DESIGN AND FABRICATION OF AUTOMATIC WASTE SEPARATOR FOR HOME

18MT801- INDUSTRIAL PROJECT

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ACCREDITED BY NAAC WITH 'A' GRADE

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SRI KRISHA COLLEGE OF ENGINEERING AND TECHNOLOGY

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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER

EXTERNAL EXAMINER

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ABSTRACT

The Internet of Things (IoT) has a significant impact on research for real time data monitoring. Waste segregation and control based on IoT is a significant task in metropolitan cities and municipal corporations. It is a needed process in metro cities and urban areas due to spreading of diseases. The advancement of key enabling technologies dependent on IoT enabled devices. Waste segregation and disposal mechanisms are among the severe problems associated with smart cities, which have a negative impact on our society and health. The trash bin monitoring and control is carried out through a microcontroller is proposed here. The main objective of this project is to design and fabricate of Automatic Waste Separator for home. The proposed work is used to segregate the waste product as wet, dry and metal. The details are sent as message to the user and the Central Municipality. This message indicates the garbage bin is full so that they can collect it from the customer's house. An IoT enabled smart bin utilizes a microcontroller with multiple sensors. In this study, inductive proximity sensors are used to detect metal trash, while temperature and humidity sensors are used to separate dry and wet wastes. The capacity of the bin is analyzed using Infrared sensors. IoT with sensor module allows remote control of real-time monitoring of data. While Bluetooth allows for short-range waste monitoring via a mobile app. Segregation makes it attainable to utilize and recycle the waste effectively.

PROJECT COMPLETION CERTIFICATE

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The Era of Internet has advanced both Information and communication systems for many computer applications. Traditional communication processes, say message transfer protocols, Machine-to-Machine (M2M), real-time audio/video processing, sensory data transfer and other things are all rapidly improving every day. A modern-day problem in the modern world is the accumulation of garbagewastes all around us. Different types of garbage were easier to classify in the past,and people living at the time had more time to sort the waste into the appropriate category. However, as the world progresses and modernity emerges, the types ofgarbage produced become more varied, and people have less and less time to identify the wastes. In a city or in house the waste collection and management isvery tedious tasks. Dedicated attention to the amount of waste generated and howit is handled is a challenge in this information and technology era. It is rapidly improving every day. It is essential to concentrate on waste management by segregating it. Nowadays companies are operating at low costs and provide residents and businesses with the same high-quality service regardless of their location.

1.2 OBJECTIVE OF PROJECT WORK

The objective of this project is to design and fabricate an Internet of Things (IOT) based waste segregation and management system for smart home automation systems. The proposed work focuses on segregating waste based on its parameters working of the product using different types of waste and this work categories the waste as dry, wet and metal by observing the classification of waste. When the bin is filled the sensor sends a signal and sends a message to the user. It is also an objective of this work.

The literature reviews depict solid waste segregation and management methods need certain hybrid protocols for effective handling of solid waste in application to smart cities. This work proposed an effective solution for this problem based on IoT technology. The following are the main focus of this project.

1. Hybrid architecture to monitor the household trash bin.
2. Intelligent centralized controlling unit will monitor the household bin capacity. Sensors are used to monitor the status of each trash can in the house and can identify and split the type of waste.
3. To collect household trash and notify the municipal network for collection, using a centralized controller with a Bluetooth module is embedded.

1.3 ORGANIZATION OF CHAPTERS

Introduction

The concept of automatic waste segregation process and its various types are discussed in this chapter.

Literature Review

Researches in various journals are made to understand different technologies and mechanism implemented in automatic waste segregation machine.

Material and Methods

In this chapter, the materials required for the waste segregation machine, the methods by which it can be made are discussed.

Design Calculation

The selection of components is made according to the calculation and is verified.

System Architecture

In this chapter, assembly and interfacing of hardware components based on the design setup is discussed.

Results and Discussions

In this chapter, the outcome of the project, the results when tested with various test subjects are discussed in detail.

Cost of the project

In this chapter, the bill of materials and the cost of the waste segregation machine are discussed.

Conclusion

This chapter concludes the working of the automatic waste segregation and management machine.

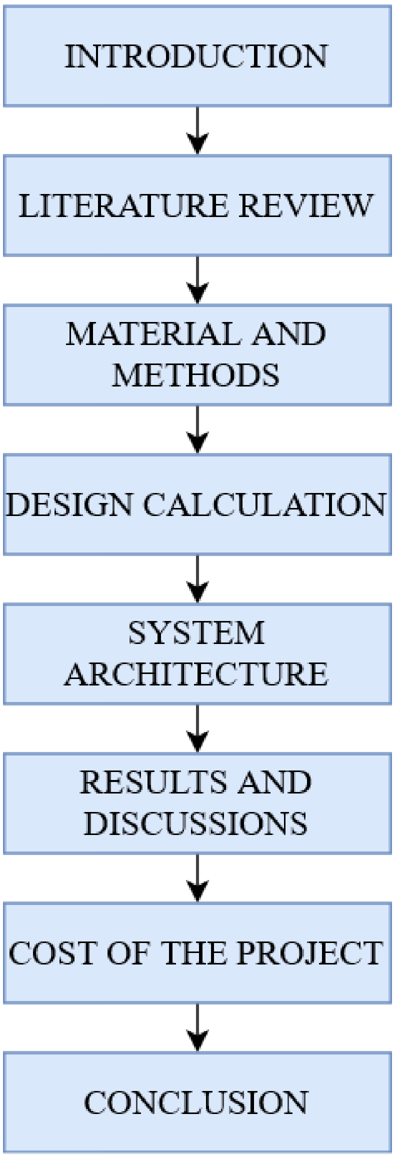

Fig 1.1 Organization of Chapters

1.4 CONCLUSION

Thus, the introduction to this project, the problems faced in the day-to-day life,the objective of the said project has been discussed in detail in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Literature review in a project helps us to understand what previous works intended to do, what major differences the two different reviews have, what can be improved from the previous projects. A well-versed knowledge with the project related literature reviews can help in improving the outcome of the current project.

