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THE USE OF AUTOMATED PROXIMITY SENSOR AS HOUSEHOLD WASTE SEGREGATOR BIN

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ABSTRACT

Improper disposal of waste is a rampant problem that contributes to pollution. The objective of the study is to create an automatic waste segregator bin to be used by the households utilizing proximity sensors. Papers, plastics, and metals are the common wastes at home. Using proximity sensors such as inductive, and capacitive sensors, and with the help of motors the machine can automatically segregate the papers, plastics, and metals into their correct bins. The researchers created the whole setup of the motors and sensors using wood, pipe, screws, and nails to be able to create a functional segregator machine. Proving its effectiveness, testing procedures were conducted in detecting and segregating papers, plastics, and metals, then each was tested based on its maximum weight capacity, the detection time, and lastly, the success rate of being able to detect different types of wastes were tested. The results showed that the segregator has a success rate to detect 100% of metals accurately, 100% of papers, and 100% of plastics. The segregator bin has a maximum weight of 0.6 kg and an average detection time of 1.73 seconds. Through the different testing procedures, the researchers found that it is feasible to create an automated segregator bin using proximity sensors which is also a smart recycling bin as it was able to accurately detect papers, plastics, and metals. Although the researchers were able to attain the desired results, future researchers are still recommended to modify, innovate, and improve the automated waste segregator bin.

KEYWORDS: Waste Segregator Bin, Segregation, Proximity Sensors, Inductive Sensor, Capacitive Sensors, Waste recycling system, Smart recycling bin

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I. INTRODUCTION

Improper disposal of waste is an obvious problem that contributes to pollution. A significant quantity of untreated garbage is placed in landfills as a result of improper segregation practices. This can cause issues such as damaging the environment and people's health due to overflowing landfills and rubbish dumping on the outskirts and outside of cities. Waste segregation holds a very important role in preventing pollution. Segregating allows recycling opportunities and correct disposal of these wastes according to how they were categorized. This gives way to more opportunities to reusing and recycling of materials as it helps us identify hazardous and non-reusable materials from ones that can be reused and recycled. Waste segregation can be simple however, it is not normalized in any many countries as it should be, that is why the researchers thought of a plan to create a device, a household waste segregator that can segregate and recognize the type of waste that we dispose of by using proximity sensors for identifying the materials that it will be allowed to take and automatically place it in the appropriate container. Applying our approach at the home level will minimize trash disposal costs, human labor necessary for waste segregation, and garbage that can be readily recycled, reused, and reduced.

Proximity sensors are well known to the public for their frequent use; typically, these sensors function by detecting movements, such as the sensors used in hand dryers, sliding doors, and dispensers, which are all for the convenience of humans. Individuals in their homes prefer to have their trash cans nearby. When they're busy, they frequently put their garbage in a random pile instead of sorting it because sorting takes a lot of time, especially when they're busy or they just don't feel like it. Aside from this, Proximity sensors can also be used to identify objects according to their characteristics. For example, an Inductive proximity sensor detects metal targets using electromagnetic energy without contact. The researchers decided to use this type of sensor for waste segregation and program it through Arduino to detect the different characteristics of materials done manually by installing different bins for collecting different types of waste such as plastic, paper, and metals to segregate them. Through the use of Proximity sensors, proper segregation of materials can be done.

A bin that is able to segregate waste when it detects and puts the waste in its category. It will automatically do its job by sending signals as the bin has a sensor that allows us to know when it's full. When the waste reaches its peak, and the sensor detects it, it means that the bin is already full. The researchers will help solve the waste segregation problem and help build a greener society, with no compromise on health and hygiene for household use to help make segregation in the household an easy use for everyone.

This basic piece of technology aids in the identification of various waste products, especially for young children and adults who are unfamiliar with the waste management system, preventing wastes from ending up in landfills and making recycling less complicated. This study can serve as a basis for future researchers

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who are interested in and looking for information about Proximity sensors and how it could be used for segregation of materials such as papers, plastics, and metals. The product of this research can be further studied by future researchers to create an improved and modified automated proximity sensor waste segregator bin.

RESEARCH QUESTIONS

The objective of this study was to develop a waste segregator bin automated proximity sensor as a household waste segregator bin. Specifically, it sought answers to the following questions:

1. How accurate is using proximity sensors in segregating the following wastes:
1.1. plastics;
1.2. papers; and
1.3 metals?

2. What are the characteristics of automatic segregator bin using proximity sensors in terms of:
2.1. maximum weight capacity; and
2.2. time it takes to detect the waste?
3. What is the success rate of detecting various waste types using the automated proximity sensor waste segregator?

Hypothesis

H1: It is feasible to make a waste segregator bin that detects plastics, papers, and metals using proximity sensors.

