Project Report Entitled

“Trashmart”

Submitted in partial fulfilment of the requirements for the award of degree of

Bachelor of Technology (B. Tech.)

In

Information Technology

SUBMITTED BY

Shristi Jalan(C22016441540) **Pragya Jha**(C22016441501)

Akanksha Kor(C22016441535) **Megha Mane**(C22016441531)

UNDER THE GUIDANCE OF

Mrs. Leena Panchal

(Assistant Professor, Department of Information Technology)

DEPARTMENT OF INFORMATION TECHNOLOGY

MKSSS’s Cummins College of Engineering for Women, Pune

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

July 2020

Certificate

This is to certify that the Project/dissertation report entitled **"TRASHMART"** submitted by

1. Shristi Jalan (C22016441540)
2. Pragya Jha (C22016441501)
3. Akanksha Kor (C22016441535)
4. Megha Mane (C22016441531)

is a record of bonafide work carried out by her, under my guidance, in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology (B.Tech.) in Information Technology of MKSSS's Cummins College of Engineering for Women, Pune, affiliated to Savitribai Phule Pune University.

Mrs.Leena Panchal
Guide
Department of Information Technology

Dr. Ajit A. Bhosale
Head
Department of Information Technology

Dr. Madhuri B. Khambete
Principal
MKSSS's Cummins College of Engineering for Women, Pune - 411052

Date:

Place: Pune

Report Approval

Project Report Entitled

TRASHMART

By

Shristi Jalan(C22016441540) **Pragya Jha**(C22016441501)

Akanksha Kor(C22016441535) **Megha Mane**(C22016441531)

is approved for the degree of Bachelor of Technology

of

Department of Information Technology

MKSSS's Cummins College of Engineering for Women, Pune

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

_____ Guide

_____ External Examiner

DECLARATION

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke action from the sources which have thus been properly cited or from whom proper permission has not been taken when needed.

Name of Student

Date:

ACKNOWLEDGMENT

Sincere, heartfelt gratitude to our mentor, Mrs. Leena Panchal, for working with us and supporting us throughout. We would also like to thank our HoD, Dr. Anagha Kulkarni for providing us with opportunities, encouraging us, and making sure our seminar was well planned and executed. No acknowledgment is complete without thanking our parents, who have nurtured, supported, and helped us grow into the person we are.

Name of Student

ABSTRACT

In 2018, India slipped to the position of 177th in the World Economic Forum's Green Ranking. When we saw this ranking we were shocked because ranking 177 among 180 countries is alarming and proper measures should be in place to avoid the deterioration. It is determined that a million tonnes of waste is generated and less than 60 percent of it is collected, the rest waste is just left on the streets which are then eaten by stray animals or are stuck in the drains. Most dustbins out in the streets are full of dirt or tobacco stains these days, leading to many people not throwing garbage in such dustbins. Statistics reflect that there is a need, the importance of waste separation in India, and how automation can be introduced into existing systems. Manual laborers do the less efficient segregation of solid waste which is very time-consuming, and because of an outsized amount of waste isn't completely feasible. The proposed system is an IoT enabled intelligent bin that can segregate waste through sensors. So sensors are used for distance measurement purposes and to detect the type of waste(dry or wet). The end result of the proposed system is to open the lid intelligently as it sees a person approaching and segregate waste that is Dry or Wet. This approach is a proper solution for the management of dry and wet waste since it can smartly separate the two types of waste into the respective bins and thus cut the problem of segregation at the bud. But at the same time, it is not the most perfect solution since the product is a bit expensive. By using different types of sensors, segregation of waste into metal/non-metal or plastic can be achieved.

Table of Contents

List Of Figures

Chapter 1 Introduction

In 2018, India slipped to the 177th position in the World Economic Forum's Green Ranking. When we saw this ranking we were shocked because ranking 177 among 180 countries is alarming and proper measures should be in place to avoid the deterioration. Apart from this index, there are other environmental indexes that we have come across like the Environmental health index, Ecosystem vitality, etc where we are constantly ranking last. These indexes are based on certain variables like different types of pollution, sanitation, and waste management. When we researched and went deep into the rabbit hole we were appalled. India is one of the most populated countries in the world. India generates 62 million tonnes of waste, out of which only 60 percent i.e only 37.2 million tonnes is collected every year. Out of that 37.2 million tonnes, only 15 percent i.e 5.58 million tonnes is processed. The difference of 62 million tonnes to 5.58 million tonnes is 11.11 folds. The rest of the waste generated is not processed or collected and is left on the streets to be eaten by stray animals or gets clogged into the drains instigating several other problems. So we embarked upon the journey to solve this challenge and cut the problem at its source. [1]

When we were pondering over the question and trying to think of the solution we came across one more challenge; even though there are dustbins out there on the street and proper collection strategy by the government in place, people do not throw garbage into the dustbin, one of the reasons for doing so was because of the dirt, tobacco stains and hygiene of the dustbin, people did not want to throw garbage into a dustbin where they have to touch the dirty lid. Other than that people are less aware of the segregation policies in place, most of the dustbins out there do not have segregator, even if they do the dustbin lids are open and have an unbearable smell and thus they are a host to multiple diseases.[4]

Previous works in this field of smart waste management included a system that was using conveyor belts to segregate the waste produced by households into dry waste that is recyclable and wet waste that is residual with the help of sensors as mentioned in the paper 2 from a literature survey in this report. But this system design uses a conveyor belt approach which is very huge and not efficient. There also exists a system where the user could be notified about the level of a dustbin and also segregation was done but it was built on high-cost devices so was not feasible in household areas as in paper "Smart Trash Can Using IoT(2019)". In the other paper "IoT Enabled Dustbin(2017)" the system mentioned sends data collected at intervals of 15 minutes each and then the decision-making system decides whether to add the dustbin in the list of garbage collection or not, the shortcoming for this system was that it is not usable for household purpose. In the paper 3 of a literature survey, a platform was designed where smart waste containers were provided and that they transmitted period of time facts that indicated the share of the bin crammed. Lastly in paper "Smart Dustbin Management System(2017)", the system controls the overfilling of the dustbin by notifying the user for its cleaning. The papers are further discussed in the next chapter. Most of the designs we saw were not that efficient and were not fully able to integrate multiple features in one project.

With the enhancements in smart cities emerging across the cities in India, the 'Intelligent Garbage Management System' is a pressing need. The necessity and importance of waste segregation are statistically proven and research highlights automation in this field. The proposed system is an IoT enabled intelligent bin that can segregate waste through sensors.

The objective of our proposed system is as follows:

1.1 Automatic lid opener based on sensors.

2.1 Segregation of the waste into wet and dry waste.

We started the project by jotting down the scope and timeline after that we started reading the different statistics surrounded by the idea of our project. Then we read many papers to understand what has been previously done and what gaps are there that need to be filled. After this, we finalized the project tech stack and the type of sensors that we will be using to solve the problem. Reading about the implementation and internal working of all the hardware parts we used which includes raspberry pi and sensors. After this, we learned how to boot up the OS into the raspberry pi and how to start up the pi board. We then started to implement the design and how the sensors will be placed and how the coding is to be done.

Our aim through the project is to expand our knowledge through practical implementation of technology to solve everyday problems, also to learn how hardware and software interfaces with each other. All of us belonging from the IT stream have had little to no experience working with hardware circuits and sensors. So we would like to learn more about sensors, raspberry pi, and the Python language which we are using to code in the Raspbian OS.

Our goal through this project to help promote the health and cleanliness importance and reduce the manual labor effort that the landfill laborers have to put in going through the garbage and separating it, we want segregation to be done at generation level so as to reduce this effort and help them live a healthy life by breathing less toxic air. Our project also perfectly fits into the Swachh Bharat Mission promoted by Honorable Prime Minister, Mr. Narendra Modi. We are trying to promote health and cleanliness by using measures of proper segregation and smart systems.

The following chapter of the report is the Background and Literature review which takes a deep dive into the different resources that we have referred to get a grasp at what has been proposed for the problem so far. Following which is the Requirements and Analysis which covers what are the requirements and specifications needed to solve the problem this includes details about the hardware and software requirements. After this comes the design of the project which has the architecture and the list of components of the project with proper and detailed diagrams. The implementation section covers the actual practical application of all the things mentioned before and how the implementation is done based on those methodologies in detail. The report ends with a conclusion and references used.

Chapter 2 Literature Survey

2.1 Paper 1: Smart Trash can using IoT

2.1.1 Introduction

The problem in India is the population because it is increasing exponentially day by day however the atmosphere/environment isn't as clean as it ought to be. One reason behind the unusual environment can be our garbage management system is handled by the government through a municipal corporation as we see the overflowing of garbage bins in our city. This project is done to make our society more cleaner. In the proposed system when the bin will be fully filled then it will notify the house owner to empty it. Apart from this, this bin will also do segregation (i.e. it will separate dry and moist waste) with the help of Sensors. As a result, the system gives dry and wet garbage in separate dustbins.[5]

This system is composed of two phases: first is the physical model and the second is coding. Coding is done in C language in Arduino. The main challenge is to make a physical model that can be used to segregate the waste and can successfully give the depth of the bin.[5]

2.1.2 Components Used

- Arduino UNO and Arduino Nano.
- Bluetooth Module.
- Ultrasonic Sensor.
- Moisture Sensor.
- DC motors
- 9V Battery.
- 12V, 2A Adapter.