2.2 LITERATURE REVIEW

The architecture of the garbage system is done in an efficient manner such that the process of garbage monitoring and segregation is done in an easier way [1].

Contamination is addressed in order to achieve efficient recycling. The microcontroller is used for controlling purposes. The supervision of sensors in a stage-by-stage and better working method is described. The effectiveness of using an LCD with an Arduino microcontroller for trash classification is discussed [2].

The architecture for monitoring the garbage system using IoT and image processing is discussed. The operation of the garbage overflow system and its monitoring system is detailed. The data is also sent to the appropriate officials for action [3].

The garbage monitoring system study is described. It demonstrated garbage separation and collection in real time application. It is proposed to design a sensor network that detects the target and sends signals to the board. If the bin is frequently filled by the user, sensors will send a signal to the nearest vehicle driver [4].

An app is made with the help of Thing-Speak to send the user about the level of the garbage bin [5].

To automate the process, the IoT-enabled automatic waste segregation and management system uses a mechanical system. Every household feels compelled to use two different trash cans and sort the garbage manually. This project helps the user to avoid the need for a second trash bin and human interaction during the waste separation process. Based on data gathered from the sensors the type of trash is also displayed on the LCD display. When the trash trays are full,ultrasonic sensors on the trays send data to the node MCU, which is then transmitted to the user's phone via an open-source app [6].

The information detailing the integration of the different sensors to the Arduino microcontroller is proposed in this paper. The various types of wastes and segregation is discussed [7].

This paper discussed the control of environmental issues such as inadequate wastetreatment, collection, and recycling. A review of garbage bin tracking is presented. When the bins are full, an alert message is sent so that the garbage can be properly managed. Components such as an ultrasonic sensor, a node MCU, a servo motor, and microcontrollers are employed [8].

Communication and sensing are handled by the various modules. The use of ultrasonic sensors to monitor the amount of waste in the bin and gas sensors to detect the stench of the gases is proposed. The sensors are built in the AVR microcontroller, which connects to the LCD display and displays the bin status [9].

A review of garbage bin tracking is presented. When the bins are full, an alert message is sent so that the garbage can be properly managed. Components such as an ultrasonic sensor, a node MCU, a servo motor, and microcontrollers are employed. The paper describes how to create a smart bin to communicate with the user and take appropriate action [10].

The paper discussed how a smart bin sends information to the end user so that they can take the appropriate action. The sensors are used to keep track of how well the garbage is being collected. The device's decisions are updated on a specified server using the Node MCU. The device's status can be monitored [11].

The process of garbage monitoring using IoT is detailed. IR sensor is used to identify the level of the garbage bins and notifies the user about the level [12].

2.3 CONCLUSION

Thus, the study on the literature review of various projects has been successfullycompleted and valuable information has been obtained which will be necessary for the project.

CHAPTER 3

MATERIALS AND METHODS

3.1 INTRODUCTION

To fabricate a product, it is necessary to understand materials details. It is necessary to develop and model the product based on the requirement of a product to operate in an efficient way. The following sessions described the materials and the methods adopted in our project work.

3.2 COMPONENTS REQUIRED

The proposed system comprises following components like sensors, Microcontrollers, motors and communication module. The components details and its specifications are given below.

3.2.1 NodeMCU ESP8266

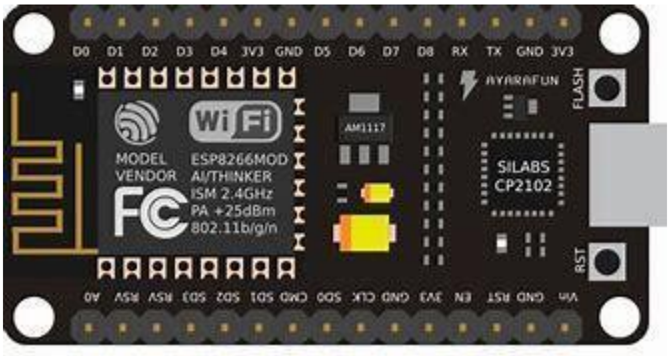

Fig 3.1 NodeMCU ESP8266

The NodeMCU ESP8266 is employed as an integrated semiconductor in this application. This will support the IoT environment by connecting the Arduino microcontroller to the internet. It is made up of 30 pins. There are 9 digital pins and 1 analogue pin here. The bin details are wirelessly communicated to the centralized control unit which in turn will provide the mechanism for proper disposal of waste.

3.2.2 Arduino UNO Microcontroller

Fig 3.2 Arduino UNO Microcontroller

The Arduino UNO is a microcontroller board. It is a piece of open-source hardware that includes a physical board as well as software with an IDE. As a result, the board will be easier to program. The board includes a USB port for easy uploading of software code. The Arduino Uno board provides the control for the interfaces and also it controls the sensors functioning.

This board includes a Wi-Fi module as well as digital and analogue pins for interacting with other devices. The user can gain access to information such as type of waste and bin level filling details by using Node MCU. The ESP8266 model was chosen for the proposed work. Node MCU(ESP8266) is easy to integrate with the Arduino Uno board.

On a single board, it integrates GPIO, PWM, IIC, 1-Wire, and ADC. As a result, it facilitates the coding of functions and the delivery of networking functionalityto the end user.