II. METHODOLOGY

This study utilized the experimental design of research. Jim (2023) defined that an experimental research design is a data collection procedure that occurs in controlled conditions to identify and understand causal relationships between variables. In this study, the Proximity Sensor is the independent variable and the waste detector as the dependent variable. Quantitative method was used to properly organize the experiment and ensure that the appropriate type of data is available to answer. This method is required because it provides a high level of control over the variables that demonstrate an outcome and has an advantage in determining accuracy, consistency, and precision in its results.

The procedure shows the step-by-step process that shows and instructs how to make an automated proximity sensor waste segregator.

Ensuring Protection and Maintaining Safety

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1. Wear proper equipment such as safety gloves, safety goggles, and proper clothing when building and cutting the wood and pipes for the segregator.

Preparation of Materials

1. Acquire the needed electronic materials.
2. Buy the wood and nails.
3. Cut the wood into its proper pieces.

Constructing of the Wood Stand

1. Put on necessary safety equipment
2. Put the specific wood pieces in their proper places.
3. Nail the woods together.

Building of the circuit board

1. Connect the positive pole of the battery to the step-down converter and the negative pole to the ground pin of the Arduino Uno.
2. Attach the electronics' ground wire to the negative power rail and the power wire to the positive power rail of the breadboard.
3. Wire one servo motor to pin 10 and another to pin 11 of the Arduino Uno.
4. Attach the inductive sensor to pin A0.
5. Connect the Capacitive sensor to pin 2.
6. Wire the ultrasonic sensor's trigger pin to pin 7 and the echo pin to pin 8 of the Arduino Uno.

Programming and coding of the Arduino Uno

1. Use and open Arduino Ide.
2. Define the pins.
3. Encode the codes needed for the waste segregator to work.

III. RESULTS

The findings of the experiment conducted are presented below:

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Table 1 1.1. Trials in identifying the Effectiveness of the automated waste segregator bin in various wastes

Trial 1	Metals	Plastic	Metals
Pictures			
Item	Tweezer	Medicine containers	Box cover
Detection	Successfully detected	Successfully detected	Successfully detected

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Trial 2	Metals	Plastic	Paper
Pictures			
Item	Pepsi can	Baby powder container	Box cover
Detection	Successfully detected	Successfully detected	Successfully detected

Trial 3	Metals	Plastic	Paper
Pictures			
Item	Scissors	Plastic water bottle	Water ticket

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Detection	Successfully detected	Successfully detected	Successfully detected

Table 1 shows the results on the accuracy of the waste segregator bin in identifying different kinds of wastes such as paper, metal, and plastic using the installed proximity sensors. In all of the three trials consisting of random placement of wastes, a 100% success rate of wastes detection was recorded accurately and effectively and classified in its allocated bins.

This is in line with Jhayden (2009), statement that a magnetic field is used by inductive sensors crucial in detecting conductive materials, hence the fact that it can easily detect the metal wastes and allocate it to its proper bin. While the capacitive sensor uses an electric field, detecting non-conductive materials, such as paper. The researchers were able to program and assess the characteristics of the sensors to cater to the waste materials used in the study.

Table 2 Trials for Maximum weight Capacity

Item	Picture	Mass
Plastic Bottle 1 (filled with 400ml water)		400 g

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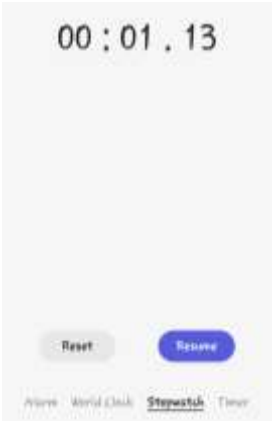
Plastic Bottle 2 (Filled with 600ml water)		600 g

Table 2 indicates the maximum weight capacity of the trash, this was represented with a filled water bottle which can be equated to the weight of plastic, paper, and metals wastes. This also provides information that the mass of wastes can be detected as well by the sensors. The motor can support a maximum weight of 20 kg, though the torque is made of wood, lowering the possible maximum weight capacitance; however, a maximum weight of 600g would be preferable for a more comfortable process of trash separation.

Table 3 Trials for Time it takes to detect waste and placement to allocated bins

Trial 1	Paper	Plastic	Metals
Photo of recorded time detection			

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Item	Box cover	Plastic water bottle	Tweezer
Time (seconds)	1.13 seconds	4.20 seconds	0.76 seconds

Table 3.2

Trial 2	**Paper**	**Plastic**	**Metals**
Photo of recorded time detection			
Item	Water ticket	Baby powder container	Pepsi can
Time (seconds)	2.57 seconds	0.68 seconds	1.32 seconds

