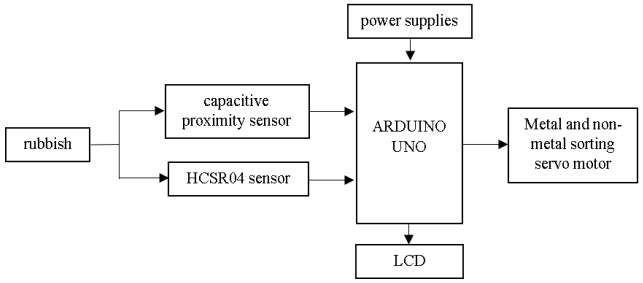

Figure 2.1.1 Block Diagrams

From the block diagram above, you can find out a little about the description of the object of this research and the following is an explanation of the function of each block:

1. Proximity Sensors

   Proximity Sensor is a sensor that functions to detect metal and non-metal waste. If there is waste in the form of metal and non-metal, the proximity sensor will detect it and then send data to the Arduino Uno.

2. HCSR04 Sensor

   The HCSR04 sensor functions to detect the distance of objects.

3. Arduino Uno

   The microcontroller used is an Arduino Uno which functions as a data processor where the data will be sent by sensors to be able to control the entire system.

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4. Servo Motor.

   The Servo Motor functions to direct objects to a storage area according to the type of waste that will be detected. Then the data that has been processed on the Arduino will be displayed on the LCD.

2.1.2 Product Design

In the design of this waste sorting tool, the dimensions are 30 cm long, 40 cm wide and 75 cm high. And under this waste sorting tool, there are two small pieces of waste as a place for the results of the waste sorting tool, each measuring 30 cm long, 30 cm wide and 30 cm high.

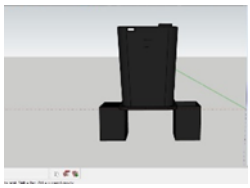

Figure 2.1.2 Design of side waste sorting tool

2.1.3 Wiring Diagrams

The installation section consists of several processes, namely input, data processing and output. In the data input section, several components are used, namely the capacitive proximity sensor, HCSR04 sensor, and the Blynk application. Meanwhile, data processing uses Arduino. And in the part of moving waste using a servo motor with a power supply to supply the performance process of the system.

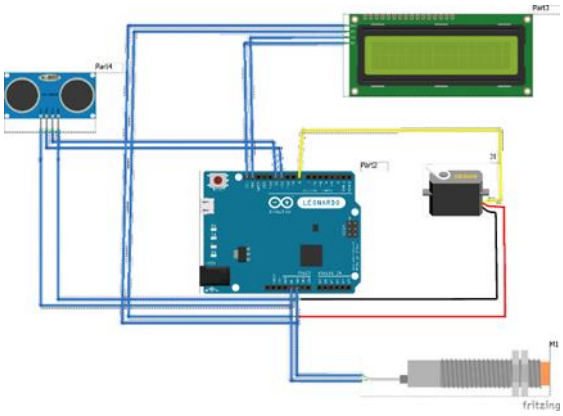

Figure 2.1.3 Wiring Diagram

2.1.4 Flowcharts

Figure 2.1.4 shows how the waste separator control system works using Arduino as a microcontroller and using 2 sensors.

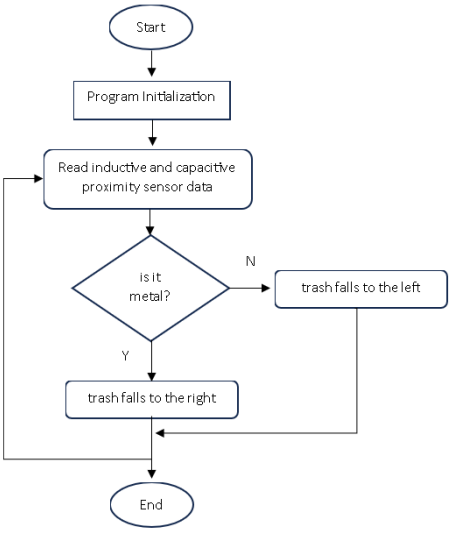

Figure 2.1.4 Flowchart

`The process begins with turning on the tool and placing the waste into the designated area, at which point the system waits for the sensor to identify the type of waste. If the waste is metal, the proximity sensor will detect this and register a value of 1, prompting the motor to rotate to the right. Conversely, if the waste is non-metal, the proximity sensor will read a value of 0, causing the motor to rotate to the left. This automated response ensures proper sorting based on the waste material detected by the sensor.