Specifications:

Operating Voltage: 5 Volts

• Input Voltage: 7 to 20 Volts

• Digital I/O Pins: 14 (of which 6 can provide PWM output)

• Analog Input Pins: 6

• DC Current per I/O Pin: 20 mA

• DC Current for 3.3V Pin: 50 mA

• Flash Memory: 32 KB of which 0.5 KB used by bootloader

• SRAM: 2 KB EEPROM: 1 KB

• Clock Speed: 16 MHz

• Weight: 25 g

3.2.3 Inductive Proximity Sensor

Fig 3.3 Inductive Proximity Sensor

Inductive proximity sensor is a type of sensor that detects metal targets using theprinciple of electromagnetic induction. This sensor detects metal waste and it does not require physical touch. Thus, it may be used to segregate metal wastes from other waste and it is proposed in our project.

3.2.4 Rain & Humidity Sensor

Fig 3.4 Rain & Humidity Sensor

Rain and humidity sensor used to detect and measure water vapor. TE Connectivity (TE) manufactures a complete range of calibrated and amplified RH sensor products to measure relative humidity. To monitor temperature, the sensor has a specific negative temperature coefficient. This sensor is recalibrated when it is created, so it can be used with other devices. The wet garbage from the bins can be detected with this sensor.

3.2.5 Infrared (IR) Sensor

Fig 3.5 IR Sensor

An infrared (IR) sensor is an electronic device that measures and detects infraredradiation in its surrounding environment. This sensor is integrated with the machine to identify whether the garbage bin is full or not. In our work, we proposed to segregate 3 types of waste where we placed 3 IR sensors in each binto monitor the level of bin filling.

3.2.6 Liquid Crystal Display

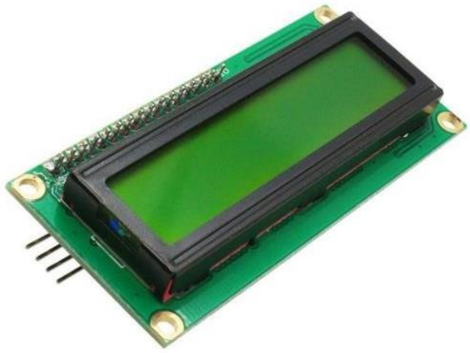

Fig 3.6 Liquid Crystal Display

A liquid-crystal display is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead usinga backlight or reflector to produce images in color or monochrome. This is used to display the various details about the sensors.

3.3 PROPOSED BLOCK DIAGRAM

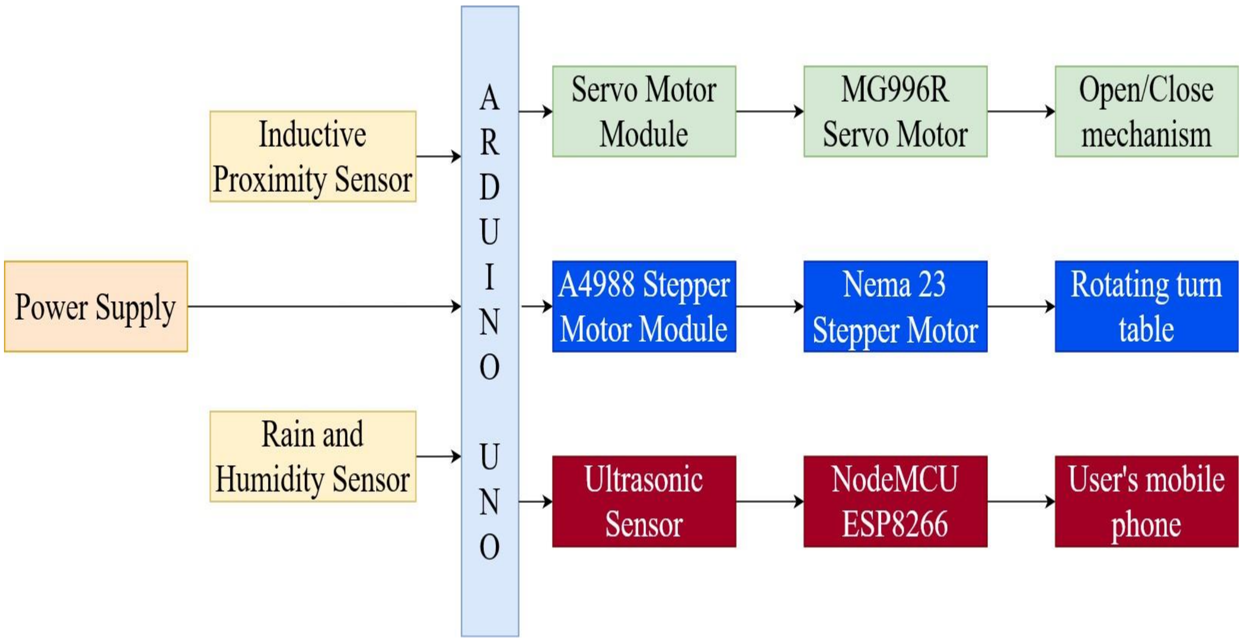

Fig 3.7 Block Diagram of Automatic Waste Segregation Machine

Fig 3.7 explains the block diagram of the automatic waste segregation machine in brief. A power supply is connected to the Arduino Uno board which provides the necessary power to operate the automatic waste segregation machine. Two sensors: inductive proximity sensor and rain and humidity sensor are connected to the Arduino Uno board for the necessary functions of identifying the type of waste. Necessary stepper and servo motor modules are connected to the respective stepper and servo motors to operate the automatic waste segregation machine efficiently.