2.1.3 Results

Materials Tested	True Acceptance	True Rejections	False Acceptance	False Rejections
Dry	76	79	87	85
Wet	74	77	80	90

Figure 2.1: Result Table [5]

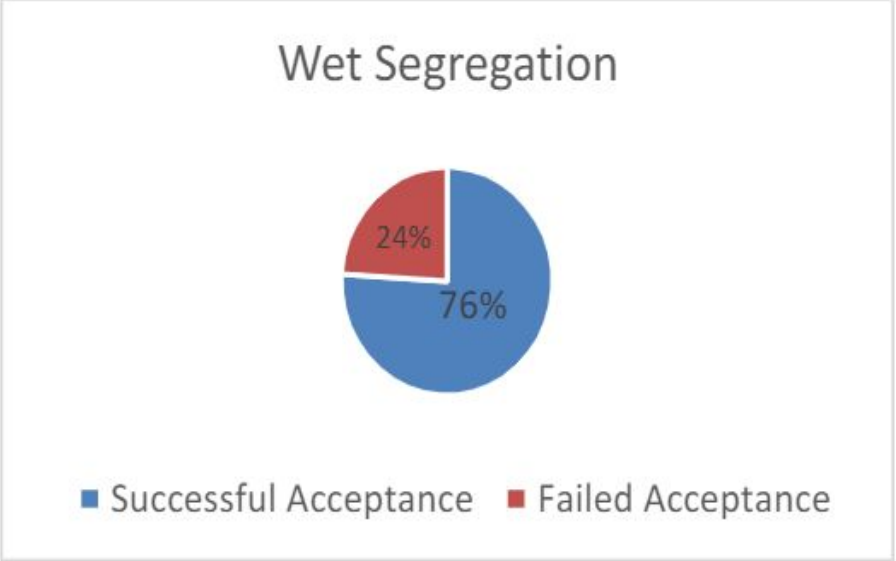

Figure 2.2: Result Wet Segregation [5]

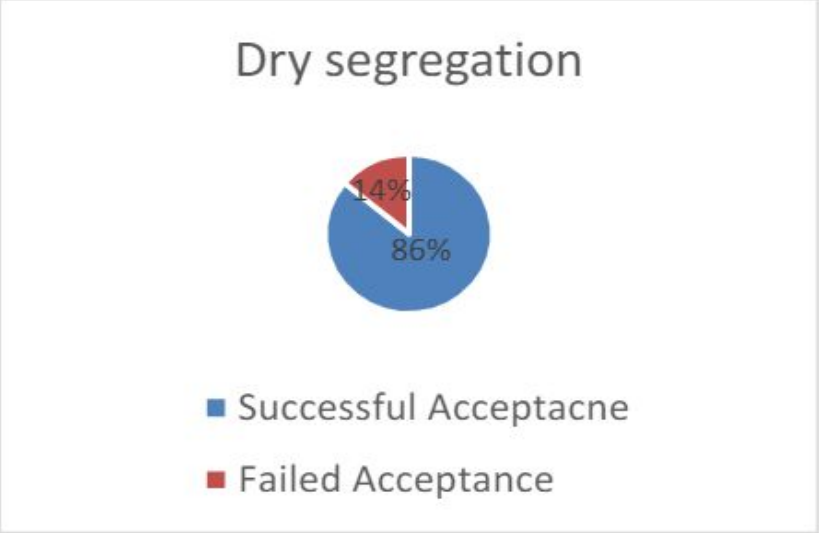

Figure 2.3: Result Dry Segregation [5]

Figure 2.1 details the results of different categories of results with true, false acceptance, and rejection rates. Fig 2.2 shows the detection of wet waste with 76% Successful acceptance and 24% failed acceptance of metal type materials. The detection of dry waste as shown in Fig.2.3 with 86% Successful acceptance and 14% failed acceptance.

2.2 Paper 2: Automatic Household Waste Separation System based on the Resistance value and Moisture content

2.2.1 Introduction

Over the last decades, the Waste Disposal-system (SWM) has been one in all the eventful matters in several countries. Within the time period, waste is handled by utilizing 4 fundamental means, which consist of disposing/landfill, flaming, reusing, and waste depreciation. In the modern age, municipal experts dealt with waste through a Waste disposal system which has become an unfolded management framework. The waste management system consists of parts like collecting, transporting, disposing, flaming, reusing, and depreciation, or very last tendencies.[3]

A system that discriminates waste and dry wet is proposed in this paper. It is exhibited that waste can be separated by employing a moisture sensor to sort them into residual and recyclable, automatically. The current resisting value and percentage of water in waste decides the state of waste.[3]

2.2.2 Components Used

- Arduino Uno
- Servo Motor
- Moisture sensor FC-28
- Ultrasonic sensor
- 12 V DC Motor
- Conveyer Belt

2.2.3 System Design

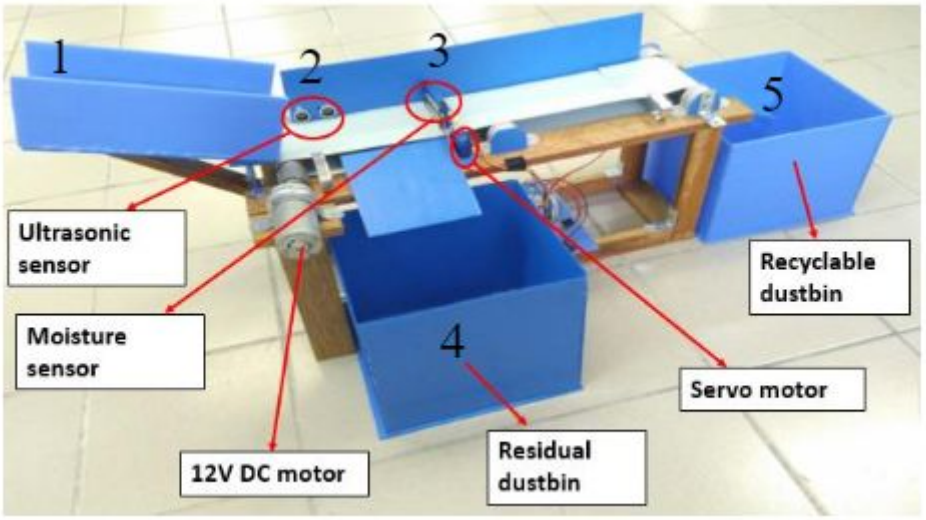

Figure 2.4: Automatic Household Waste separation system [3]

The final prototype of an automated waste segregation system is shown in figure 2.4. This system can differentiate between moist and dry waste. It includes a moisture sensor, an ultrasonic sensor, 1 servo motor, 2 separate dustbins, and a 12V DC motor. It operates on the notion of a conveyor belt to shift the waste into its respective bin. [3]

2.2.4 Results

Material (Waste)	Resistance (Ω)	Percentage of moisture content (%)	State of material (waste)
Water	544	46.75	Wet
Onion	320	68.77	Wet
Rose apple	618	38.05	Wet
Cake	442	56.84	Wet
Tin	1012	1.12	Dry
Plastic bottle	1023	0.00	Dry
Glass	1019	0.39	Dry
Wood	1022	0.10	Dry

Figure 2.5: Results of Automatic Waste separation system [3]

Figure 2.5 shows the results of eight kinds of material that are experimented, which encompass onion, water, rose apple, plastic bottle, tin, glass, cake, and wood. The table also shows the resisting value (Ω), the % of moisture content of the above material. Dry waste like

tin, glass, wood, plastic bottle has high resistance when compared with wet waste like cake, onion, apple, water, rose. The resistance value of the waste is used to calculate the percentage of moisture content. Dry waste like tin, glass, plastic bottle, and wood, with moisture ranging between 0-1.12% does not have as much moisture content that wet waste has [between 38.05-68.77%].[3]

Aside from that, the author is about to implement a system that may be further improved where the recyclable (dry) waste will be categorized into glass, metal, plastic, paper, by capturing the properties of the waste item.[3]

2.3 Paper 3: Design of Smart bin for Smarter cities

2.3.1 Introduction

With the idea of urban communities making progress all through the globe, an outsized number of duties must be satisfied. A city which is termed as "Smart" requires its inhabitants to own up a reasonable way of life and for a wise way of life, sanitation could be an essential need. In this way, it is important to create smart waste management schemes all through the planet with the help of innovation to make urban areas smarter. An alternate waste handling strategy is given in this paper to tackle the matter.[6]

For the execution of this alternative strategy, a new design of dustbin with several sensors fitted inside it, is proposed for continuous checking of the level of trash inside the bin. At whatever point the trash level inside the bin-container will cross a certain pre-agreed edge, a message would be sent to the one who cleans it to proceed to cleansify it. In this manner, this will tackle the matter of under-use of the bin and additionally the matter of flooding of waste in the waste-bin .[6]

2.3.2 Sensors Used

- Ultrasound Range sensor: For determining fill rate.
- PIR sensor: For identifying movement and instructing the servo motor to open the covering of the bin.
- Proximity sensor: For observing attendance and cleaning bin.
- Temperature sensor: For testing the temperature within the bin because the temperature has consequences on waste.

2.3.3 System design

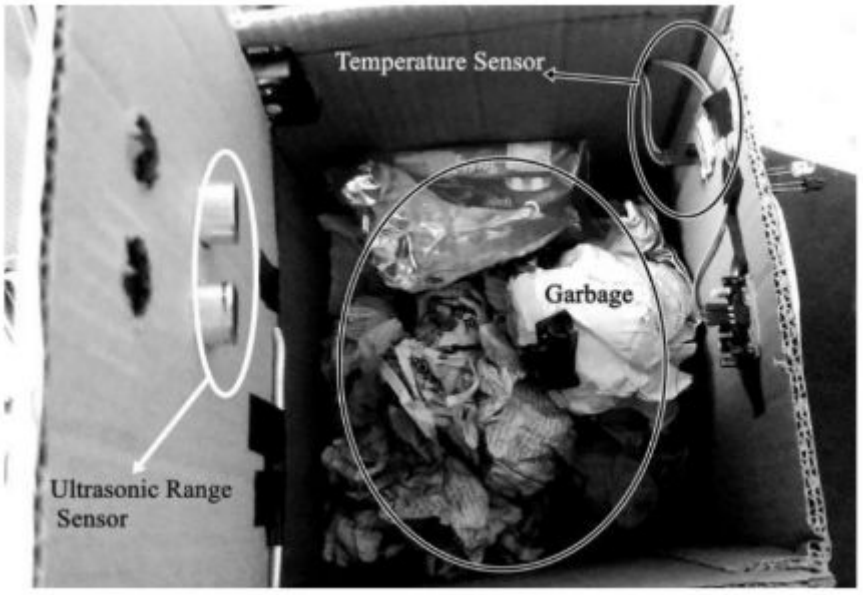

Figure 2.6: Smart bin system [6]

Figure 2.6 shows the inside view of a smart bin system, where the Ultrasonic sensor estimates the fill percentage of the bin, and therefore the temperature sensor keeps track of the temperature inside the bin because the temperature has a control over waste.