2.2 Product Test

Testing is a process so that the systems and tools created can work properly. By using several existing theories, there are several tests that will be carried out, including:

2.2.1 HCSR04 Sensor Testing

To read the distance in the trash box, in principle this tool functions in a way that when an object is put in it will read that there is trash in it.

2.2.2 Capacitive and inductive Proximity Sensors

Testing on the Proximitry sensor is carried out with the aim of detecting the waste, if the waste is detected as metal or non-metallic waste.

2.2.3 Testing servo motors

Servo motor testing is carried out by providing Pulse Wide Modulation / PWM via the control cable

2.3 Variables and Variable Operational Definitions

A variable is something that can vary or change values. Values can be different at different times for the same object or values can be different at the same time for different objects. In this research there are several variables aimed at obtaining the results achieved, including:

1. HCSR04 Sensor and Capacitive and inductive Proximity Sensors
2. Arduino Uno functions as the dependent variable in this research.

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2.4 Data Analysis Methods

In this research, the descriptive analysis method is employed to describe the data according to the test results and to analyze the level of accuracy using appropriate tools after testing. The process begins with the first stage, which involves creating a waste sensor tool. In the second stage, the HCSR04 sensor is tested to determine its capability in detecting objects or rubbish. The third stage focuses on testing the proximity sensor to evaluate its accuracy in detecting metal. In the seventh stage, all components are tested together to ensure they work harmoniously. Finally, the success of creating a metal waste detection system is concluded based on the results of these tests.

III. RESULTS AND DISCUSSION

3.1 Product Results and Evaluation

When designing systems and creating tools that can be used and applied among the community. As a waste detection tool. By using 2 sensors it can recognize the type of waste that is put in the trash box.

There are several components, namely the HCSR04 sensor, proximity sensor, servo motor and Arduino Uno as the data processor.

3.2 Data Presentation

Based on the experiments carried out, analysis of the data obtained produced the following data:

1. HCSR04 Sensor Testing

   Testing of the HCSR)$ sensor is carried out for the distance that can be reached by the sensor to the waste that is inserted.

Table 3.2.1 HCSR04 Sensor Test

No	Distance	Results
1	2 cm	Succeed
2	3 cm	Succeed
3	4 cm	Succeed
4	5 cm	Succeed
5	6 cm	Succeed
6	7 cm	Succeed
7	8 cm	Succeed
8	9 cm	Succeed
9	10 cm	It worked but it took a bit longer, namely 0.10 seconds
10	11 cm	It worked but it took a bit longer, namely 0.15 seconds
11	12 cm	It worked but it took a bit longer, namely 0.20 seconds
12	13 cm	It worked but it took a bit longer, namely 0.20 seconds
13	14 cm	It worked but it took a bit longer, namely 0.20 seconds
14	15 cm	It worked but it took a bit longer, namely 0.30 seconds
15	16 cm	It worked but it took a bit longer, namely 0.40 seconds

2. Proximity Sensor Testing

   Sensor testing is carried out to test the tool's sensing function in detecting metal. Capacitive proximity sensor testing is carried out by bringing an object close to something that will be categorized as non-metal and metal.

Table 3.2.2 Proximity Sens or Test- nonmetal

No	type of waste	sensors		results
		Inductive proximity	Capacitive proximity	
1	static plastic	-	√	Succeed
2	plastic noodles	-	√	Succeed
3	plastic gum	-	-	Not Successful
4	solation	-	√	Succeed
5	acrylic	-	√	Succeed
6	aqua glass	-	√	Succeed
7	bottle	-	√	Succeed
8	ballpoint	-	√	Succeed
9	small plastic ruler	-	√	Succeed
10	eraser	-	√	Succeed
11	paper	-	√	Succeed