3.4 PROPOSED SYSTEM MODEL

An ultrasonic sensor is used to calculate the distance between objects. The sensoremits ultrasonic vibrations. The time between emission and reception is used to calculate the distance. Each bin has an ultrasonic sensor that warns the user whenit is full. The ultrasonic sensor is highly accurate and does not miss the target. The vibrations produced by this sensor are of extremely high quality, ensuring that no failures occur. Vibrations are sent when an object (trash) is detected by the ultrasonic sensor. It will search for any objects that are blocking its field and,if found, it will send a signal to the board. In this work, an ultrasonic sensor operates in free run mode.

A rain and humidity sensor is used to detect the temperature and humid state. Humidity is the presence of water within the air. The amount of water vapor thatis present in the air can affect not only personal comfort but can also affect variousmanufacturing processes. The humidity levels must be properly controlled and monitored to ensure proper wafer processing. Humidity control is also frequently important for incubators, respiratory equipment, sterilizers, and biological products. In addition, the presence of water vapor may also influence various other chemical, biological, and physical processes. The sensor contains an 8-bit microcontroller and a Negative temperature coefficient. The data received as serial data is efficient by the microcontroller. The values are sent as serial data to the Arduino UNO microcontroller. This sensor is capable of detecting moisture garbage from bins. However, the accuracy and functionality remain unchanged. The Temperature and Humidity will measure temperature from 0°C to 50°C andhumidity from 20% to 90% with a 1°C and 1% accuracy. Because it is factory calibrated and can easily connect to the board and set.

The servomechanism, abbreviated as servo, is a rotating actuator that is used for precise control movements of linear or angular position, velocity and acceleration. The servo motor also contains a suitable motor which is coupled to a sensor which is used for the feedback of the position. The servo motor is suitable to use in closed-loop control systems. This project makes use of servo motors for the purpose of controlling the flap. This aids in the precise control of the parameters required. For accurate flap control, the servo motor consists of a sensor connected with a conventional motor.

3.5 MOTORS USED IN THE MODEL

A brushless DC motor is contained within the stepper motor. It works on the basisof electromagnetism. This differs from a servo motor in that a complete rotationof the motor is broken into a number of smaller phases to allow for greater processcontrol. The movement here is in a stepwise manner hence the name stepper motor. Here a number of coils are arranged in phases, when given power would cause the motor in a stepwise manner. The stepper motor converts a pulsing electrical current, controlled by a stepper motor driver, into precise one-step movements of this gear-like toothed component around a central shaft. Each of these stepper motor pulses moves the rotor through one precise and fixed increment of a full turn. Stepper motor is used here because the accuracy and precision of this motor is high. With a computer controlled stepping you can achieve very precise positioning and/or speed control. However, the higher current consumption compared to the DC motor is the drawback. The stepper motors are preferred in our work because stepper motors have high torque at lower speeds, thus serving our need of having lower speed for the disc movement with higher accuracy.

3.6 PROPOSED WORK FLOW DIAGRAM

The figure 3.8 is a flowchart which depicts the workflow of the proposed model after it has been fabricated to test it and find out if any errors have occurred and proceed further after rectifying it. The process begins with the various types of sensors detecting the waste and then the program makes the table to operate as per the needs with the waste finally falling in the respective dustbin at the end.