2.3.4 Results

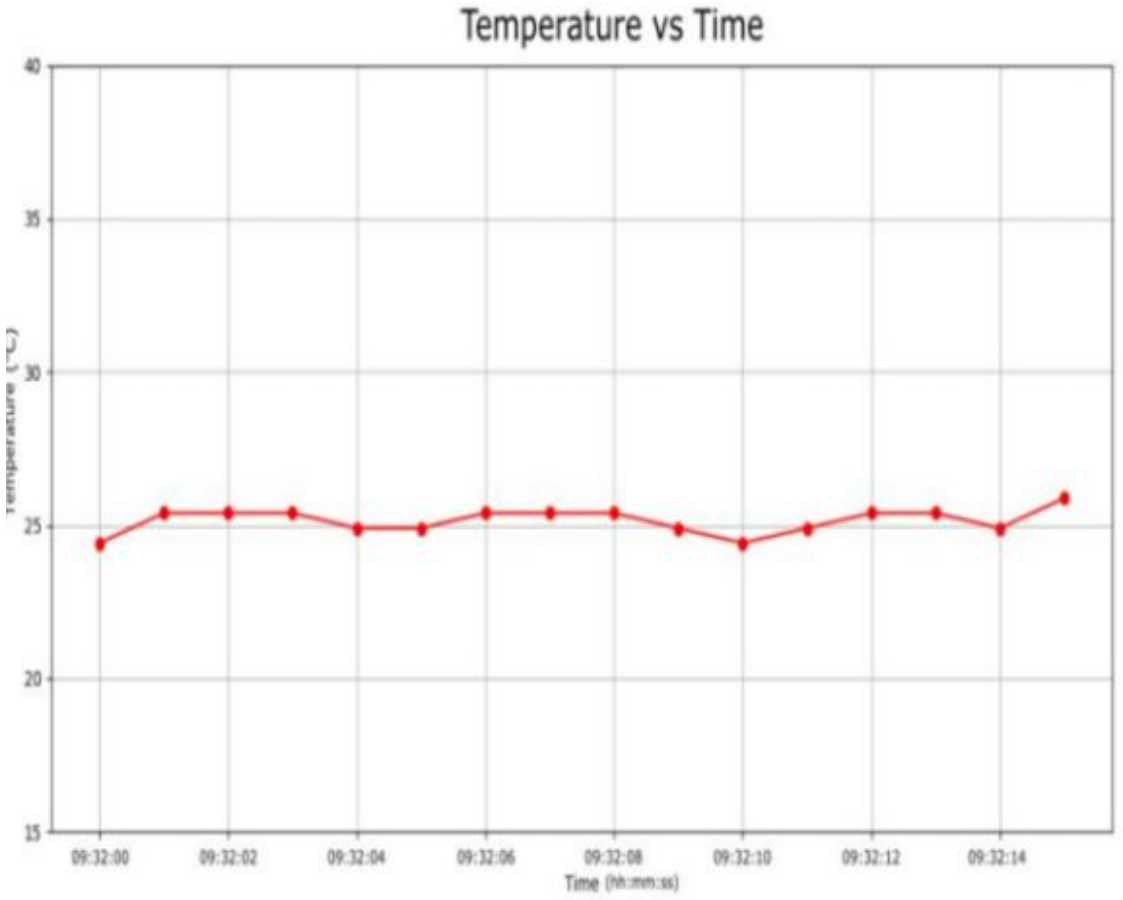

Figure 2.7: Results of Smart Bin System [6]

Figure 2.7 and figure 2.8 offers a plot of the temperature that is ongoing inside the waste-container and also the continuous plot of level filled up in the bin respectively.

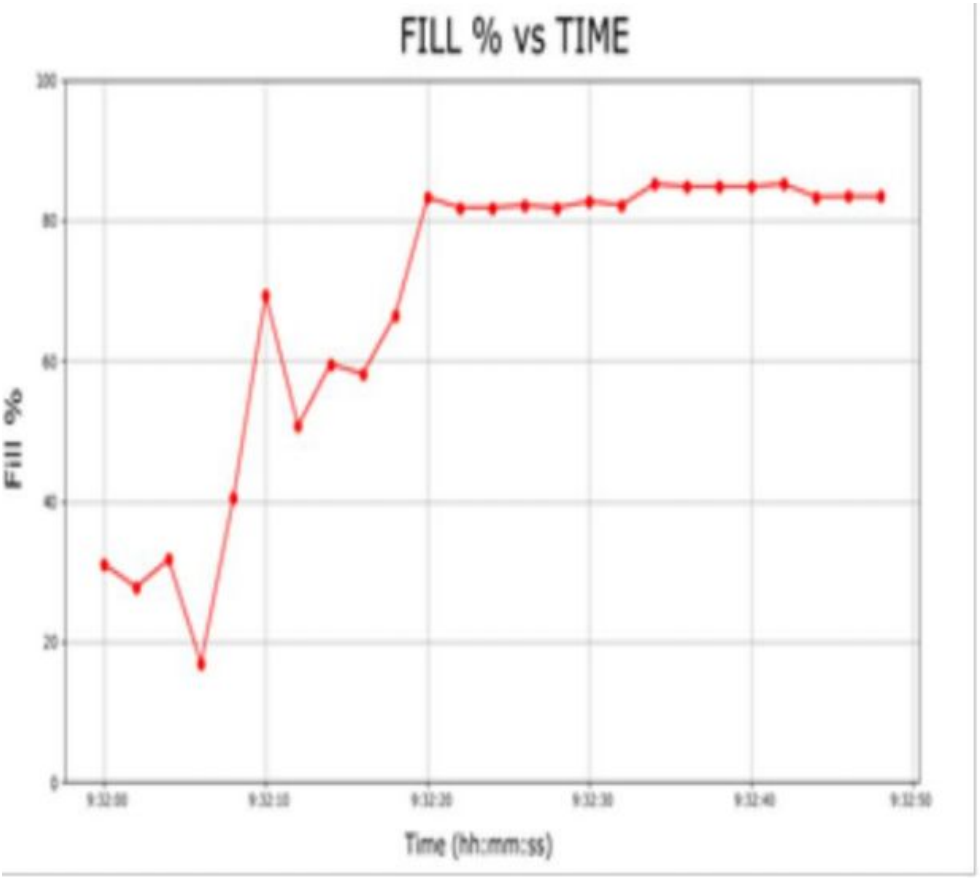

Figure 2.8: Fill % Vs Time plot [6]

The other waste administration system proposed efficiently utilizes innovation to build up a strategy which is a lot more smarter and substantially more productive than the current. The mentioned paper would work as a motivation to others to additionally survey the world of waste administration and grow increasingly productive methodologies future with the assistance of technology in the future..[6]

2.4 Summary Table

Sr.No	Name	Proposed System	Advantages	Disadvantages
1.	Smart Trash Can using IoT(2019)	This system will alert the house owner when the dustbin is filled and will also do separation (i.e Dry and Wet) using sensors.	This system will prevent the overflow of a dustbin and helps to keep the environment neat and clean. The working system has 90% accuracy in Dry Segregation and 88% accuracy in Wet segregation.	The system is not yet designed for plastic wastage, metal scrap, rubber, food wastage.
2.	Automatic Household Waste Separation system based on Resistance value and Moisture content. (2019)[3]	The notion of the conveyor belt is utilized in this paper to separate waste produced by households in recyclable(dry) and residual(wet) with using sensors.[3]	Successful implementation of the system and successful separation of waste into dry and moist waste at home and thus solving the sorting problem at its root. [3]	The system's design uses a conveyor belt approach which is very huge and not efficient. Also, it is still not designed for metal and plastic segregation.
3.	IoT Enabled Dustbin(2017)	This system sends the data collected at intervals of 15 minutes each and then the decision-making system decides whether to add the dustbin in the list of garbage collection or not.	Improvises the current waste collection system and prevents the spilling of waste all over the road.	The system is not pocket-friendly and cannot be used in household areas.

4.	Design of Smart Bin for smarter cities(2017)[6]	This system represents a Consolidated platform where smart bins are supplied with sensors and they share real-time data which tells the percentage of bin filled.[6]	It would create the world a better place to live in by making cities cleaner and healthier.[6]	The system cannot detect or measure the toxic gal level, emission level within the waste containers, and collected waste weight.[6]
5.	Smart Dustbin Management System(2018) [8]	This system can manage the overfilling of the wastebin by creating the dustbin sensible enough to give notice itself of its cleansing. It's designed on the microcontroller-based system having unhearable sensors on each of the four dustbins that will show the present situation of garbage on the LCD screen also on the app. [8]	This system is developed using minimum-cost devices like PIR sensors, ultrasonic sensors, IR sensors, etc, and also the app built is very useful in notifying the admin about the status of each dustbin and assigning each dustbin to an individual employee.	The app used in this system only notifies the value of the dustbin and not the location of the dustbin.