Table 3.2.3 Proximity Sensor Test-metal

No	type of waste	sensors		results
		Inductive proximity	Capacitive proximity	
1	nut	√	-	Succeed
2	bolt	√	-	Succeed
3	nail	√	-	Succeed
4	tweezers	√	-	Succeed
5	bear brand milk cans	√	-	Succeed
6	close the can of syrup	√	-	Succeed
7	razor blade	√	-	Succeed
8	close the can of khong guan bread	√	-	Succeed
9	battery	√	-	Succeed
10	can of Milo milk	√	-	Succeed
11	perfume can	√	-	Succeed

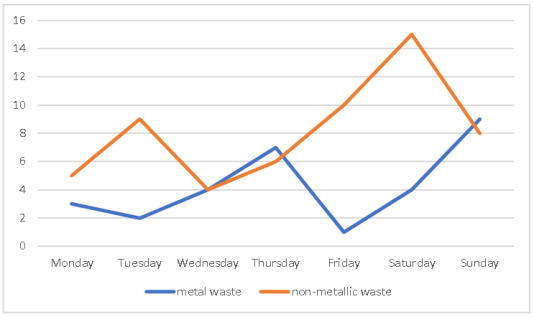
3.3 Data Analysis

From the results of trash detection carried out for one week in the environment around the house, the following detection data was obtained.

Table 3.3.1 Detection Table

Day	metal waste	non-metallic waste
Monday	3	5
Tuesday	2	9
Wednesday	4	4
Thursday	7	6
Friday	1	10
Saturday	4	15
Sunday	9	8

Figure 3.3.1 Detection graph every day



3.4. Result and discussion

In designing the metal and non-metal waste sorting system, the working system is as follows:

1. The HCSR04 Ultrasonic Sensor reads objects approaching the trash can
2. Inductive and capacitive proximity sensors to distinguish between metal and non-metal objects.

This tool uses a proximity sensor with a servo motor output via Arduino Uno which aims to move the servo motor

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to rotate to the right or left. Utilizing this tool is very useful for individuals or groups around the house, workshop and TPU (garbage dump).

The benefit is that we can use waste that has been sorted by selling it or recycling it to make a craft. This tool consists of several components, namely Arduino Uno as the driving brain, servo motor as a waste sorter, proximity sensor as a metal or non-metal waste detector, ultrasonic sensor as a sensor for people approaching the trash can and the 16 x 2 LCD functions to display the trash text that we have entered

The purpose of making this tool is so that waste made of metal can collect itself and can be collected to be sold or recycled into metal pellets again, and plastic waste can also be recycled into bottles or other objects so that they are useful and useful. does not pollute the environment that has existed until now. This technology is suitable for modern times, so TPS officers don't need to worry about voting one by one..

IV. CONCLUSION

4.1 Conclusion

From the research, testing, and analysis of the Arduino Uno-based Metal and Non-Metal Waste Sorting System, several conclusions can be drawn. This tool effectively aids in the sorting of metal and non-metal waste. The HCSR04 Ultrasonic Sensor, however, has a very low range for capturing fast movements. The inductive and capacitive proximity sensor systems are capable of reading both metal and non-metal objects, such as plastic, paper, or wood. The servo motor successfully functions as a sorter for metal and non-metal waste, and the communication between the proximity sensor, the servo motor, and the 16 x 2 LCD is efficient. The distance accuracy for reading metal waste by the proximity sensor is between 0 to 1 cm, and if the distance exceeds 1 cm, the sensor will only read the waste as non-metallic. An improvement from previous research is the faster reading time of the proximity sensor, which is 6.0 seconds. However, this waste sorter is only suitable for dry waste such as leaves, cans, and plastic.

For future research, several suggestions can be considered to enhance the system. First, the tool can be developed to allow the sorter to move faster. Additionally, a servo motor could be added to open or close the trash hole, improving operational efficiency. Incorporating an LED to indicate the type of trash being entered and adding a buzzer to the trash can would enhance user feedback and interaction. Implementing solar panels as a power source would make the system more efficient by eliminating the need for an adapter. Finally, replacing the trash can lid with one that can withstand rainwater would make the system more suitable for outdoor use.

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