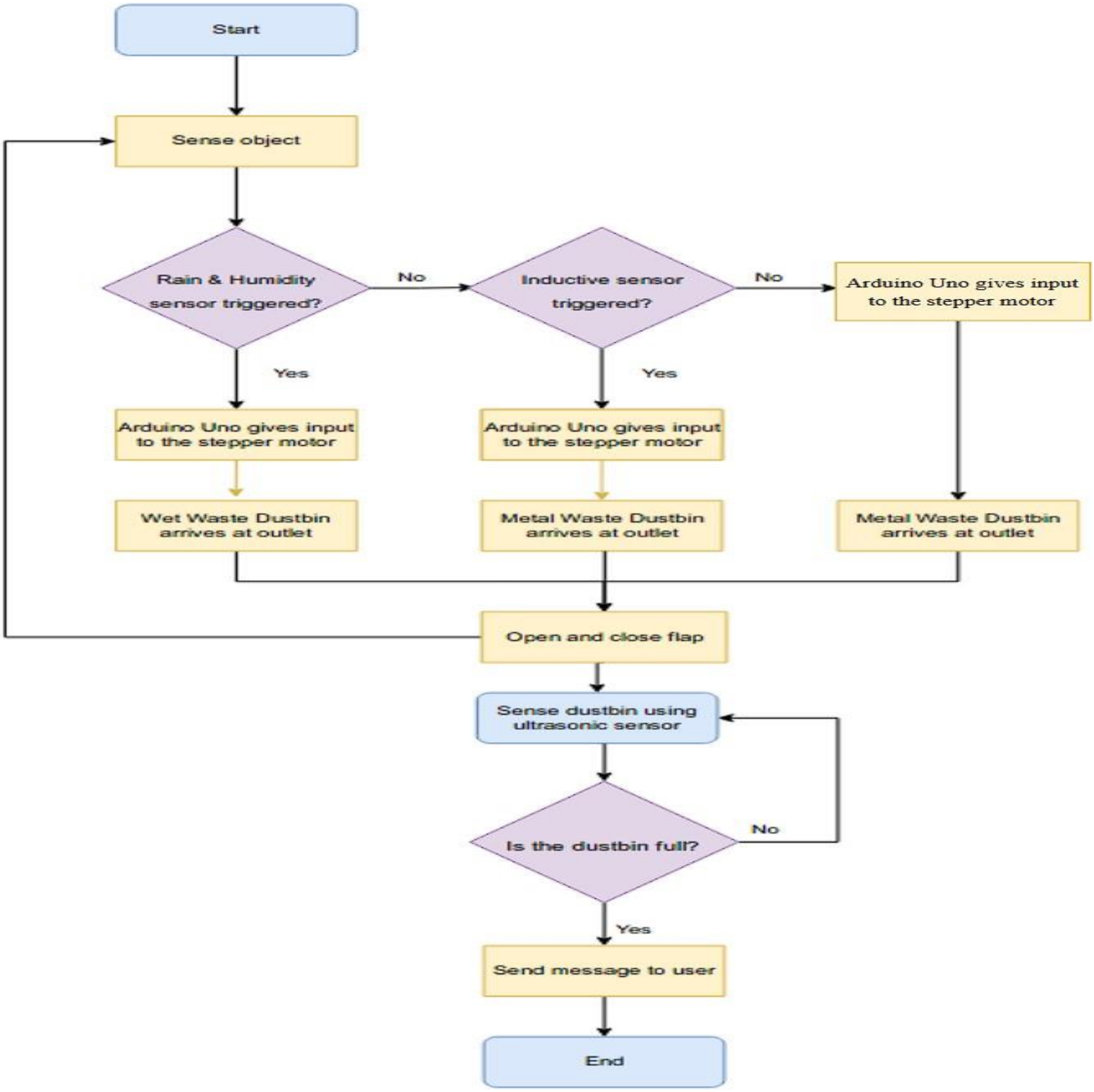

Fig 3.8 Proposed Work Flow Diagram

3.7 PROPOSED IOT SYSTEM WORKING

Each house or an area has a unit which is connected to a Central Monitoring Unit.When the dustbin is full in any one of the houses or the area, a notification is sentto the Central Monitoring Unit from the house or the area by the help of Internetof Things (IOT). When the Central Monitoring Unit gets a notification from one of the houses, it sends a notification to the Municipal Office main control unit. Itgives information to collect the trash from that area, thus making it a very efficient method of all. The segregated waste is properly managed by the centralized control unit. It makes it easier to dispose of.

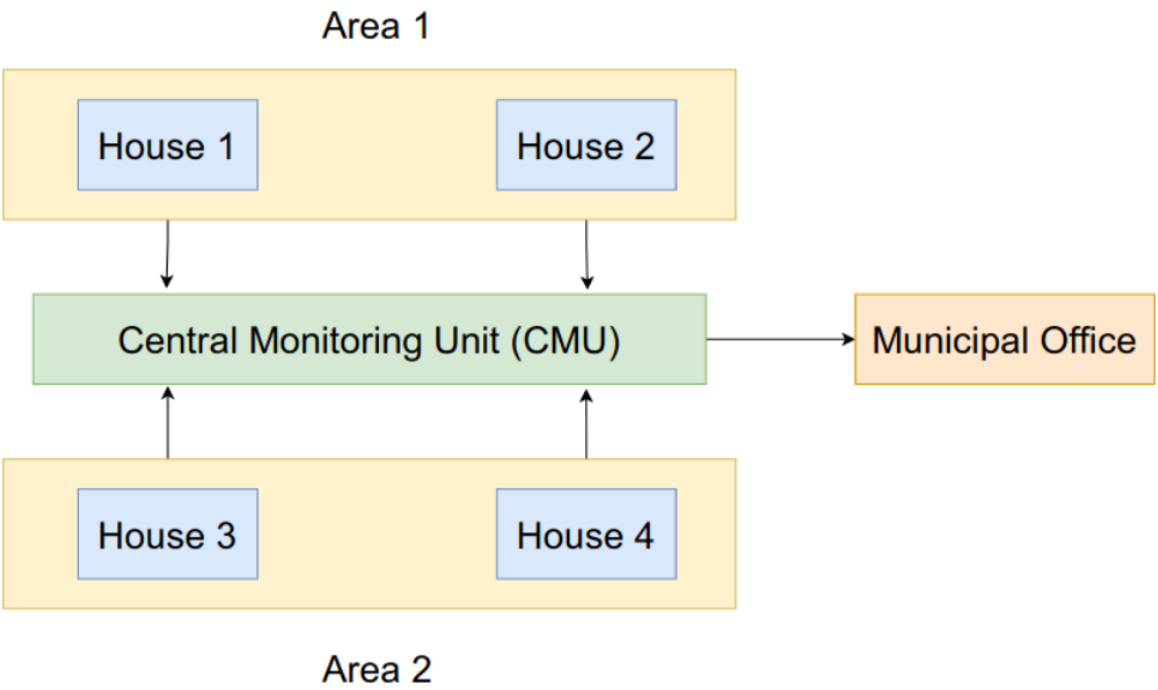

Fig 3.9 Proposed IOT Working System

3.8 ALGORITHM

The algorithm of the working model is as follows:

1. Start segregating the waste from the hopper.
2. Analyze the waste using sensors.
3. The proposed model is designed to identify the metal, wet and dry waste.

4. The waste is dropped appropriate to the bin placed in the turntable.
5. Identify the capacity of the bin through an ultrasonic sensor.
6. If the bin is full the detail is messaged to the municipal office zone.
7. Replace the new bin on the turntable.
8. Then the process proceeds from the first.
9. Similarly, the other bins are verified.

3.9 CONCLUSION

Thus, the materials needed for the project, it controls and waste segregation and management are explained. The necessary components along with its function are described in this chapter. The working and the flow of our proposed work is described in this chapter.

CHAPTER 4

DESIGN CALCULATION

4.1 INTRODUCTION

The design calculation for the various mechanisms is explained in detail. The parameters required for choosing an electronic component suitable for working of those mechanisms also mentioned in this chapter.