Chapter 3 Materials and Methods

3.1 Requirement and Analysis

3.1.1 Problem Definition

The proposed first system is an IoT enabled intelligent bin. It will automatically open the lid when a person or user comes near the dustbin to drop the waste based on sensors. The second system is the extension to the first system and it will segregate the waste produced by the households into dry and wet waste with the help of sensors.

3.1.2 Requirement Specification

The main purpose of the system is opening the lid automatically when the user or person comes near the dustbin to drop the waste. The automatic lid opener is required because the dustbins out in the streets are filled with dirt and tobacco stains these days. People do not want to touch the dirty dustbins. And because of this reason, they drop the waste anywhere other than dustbins. So the dustbin is required which will open the lid automatically and people can drop the waste in it without touching the dustbins.

Also, the dustbin will do the segregation of waste as dry and wet waste depending upon volumetric water content in waste. This system then alerts the house owner whenever the dustbin is completely full. This proposed model utilizes the conception of conveyor belts in order to segregate the input waste produced by households in two categories.i.e recyclable(dry waste) and residual(wet waste) with the help of sensors. Smart bin is built on Raspberry pi 3 platforms. It is interconnected with the Servo motor and the bin is furnished with two sensors .i.e an Ultrasonic sensor and Moisture sensor.

3.1.3 Software and Hardware Requirements

1. Hardware
    - Raspberry pi 3
    - Ultrasonic Sensor
    - Moisture Sensor

- Servo Motor

2. Software
   - Raspbian
   - Python

3. Testing tool
   - Shodan (IoT Testing)

3.1.3.1 Raspberry-Pi 3 Model

Raspberry-Pi 3 Model B 's size is similar to a tiny credit card of a computer. We only need to attach the parts of the computer like a keyboard, mouse, display, power supply, micro SD card and we will have a computer that can run any application. There are three main advantages of using the Raspberry Pi 3 over Pi 2. It contains Bluetooth, Wi-Fi, and a powerful CPU/GPU pair. An important advantage of raspberry pi is that its size is small and it's working is similar to a normal computer at a very low cost. Actually, RPi uses software that is free or open-source. So it gives the opportunity to learn more. It provides processor pins as GPIOs which are directly accessible.

It is suitable to make use of RPi at the starting as it has very few software defects and provides general performance. It is a mini-computer having Raspbian OS. It has the ability to run multiple programs at a time. It is convenient to connect the Raspberry Pi to the internet using an Ethernet port and USB Wi-Fi dongles. For storage, Raspberry Pi provides an SD cart port.

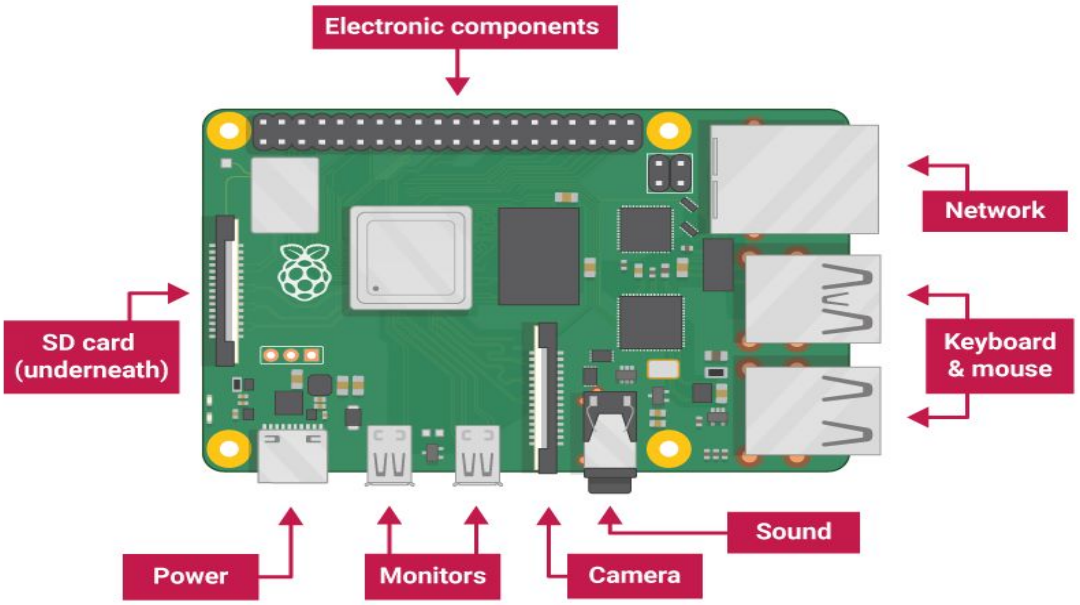

Figure 3.1: Raspberry Pi 3 Model

3.1.3.2 Ultrasonic Sensor

By measuring the ultrasonic waves , the ultrasonic sensor measures the distance. The top of the sensor releases a wave called ultrasonic waves and gets the wave reflected back from the target. This Sensor measures the actual distance to the target by measuring the time of emission and reception. The ultrasonic sensor has high frequency, high sensitivity, hence it can simply discover the external or deep objects.

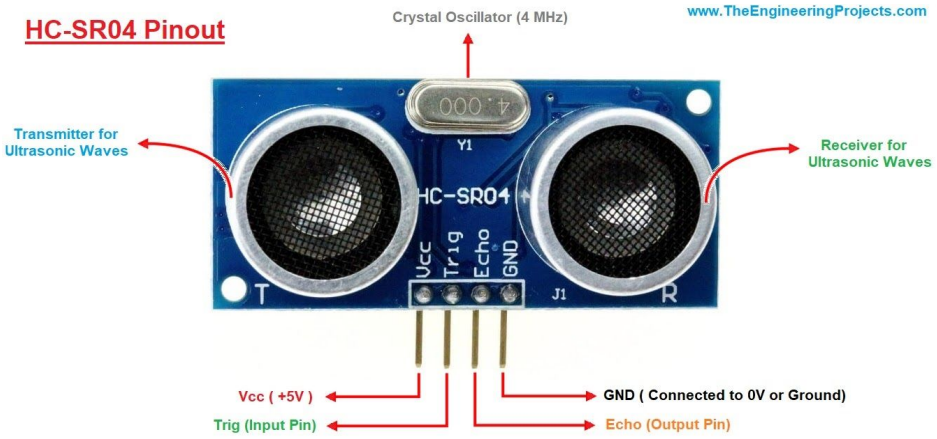

Figure 3.2: Pin diagram of Ultrasonic Sensor

3.1.3.3 Moisture Sensor

Moisture sensor is used to measure the percentage water content in the object.. As the moisture needs to eliminate, dry and simply wet. It measures the percentage of water content with the interchange with neutrons, and substitution of the moisture content and not with the direct help of dielectric constant, electrical resistance.

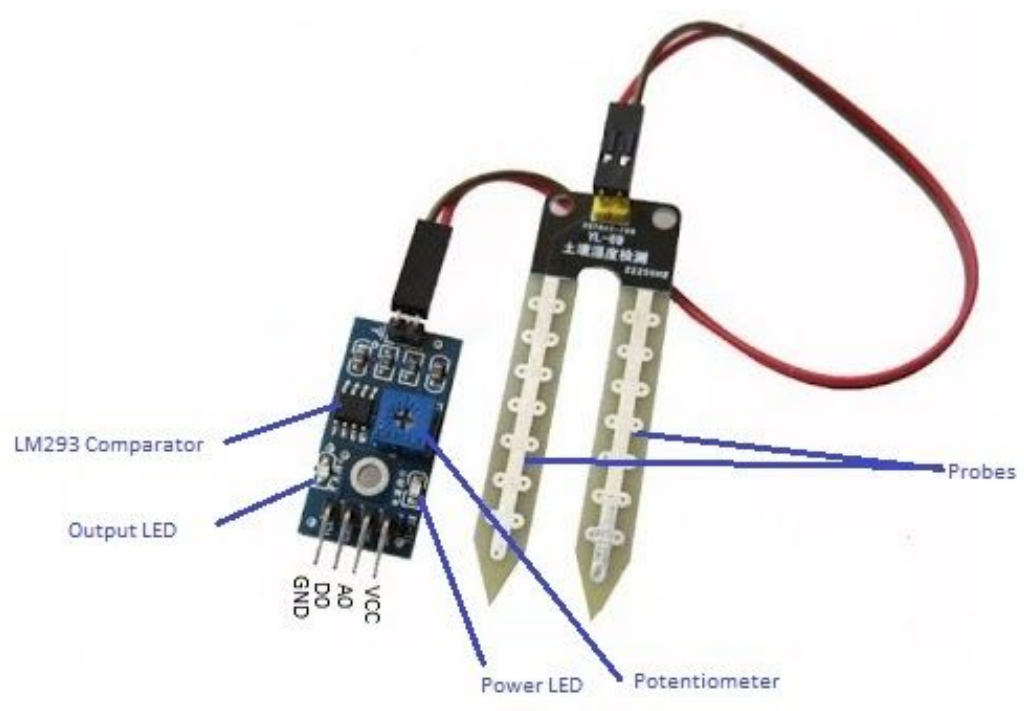

Figure 3.3: Pin diagram of Moisture Sensor

3.1.3.4 Servo Motor

Unlike stepper motors, servo motors can be authorized with a single GPIO. Servo motors works on a principle called PWM (Pulse Width Modulation) , whose meaning is that it's angle of rotation is run by the amount of time the pulse applied to its control PIN. Actually, a servo motor is built up of a DC motor which can be controlled by a variable resistor and several gears. A servo motor is an electrical gadget which can rotate an object with considerable accuracy. If you want to turn round an object at some particular angles or distance, then you can do the use of a servo motor. It is just a form of a manageable motor that runs across a servo mechanism. A motor is called a DC servo motor if the motor is DC

powered. A motor is called AC servo motor if it is AC servo powered. We can get an uncontrolled torque servo motor in a portable and lightweight bundle.Because of all these features of servo motors, people use them in many applications. For example, a toy car, RC helicopters, and planes, Robotics, Machine, etc.