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Table 3.3

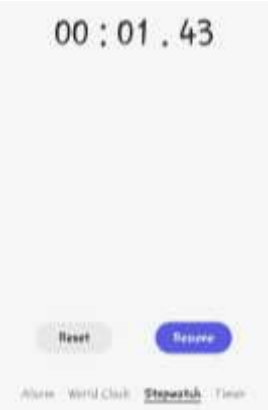
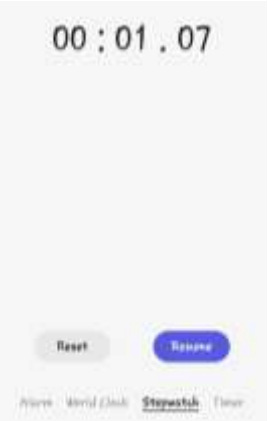
Trial 3	Paper	Plastic	Metals
Photo of recorded time detection			
Item	Arduino box	Hair Curler	Scissors
Time (seconds)	1.78 seconds	1.43 seconds	1.7 seconds

Table 3 shows the time it takes to detect the waste to record how long it took before the sensors detect it and move the pipe into its respective category bin. The researchers first placed a box cover followed by a Pepsi can, and lastly a pair of scissors and recorded the time detection using a timer. A constant one-minute interval for each waste type was set and followed for proper and appropriate time recording.

The result obtained showed that paper, plastic, and metal were sorted into their respective and correct positions with an average, sorting time of 1.827s, 2.103s and 1.260s respectively, making the metal the quickest to be detected among the materials and plastic being the slowest to be detected.

This supports Constantin & Michael (2002) exposition that the use of a capacitive proximity sensor to detect a value range of objects in various time.

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Table 4 Trials for Success rate of segregator

Table 4.1: Metals

Trial	1st	2nd	3rd	4th	5th
Picture					
Item	Pineapple Can	Small Coffee Can	Scissors	Nail Tweezers	Cola can
Detection	Successfully detected	Successfully detected	Successfully detected	Successfully detected	Successfully detected

Table 4.2: Paper

Trial	1st	2nd	3rd	4th	5th
Picture					
Item	Medicine Box	Vitamin C Box	Water Ticket	Arduino Box	Box Cover

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Detection	Successfully detected	Successfully detected	Successfully detected	Successfully detected	Successfully detected

Table 4.3: Plastics

Trial	1st	2nd	3rd	4th	5th
Picture					
Item	Juice Plastic Bottle	Hair Curler	Baby Powder Bottle	Plastic Water Bottle	Jam Container
Detection	Successfully detected	Successfully detected	Successfully detected	Successfully detected	Successfully detected

Table 4 shows the tests conducted to determine the success rate of the segregator. The researchers used 5 of the same materials consecutively to test the accuracy of the segregator. The table shows the results of the testing done. In table 4.1, the researchers tested the success rate of the segregator in detecting metals. It was able to detect all of the materials correctly, showing 100% accuracy in successfully detecting metal wastes. In table 4.2, paper materials were used to test the success rate. The segregator was able to detect all of the materials correctly, showing 100% accuracy in successfully detecting paper wastes. Lastly, in table 4.3, the researchers used plastic wastes and it was able to detect all of the materials correctly, showing 100% accuracy in detecting plastic wastes.

IV. DISCUSSION

The outcome of the study showed the feasibility to use the automated proximity sensors as household waste segregator bin. The segregator's effectiveness was proven in terms of its ability to segregate

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wastes, its average time of detection, maximum weight capacity, and its success rate in segregating the wastes. The results and observations from this investigation demonstrated that it is feasible to develop an automated household garbage segregator using proximity sensors. The proximity sensors were successful in recognizing the waste, and the motors assisted in moving the trash to the appropriate bins.

The automated garbage segregator successfully separated wastes into categories such as metal, paper, and plastic. With the provided statistics, the product can separate 100% of metals, 100% of paper, and 100% of plastic. Our research demonstrates that it accurately and successfully sorts waste into various categories, which will perhaps help in lowering the quantity of waste sent to landfills and incinerators and boosting recycling effectiveness. The automatic proximity sensor waste segregator demonstrated its ability to separate the trash even with a maximum weight of 0.6 kg and an average detection time of 1.73 seconds.

The researchers were able to successfully address the issue of inefficient waste management and came up with a solution that not only promotes efficient recycling and waste segregation but also preserves the environment. The solution developed was an automated waste segregator that utilizes advanced technology to accurately sort different types of waste, reducing the risk of human error and promoting a more streamlined waste management process that leads to significant reductions in the amount of waste sent to landfills and incinerators, ultimately contributing to a healthier environment.

This study offered convenience and advantage to community members since through the use of the segregator in households, sorting out trash was made easier. The sorting out of trash provides a benefit to recycling, as it ensures that less trash goes directly into the landfill, and more on being reused and recycled. And since more trash is segregated to their appropriate types, it lessens the risk of hazardous waste, contaminated with diseases and illnesses, to affect us.

Further, future researchers may use this study as a guide to theirs, if so ever that their research shares similarities with this study. Future researchers may test and use other sensors as household segregator bins. They may also experiment with the different variables such as, the other type of waste that can be detected, the detection time for the different kinds of waste, the type of sensors that are used, the specifications or the model of the device, and the effectiveness of using the device in other places besides a household. In making the device, we insist that future researchers must also have basic knowledge over construction and programming.

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