4.2 CALCULATION

4.2.1 Servo Motor

Mechanical efficiency of a motor = 0.92

Length of the arc of sector = 104.67mm

Torque for servo motor = 0.017 kg-cm

Coefficient of friction = 0.1

External force excluded = 0 N

4.2.2 Stepper Motor

Diameter of index table, DT = 400mm

Index table thickness, LT = 100mm

Diameter of load, DW = 150mm

Thickness of load, LW = 150mm

Material of table and load (Iron) = 7.9×10^3 kg/m^3

Number of loads = 3

Distance from center of index table to center of load, C = 150 mm

Positioning angle = 120°

Resolution, $\Delta\theta = 0.04°$

Positioning period, t0 = 0.4s

Required resolution, s = 0.02° x 2 (pulses)

Total Inertia = 0.3922 kg.m2

4.2.3 Column Calculation

Breadth of column, b = 80mm

Length of column = 1mm

Total mass = 2kg

Force = 19.62N

Acceleration & Deceleration period, t1 = 0.1s

4.2.4 Bending Stress Calculation

Yield strength of steel = 420 N/mm^2

Moment of resistance = 8025.76 N-mm

Moment of Inertia = 0.82mm

4.2.5 Column Calculation

Mass of disc = 3000g

Mass of all 3 dustbins = 750g

Mass of total waste = 600g

Mass of stepper motor = 5000g

Mass of plate = 3000g

Area of circle = 6mm

Area of cross section of circle = 7 mm^2

4.2.6 Circular Disc Calculation

Mass of 3 no. of dustbin = 900g

Mass of 3 no. of waste (approx.) = 600g

Total mass = 900g + 600g = 1650g

Total mass, m = 1.65kg

F = W = m x g

F = W = 1.65 x 9.81

F = W = 15.7N

y = t/2

W = 15.7 N

t = ?

Bending Stress

M/I = σ/y

$\sigma = \sigma_y$ / FOS

σ_y = Yield strength of steel = 250 N/mm^2

FOS = 2 (Ductile material)

σ = 250/2 = 125 N/mm^2

M = Moment of resistance for simply supported beam

M = Wl/4 = (15.7 x 400)/4 = 1570N-mm

I = Moment of inertia for rectangle = $bt^3/12$

y = t/2

M/I = σ/y

$1570/(400t^3/12) = 125/(t/2)$

$t^2 = 18840/100000$

$t = 0.43mm$

For safety and allowance concerns, the value $t = 0.43mm$ is rounded off to 3mm to the thickness of the plate. Hence, the design for the circular disk is safe.

4.2.7 Circular Flap Calculation

Mass of waste (approx.) = 0.25 kg

Mass of servo motor = 0.25kg

Total mass = 0.25kg + 0.25kg

Total mass, m = 0.5kg

$F = W = m \times g$

$W = 0.5 \times 9.81$

$W = 5N$

$t =?$

Bending Stress

$M/I = \sigma/y$

$\sigma = \sigma_y / FOS$

σ_y = Yield strength of steel = 250 N/mm^2

FOS = 2 (Ductile material)

$\sigma = 250/2 = 125\ N/mm^2$

M = Moment of resistance for simply supported beam

$M = Wl/4 = (5 \times 100)/4 = 125$ N-mm

I = Moment of inertia for rectangle = $bt^3/12$

$y = t/2$

$M/I = \sigma/y$

$(125 \times 12)/(100t^3) = (125 \times 2)/t$

$t^2 = 1500/25000$

$t = 0.24mm$

For safety and allowance concerns, t = 0.24mm is rounded off to 2mm to the thickness of the table. Hence, the design for the circular flap is safe.

4.3 CONCLUSION

Thus, the design calculation for the required component motors have been discussed briefly in this chapter. Based on the design calculation the hardware components assembly drawing is given in the next chapter.

CHAPTER 5

SYSTEM ARCHITECTURE

5.1 INTRODUCTION

The architecture of the system is an important part since it gives a clear idea on how the system should be and how it should be designed to be very efficient. It is mainly based on the design calculation, the assembly drawing, 2D & 3D models are discussed in this chapter.

5.2 2D & 3D

The 2D & 3D model of the system based on the design calculations are shown in the Figure 5.1 and Figure 5.2 respectively.