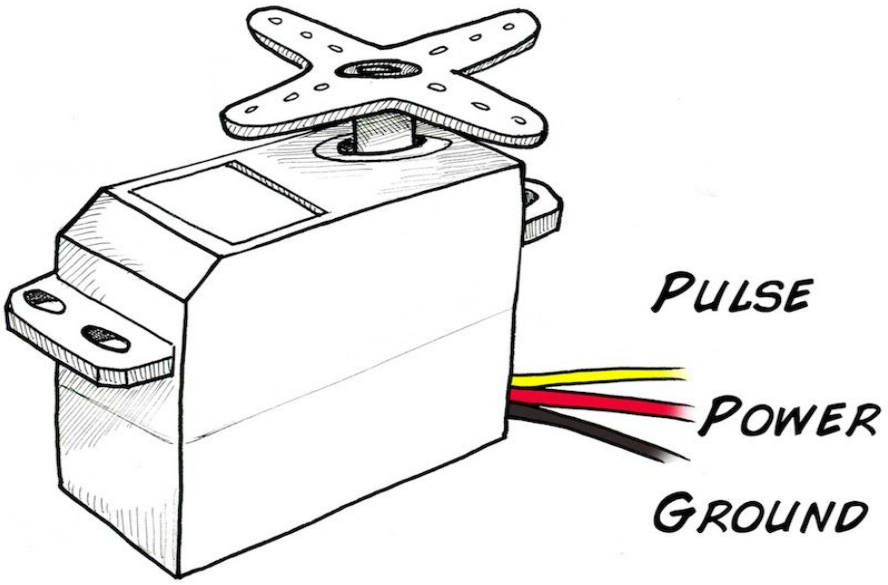

Figure 3.4: Pin diagram of Servo Motor

3.1.3.5 Raspbian

Raspbian is an operating system based on the Debian based engine ,mostly for the Raspberry-Pi and it is the perfect operating system for Raspberry-pi users. Raspbian grab the Openbox stacking window manager and the Pi Improved Xwindows Environment Lightweight coupled with a number of pre-installed software. It encompasses Minecraft Pi, Java, Mathematica, and Chromium. Raspbian OS is the Raspberry foundation's formal hold up OS and is skillful of executing any task you bowl at it.

3.2 Design

The proposed model is a hardware system that is interacting with the user and built using Raspberry Pi and Sensors.

3.2.1 Architecture

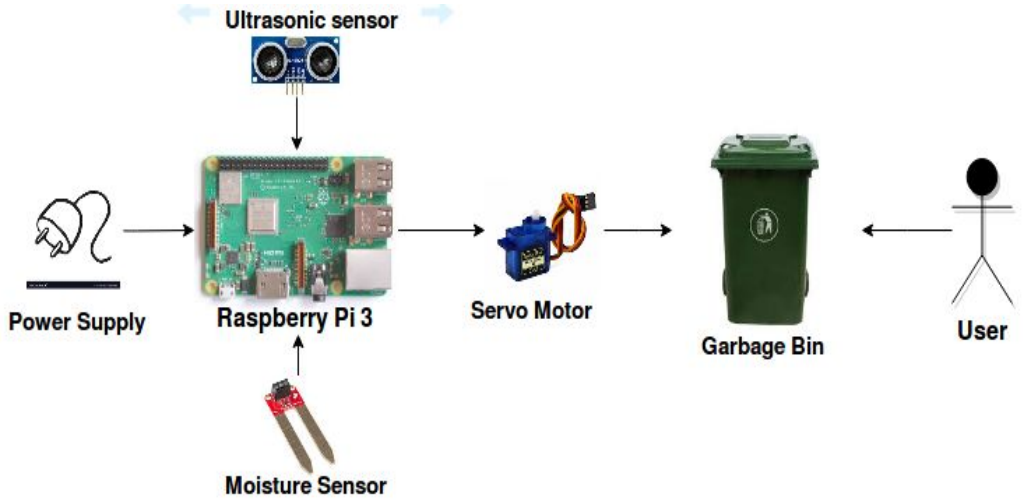

Figure 3.5: Block Diagram of Trashmart

The main block of our project is the Raspberry Pi module. The power supply provided will be 5V. Ultrasonic sensor and Moisture sensor will act as input for measuring the distance between user and bin, and input for measuring moisture content, respectively.

3.2.2 Data Flow Diagram

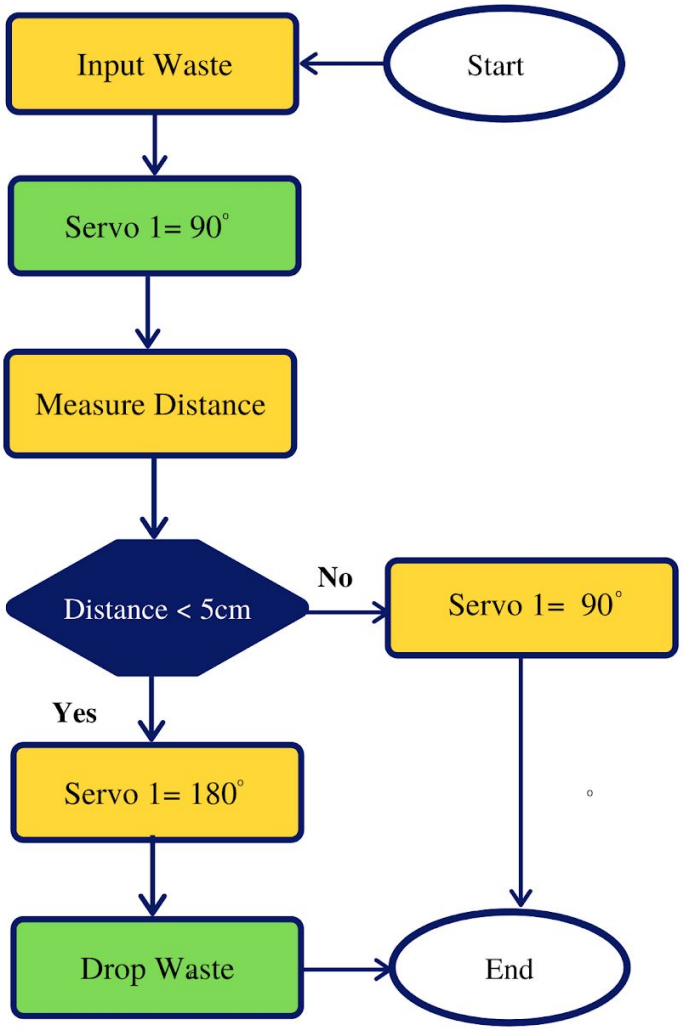

Figure 3.6: Flow Diagram for System 1

Figure above is an automatic lid opening system. System 1 will consist of 1 Servo motor and 1 Ultrasonic sensor. The initial position of the motor will be at 90^0. The ultrasonic sensor will observe a person near the dustbin. If the motion is detected and distance between

the person and dustbin is less than 5 cm, the Servo motor will change its position to 180^0 to open the lid of the dustbin.

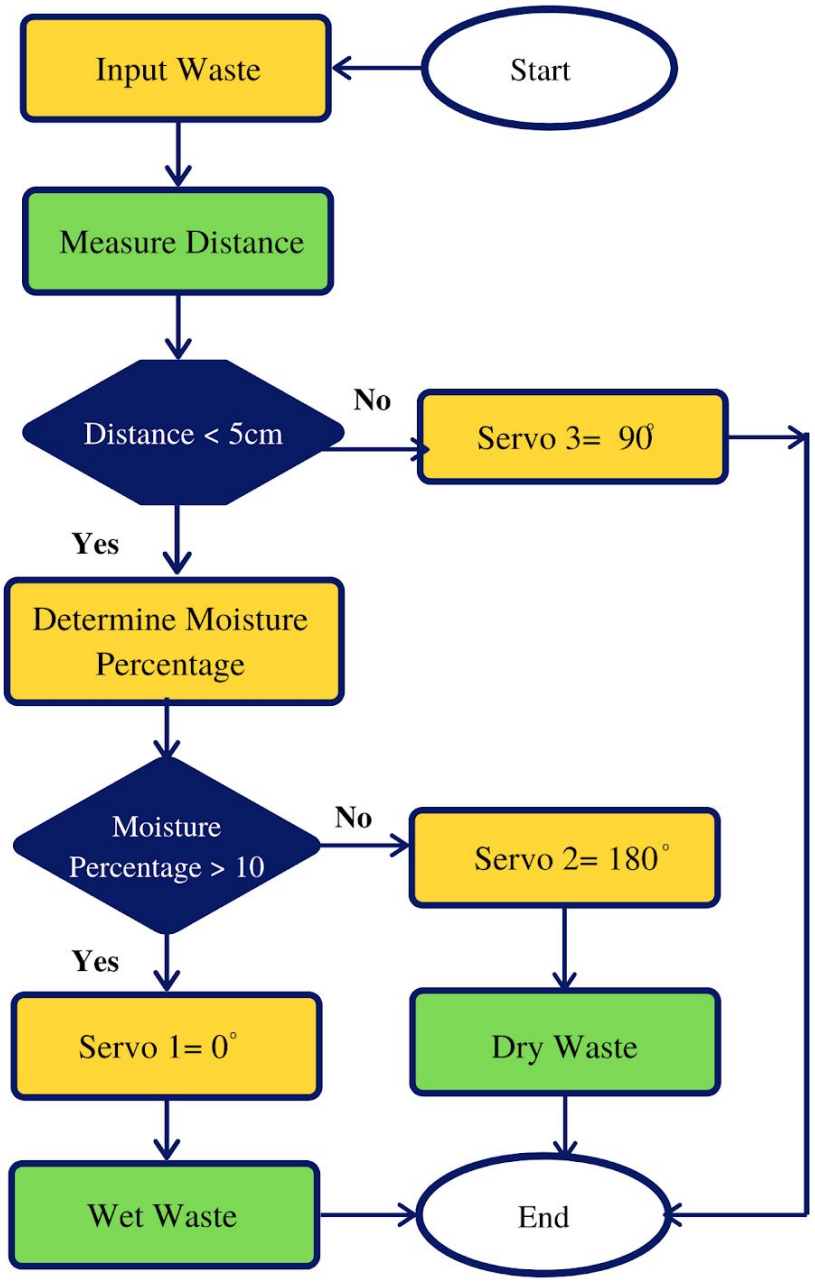

Figure 3.7: Flow diagram for System 2

Figure 3.7 shows the flow diagram of both systems combined together. The second system consists of two servo motors (one each for wet and dry waste separation respectively) and a moisture sensor. Using the ultrasonic sensor, a person is detected and when the person is close to 5 cm of the dustbin the user throws the garbage on the lid of the dustbin (where moisture sensor is placed). After this step the sensor detects the moisture percentage of waste thrown, if the percentage of moisture is greater than 10 percent, the Servo motor 1 rotates from its initial position of 90 degrees to a zero degree position and thus enables the waste to be thrown from the lid to the wet waste compartment. Similarly, if moisture percentage is less than 10 percent then the Servo motor 2 is activated and rotates from its initial position of 90 degrees to 180 degrees and enables the transfer of waste on the lid to the dry compartment of the bin.

3.2.3 Activity Diagram

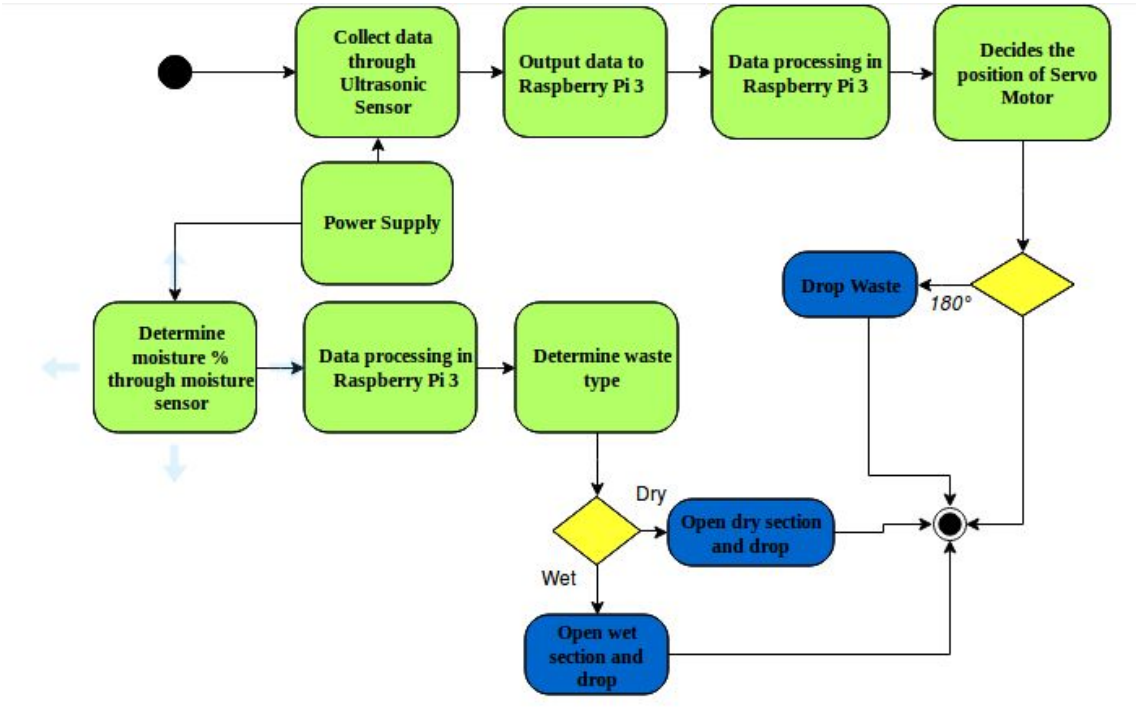

Figure3.8: Activity Diagram

Figure above is the activity diagram. Firstly, ultrasonic sensor on the raspberry pi collects data continuously to determine if there is a person standing close to the bin to throw garbage, this data continuously is sent to the raspbpi to monitor if the distance is less than 5 cm and if so, it waits for the person to throw the garbage on the lid. Once there is garbage placed on the bin, the role of the moisture sensors and servo motors become active. After this, the moisture sensor sends its collected data to the raspberry pi to measure the percentage of moisture and to process the data into whether the garbage is wet or dry based on the limit set on the raspberry pi's python script. After deciding on the type of garbage is thrown the raspberry pi activates or triggers the specific servo motor to take control which further rotates into a specific angle to push the garbage down into the respective compartment as analyzed by the raspberry pi.

3.2.4 Sequence Diagram

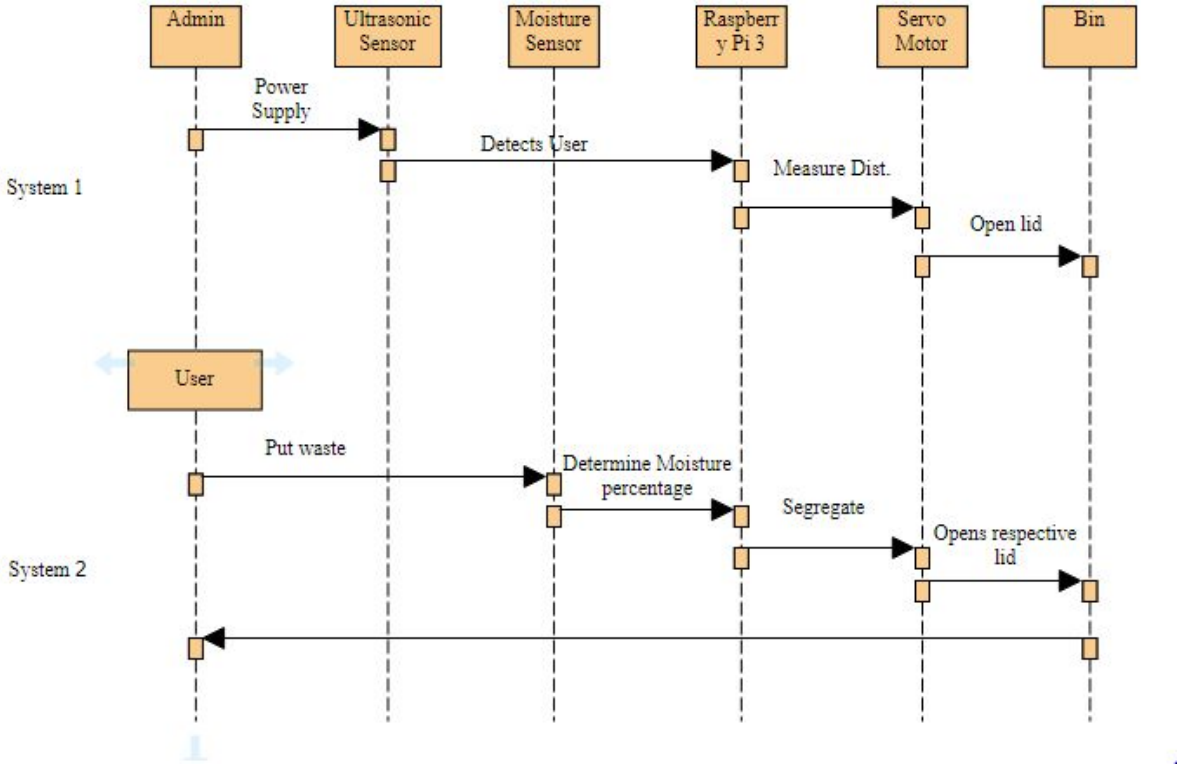

Figure 3.9: Sequence Diagram of Trashmart

In the figure above we see the flow of entire system in a specific sequence. First, there is a power supply into play which is constantly plugged in to the raspberry pi. There is an ultrasonic sensor connected to the raspbpi and keeps track of the distance of users from the bin and this information is sent to the raspberry pi which checks in case there is a distance of less than 5 cm in which case it triggers the servo motor which in turn open the lid.

3.2.5 Use Case Diagram

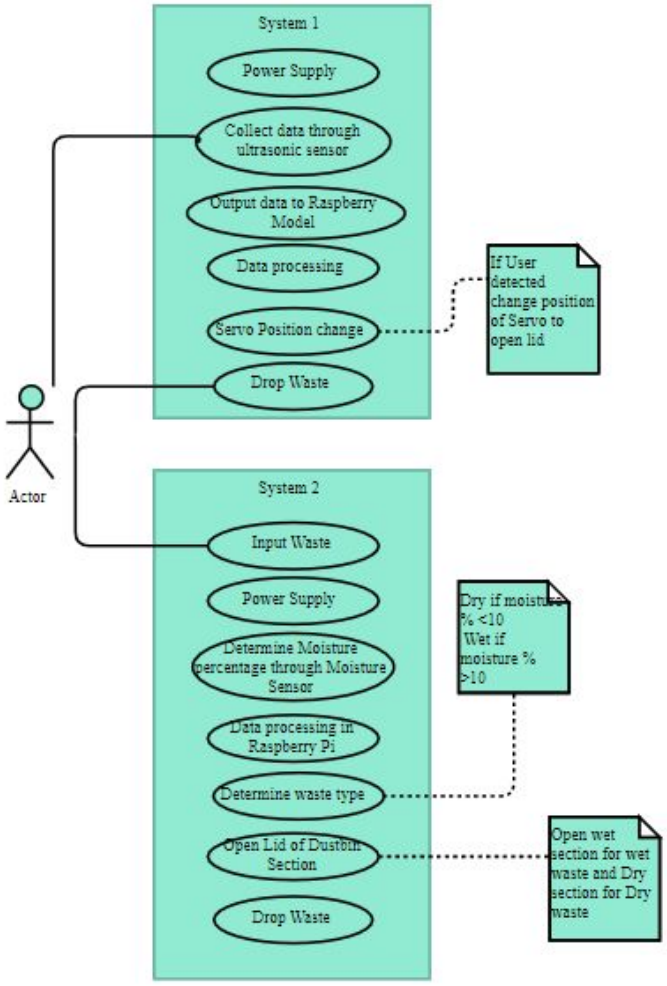

Figure 3.10: Use Case Diagram of Trashmart

In a User Case diagram, we see how a user interacts with Trashmart system. In System 1 as soon as the ultrasonic sensor detects a user present in the vicinity of 5cm or less than that it automatically opens the lid for the user and the user simply has to put the garbage into the open bin without the hassle of opening it by themselves and physical contact.