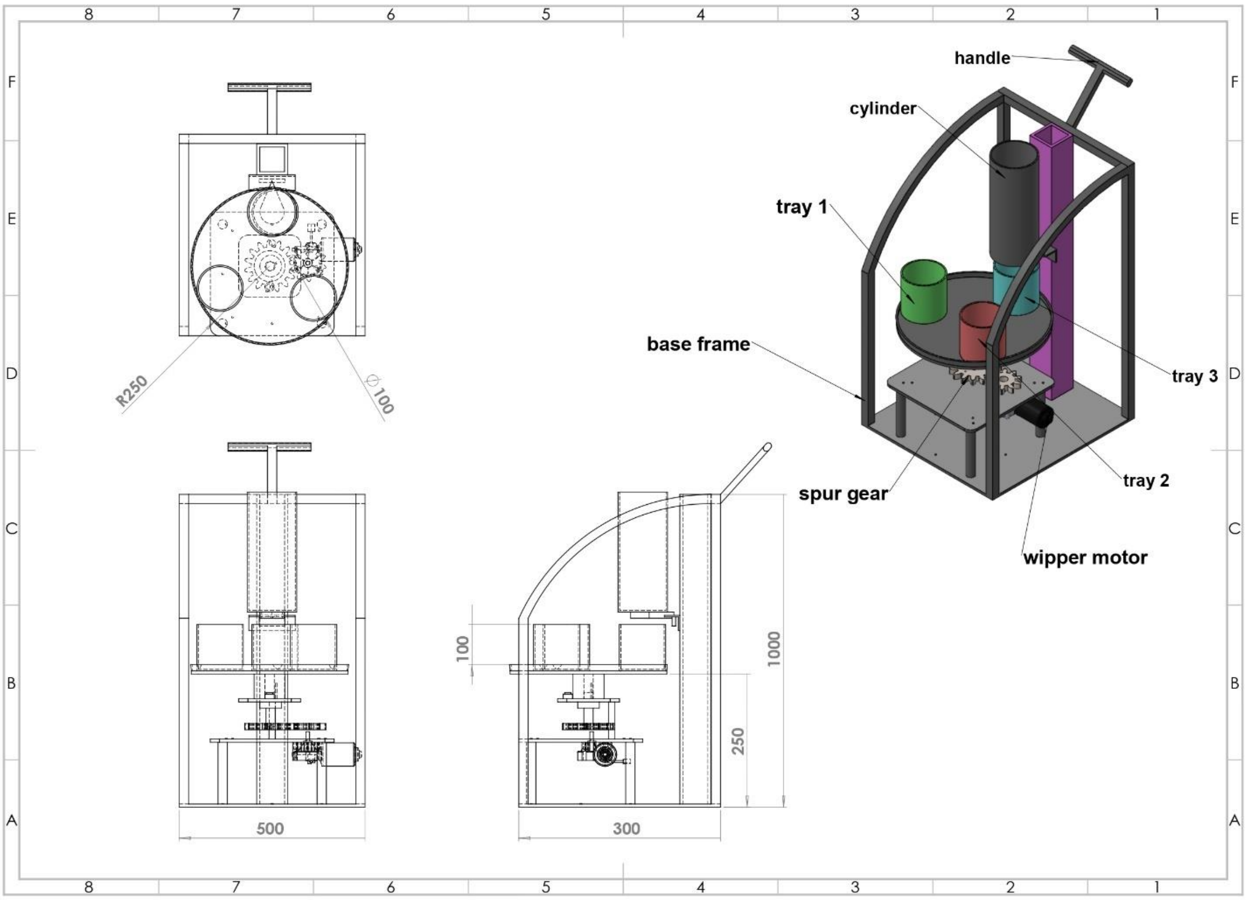

Fig 5.1 Proposed 2D model

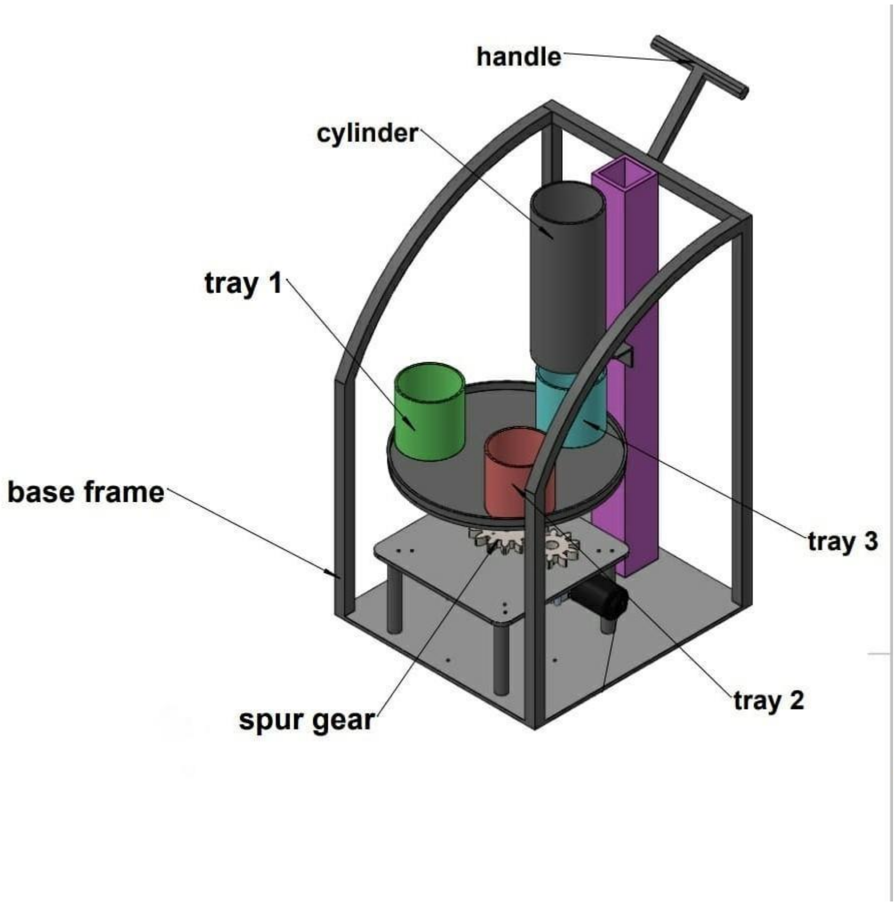

Fig 5.2 Proposed 3D model

5.3 PROCESS SHEET

The process sheet in Table 5.1 explains the necessary components required to fabricate the automatic waste segregation machine.

Table 5.1 Process Sheet

S NO.	COMPONENTS REQUIRED	SPECIFICATION
1	Stepper Motor	Oriental Motors RK564BC-N36, 5-Phase Micro-stepping motor
2	Servo Motor	Tower Pro MG90 Servo Motor
3	NodeMCU	ESP8266
4	Arduino UNO	ATmega328p based board
5	Inductive Proximity Sensor	M8 Inductive Proximity sensor
6	IR Sensor	LM393 IR Sensor

7	Temperature Humidity Sensor	Evelta SHT20 I2C Rain & Humidity Sensor
8	Liquid Crystal Display	16x2 Alphanumeric Display JHD162A
9	Wi-Fi Module	HC-05, RF Transceiver Module

5.4 ELECTRONIC CIRCUIT

The electronic circuit which operates the automatic waste segregation machine uses Arduino Uno board, various relays and voltage regulators which are shownin the Figure 5.2. The electronic circuit also includes a noise buzzer to give alerts regarding to the various sensors used.