In system 2 the user interacts with the system by just placing the garbage into the top lid of the bin and the system then does the rest of the process which is measuring the moisture percentage and accordingly activation of servo motors and segregation of waste into respective bins is achieved.

Chapter 4 Outcomes And Discussions

4.1 Estimation for cost

4.1.1 System 1

Sr.No.	Items	Quantity	Price
1)	Raspberry-pi Kit	1	2850
2)	Servo Motor	1	161
3)	SD Card	1	475
4)	Ultrasonic Sensor	1	80
5)	Dustbin	1	70
6)	Jumper Wires	5-6	10
7)	Breadboard	1	168
8)	Battery	1	23
			Total = 3837

Figure 4.1: Cost Table for system 1

For the first system, we required a total of 8 items. The 1st item is Raspberry-pi Kit. We have used only a single kit of Raspberry-pi. Its cost is Rs. 2850. The 2nd item is Servo Motor. It is basically a rotary actuator used for rotation. Its cost is Rs. 161. The 3rd item is SD Card and it costs Rs. 475. We were required to have only one SD Card. The next item is the Ultrasonic Sensor. These sensors are used to detect solid or liquid targets by using sound waves. For this system, only 1 ultrasonic sensor is used and its cost is Rs. 80. The 5th item is Dustbin. We have used a single medium-size dustbin and its cost is Rs. 70. The next item is Jumper Wires. We required 5-6 wires for this system and it costs around Rs. 10. We used a

single Breadboard for this system which is used to make a quick connection between the components and its cost is Rs. 168. The last item is the Battery. We have used a single battery and its cost is Rs. 23. The total cost of system 1 is Rs.3837.

4.1.2 System 2

Sr.No	Items	Quantity	Price
1)	Raspberry-pi Kit	1	2850
2)	Servo Motor	1	161
3)	Moisture Sensor	1	153
4)	SD Card	1	475
5)	Dustbin	1	70
6)	Jumper Wires	7-8	15
7)	Battery	1	23
			Total = 3747

Figure 4.2: Cost Table for system 2

Most of the items used in system 2 are the same as system 1. But in system 2, we have used a Moisture Sensor instead of Ultrasonic Sensor. The moisture sensor has been used for detecting the volumetric water content in the waste. Its cost is Rs. 153. Also, in the 2nd system we required more Jumper Wires for connections than that of the system 1. In system 2, we have used 7 to 8 Jumper Wires and its cost is Rs. 15.After this when we add the costs of all items used for system 2, we get the total cost Rs.3747.

4.1.3 Price Comparison

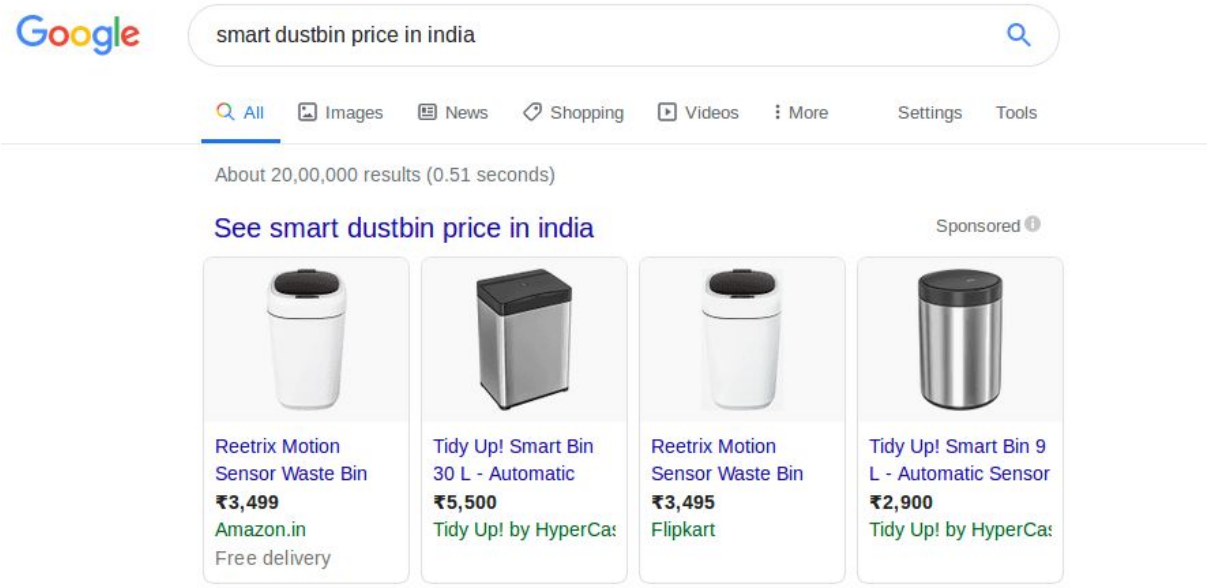

Figure 4.3: Smart dustbin price in India

4.2 Guide for Users

4.2.1 Introduction

Most dustbins in the market these days are operated by hand or foot. However, our product is of the latest design which automates the opening of the dustbin in System 1 and segregates the waste that is placed on top of the lid in System 2. The product can be used for indoor as well as outdoor purposes.

4.2.1.1 Graphic Illustration

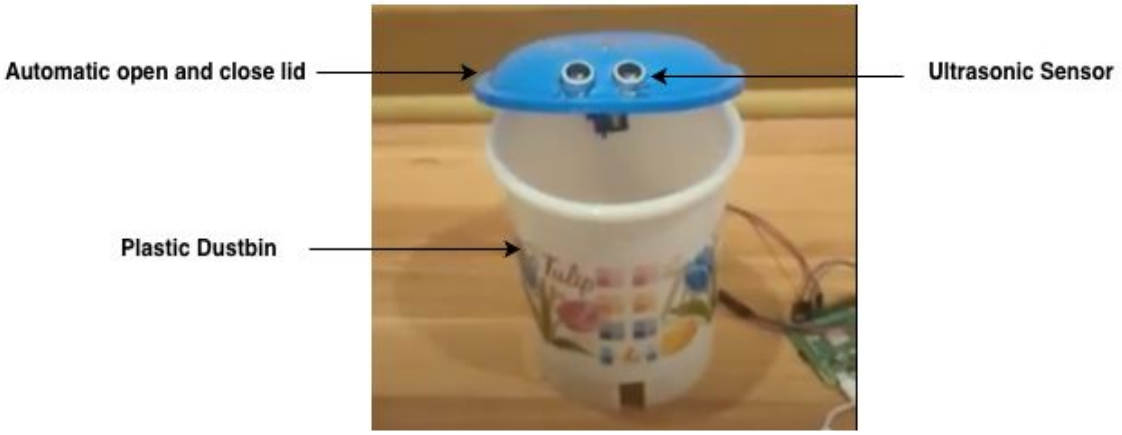

Figure 4.4 : System 1: Automatic Lid Opening System

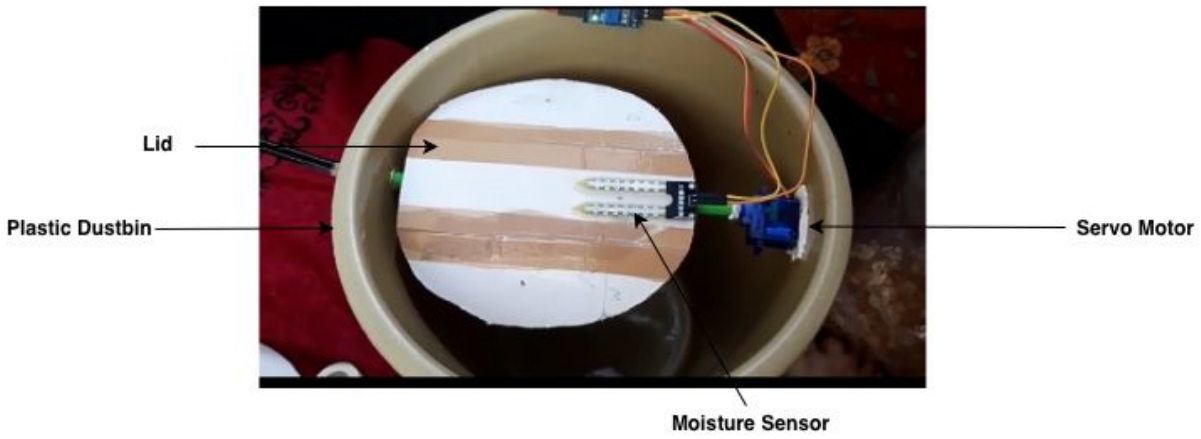

Figure 4.5: System 2: Automatic Segregation System

4.2.2 How To Use It?

4.2.1.1 System 1: Automatic Lid Opening System

1. To open the lid, stand at a distance of at most 1 meter from the dustbin.
2. Once the lid opens, throw the waste right into the trash can.
3. The lid closes automatically after 5 seconds.

4.2.1.2 System 2: Automatic Segregation System

1. Place your waste right above the moisture sensor indicated in the above figure so that it is accurately segregated into the right section.
2. Once you place the waste, it will automatically turn the lid down to the right section.
3. In this way, your waste goes to the right place!

4.2.3 Attention!

1. Use a dry fabric to clean the dustbin. Water or liquid can harm the electronic components in the bin. If the electronic components are damped, please turn off the power and put it in the ventilated place. Once it is dry, then activate it by turning on the power.
2. Do not press or flip the lid in the process of its opening and closing.
3. Replace the batteries once the power's out.
4. Do not use acidic batteries and alkaline batteries, or rechargeable batteries and disposable batteries all mixed up.
5. Do not repair or replace the accessories without explicit approval.

4.2.3.1 Solutions To Common Failure

FAULT	SOLUTION
Abnormal Opening Of The Lid	1. Check the battery whether it is put in accordance with the positive and negative indication. 2. Restart the power if needed. 3. Wipe the sensor area with a clean cloth.
Abnormal Closing Of The Lid	1. Check the electronic elements whether or not it's damped. If yes, put it in a vented place to make it dry. 2. Restart the power. 3. Check the lid whether it is blocked. If yes, remove that thing that is blocking it.
Lid Open Slowly	1. Battery power is low, replace it with a new one. 2. One of the batteries is put in the wrong

	direction.
Incorrect Segregation Of The Waste*	1. Place the waste exactly on top of the moisture sensor.

*THIS ALSO DEPENDS ON THE ACCURACY OF THE MOISTURE SENSOR.

4.3 Future Enhancements

4.3.1 Contactless Sensors

In the present system for the segregation of waste into the wet and dry, we are using a moisture sensor that needs to come in contact with the garbage to be segregated. Instead of using the contact moisture sensor, we can also use non-contact moisture sensor detectors, which do not get dirty, can withstand more temperatures, provide more accuracy and sensitivity to the alterations in the moisture content of the garbage thrown. But since the cost of such sensors is very high this will further add to the price of the dustbin and thus there will be a price and accuracy tradeoff.

4.3.2 Compact design and security

The proposed system as of yet does not have any security feature installed in it. Since the dustbin will be used in public places there are chances of the pi board and other electronic parts being stolen. We can also add a GPS system to constantly track the location of the pi board and have a secure lock case placed around the pi board for its protection. The design of any system can never be perfect, we are also working towards the design of the system so as to make it more and more compact and appealing to the
end-user.

4.3.3 Alert System

An end-user can install a simple mobile application or a chatbot depending on their convenience and open querying or via notifications they can receive a message regarding how full the dustbin is? This will help user-friendliness and let them know when the dustbin needs to be emptied. This can be done via the help of a few cloud-based APIs and using ultrasonic sensors and setting a limit for the different distances that fall into different categories. For instance, we can categorize as 1-2 meters - Full, 2-5 meters - x % full, Greater

than 5m Empty. We do realize the limitations to this and this can change according to the size and the place of usage of the dustbin.

4.3.4 The efficient transportation system for garbage collection

Since garbage collection is a major problem in the country with the help of the proposed system we can make the garbage collection activity more efficient. Presently, the garbage collection trucks from the municipal corporation have a predetermined time and route set for a particular location, this has a lot of inefficiency and wastage of time and fuel cost as many of the dustbins in the route are not even full to collect for the day. Instead, we can use the above-mentioned alert system and provide that data with the location of the dustbins and the dustbins that have a minimum (can be changed according to usage) threshold amount of garbage-filled data that can be sent continuously to the appropriate officials. After receiving the data there can be a routing protocol algorithm that can be used to find out the most efficient and less time-consuming path to collect garbage from those particular dustbins that have that threshold limit can be collected on the route. This will not only save time but also save the unnecessary trips that can be saved, and in turn save the fuel cost.

4.3.5 Waste segregation using CV

By installing a camera module on the lid we can get the image of the garbage that the user wants to throw in the dustbin. Using the pre-trained machine learning algorithm using computer vision by using pictures and labeling them wet and dry we can further input the live image to the algorithm and then based on the result of the algorithm the dry or wet section of the dustbin can open.

4.3.6 Using different categories of garbage by adding more categories and sensors

As different countries and different local governing bodies have different segregation categories for waste generators, our system poses a limitation as it can currently only segregate garbage into dry and wet categories. We can add multiple other sensors and create

other compartments in the bin to throw garbage of a particular category into their respective compartments with the help of sensors. For example, we can easily add a metal section that will store any metal items in the garbage into that compartment. We can further add a recycling compartment for plastic and papers so users can recycle more and solve the problem of the collection of these recyclable items at landfills.

Chapter 5 Conclusion

Through this prototype, we aim to propose an approach that is separation of wet and dry waste done automatically using sensors like moisture sensors. Condition of waste is the water content percentage. Still, there's more space for refinement of this design proposed which can strengthen the automated methodology and also prevent further possible deficiencies.

In succession, it will make the metropolitan areas and rural areas cleaner and the globe a good atmosphere to reside in. The prototype of the design that was required and suggested as a substitute for handling of waste strategy was fulfilled in success. By having the right people giving the appropriate and right support and encouragement and with slight modifications, it is very much achievable to expand this current model into an extensively operative and useful model.

References

[1] “2018 epi results | environmental performance index. (Accessed on 12/18/2019).

[2] “Raspberry pi technology, working and its applications. (Accessed on 12/18/2019).

[3] Ahamad, Nurul & Mohamad, Sarah & Midi, Nur Shahida & Yusoff, Siti & Abd Rahman, Faridah. (2019). Automatic household waste separation system based on resistance value and moisture content. Bulletin of Electrical Engineering and Informatics. 8. 10.11591/eei.v8i2.1491.

[4] Devi, R. S., Vijaykumar, V., and Muthumeena, M. “Waste segregation using deep learning algorithms.

[5] Gurjwar, R. (2019). “Smart trash can using iot.

[6] Poddar, Hitesh, et al. "Design of smart bin for smarter cities." *2017 Innovations in Power and Advanced Computing Technologies (i-PACT)*. IEEE, 2017.

[7] Mirchandani, Sahil, et al. "IoT enabled dustbins." *2017 International conference on big data, IoT and data science (BID)*. IEEE, 2017.

[8] Sharma, Swati, and Sarabjit Singh. "Smart Dustbin Management System." International journal of Engineering Sciences and Research Technology (IJESRT) 7.5 (2018).

[9] A. S. Wijaya, Z. Zainuddin, and M. Niswar, “Design a smart waste bin for smart waste management,” in 2017 5th International Conference on Instrumentation, Control, and Automation(ICA), pp. 62–66, IEEE, 2017

[10] H. Chugh, D. Singh, S. Shaik, and A. Singla, “Iot based smart bin,” International Research Journal of Engineering and Technology, vol. 4, no. 9, 2017

[11] G. K. Shyam, S. S. Manvi, and P. Bharti, “Smart waste management using internet-of-things (iot),” in 2017 2nd international conference on computing and communications technologies (ICCCT), pp. 199–203, IEEE, 2017

[12] A. Sharanya, U. Harika, N. Sriya and S. Kochuvila, "Automatic waste segregator," 2017 International Conference on Advances in Computing, Communications and Informatics (ICACCI), Udupi, 2017, pp. 1313-1319, doi: 10.1109/ICACCI.2017.8126023.

[13] C. Kolhatkar, B. Joshi, P. Choudhari and D. Bhuva, "Smart E-dustbin," 2018 International Conference on Smart City and Emerging Technology (ICSCET), Mumbai, 2018, pp. 1-3, doi: 10.1109/ICSCET.2018.8537245.

[14] Keerthana B, S. M. Raghavendran, Kalyani S, Suja P and V. K. G. Kalaiselvi, "Internet of Bins: Trash Management in India," 2017 2nd International Conference on Computing and Communications Technologies (ICCCT), Chennai, 2017, pp. 248-251, doi: 10.1109/ICCCT2.2017.7972277.

[15] A. S. Wijaya, Z. Zainuddin and M. Niswar, "Design a smart waste bin for smart waste management," 2017 5th International Conference on Instrumentation, Control, and Automation (ICA), Yogyakarta, 2017, pp. 62-66, doi: 10.1109/ICA.2017.8068414.

[16] Petr Fedchenkov, Arkady Zaslavsky, and Inna Sosunova. 2017. Enabling smart waste management with sensorized garbage bins and low power data communications network. In Proceedings of the Seventh International Conference on the Internet of Things (IoT '17). Association for Computing Machinery, New York, NY, USA, Article 28, 1–2.

[17] Samion, Norhafiza & Kaamin, Masiri & Adan, Nor & Nadiah, A & Kadir, Aslila & Tun, Universiti & Malaysia, Hussein & Raja, Parit & Pahat, Batu. (2018). The effectiveness of segregation recyclable materials by automated Motorized Bin. Journal of Advanced Manufacturing Technology. 12.

[18] Rohit, G. Sai, et al. "Smart Dual Dustbin Model for Waste Management in Smart Cities." *2018 3rd International Conference for Convergence in Technology (I2CT)*. IEEE, 2018.

[19] Kolhatkar, Chinmay, et al. "Smart E-dustbin." *2018 International Conference on Smart City and Emerging Technology (ICSCET)*. IEEE, 2018.

[20] Kumar, N. Sathish, et al. "IOT based smart garbage alert system using Arduino UNO." *2016 IEEE Region 10 Conference (TENCON)*. IEEE, 2016.