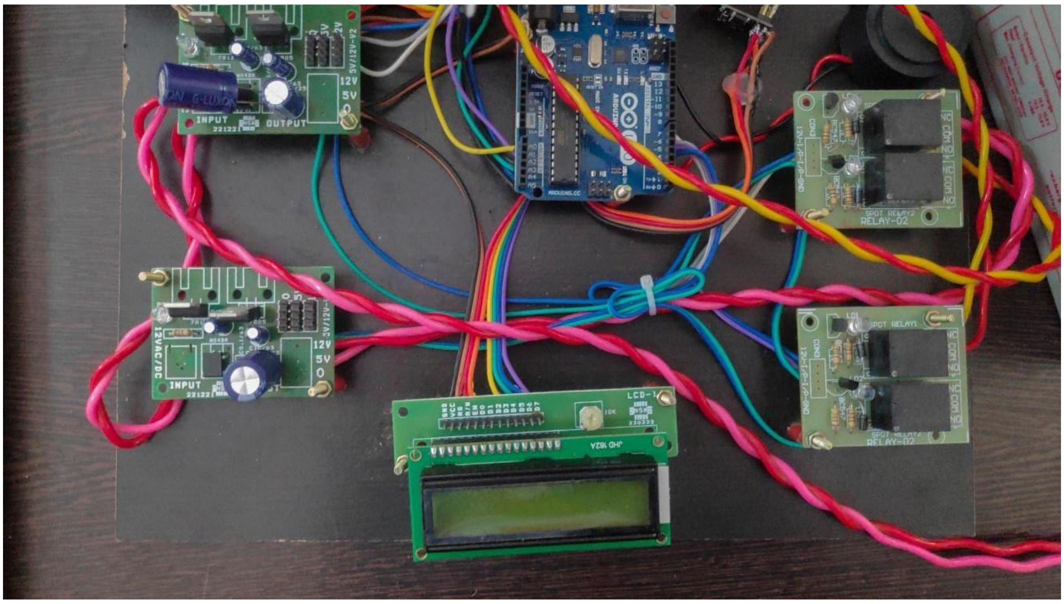

Fig 5.3 Electronic Circuit of the system

5.5 OUTCOME OF THE PROJECT

Fig 5.4 Experimental Prototype

Fig 5.3 shows the picture of the experimental prototype. When tested, the three sensors used here do a good job of identifying the type of waste dropped in the bin and help us to separate the wastes. With a delay time of 2 to 3 seconds for identifying the type of waste, the entire operation takes a total of 7 seconds. With two sensors being non-contact, and only the temperature and humidity sensor being contact sensors, a better alternative to this type of sensor might be added to our project in the future. With the Wi-Fi module getting a voltage of 3V, all the other components require a voltage of 5V. Hence to supply a constant power source two voltage boards are connected to the power supply with two voltage regulators (7805 and 7812) respectively. The 16x2 LCD does a good job of indicating to the user the type of waste dropped here and indicates to them if the bin is full. The 2 channel relays used for controlling the motors take a delay time of 3 seconds which can be reduced to two seconds in the future.

5.6 CONCLUSION

Thus, the architecture of the system and the electronic circuit of the system are briefly shown in this chapter.

CHAPTER 6

COST OF THE PROJECT

6.1 INTRODUCTION

When fabricating a product, along with the efficiency of the product, the cost estimated to fabricate the product should also be taken into account. Cost of the product plays an important role in fabricating and marketing the product effectively. The better the cost estimation of the product, the better the response it receives in the market when it is selling.

6.2 BILL OF MATERIALS

Table 6.1 Bill of Materials

S NO.	COMPONENTS REQUIRED	UNITS	COST (in Rupees)
1	Stepper Motor	1	₹5500
2	Servo Motor	1	₹599
3	NodeMCU	1	₹362
4	Arduino UNO	1	₹1385
5	Inductive Proximity Sensor	1	₹550
6	IR Sensor	4	₹140
7	Temperature Humidity Sensor	1	₹1108
8	Liquid Crystal Display	1	₹230
9	Wi-Fi Module	1	₹454
10	Fabrication		₹5500
			~ ₹15500

6.3 CONCLUSION

Thus, the cost of various materials, sensors, the fabrication cost have beendiscussed in this chapter.

CHAPTER 7

CONCLUSION

7.1 INTRODUCTION

The product after fabricated, tested out and if no errors are found, it was then released for the public use which will greatly help in the segregation of the different types of waste which in turn will be effective while it reaches the stage of recycling process. The domestic garbage separator functions as a smart bin, separating waste into three categories: wet, dry, and metallic. The garbage bin module is also connected to the centralized control unit of the smart home to alert the user about the garbage bin.

7.2 FUTURE SCOPES

To minimize trash size and make recycling easier, the inlet can be modified to include a crusher mechanism. The crusher can be automated with the help of smart homes. When the bin is filled, the bins can be upgraded to include a packing mechanism. To avoid leakage, a dryer mechanism might be used to dry the moist waste. An odor detection sensor can be used to alert the user to the presence of a noxious odor. Solar panels can be utilized to provide power. The temperature and humidity sensor can be replaced with a better sensor which does not require to sense the object when in contact only.

7.3 CONCLUSION

Thus, the conclusion of the project, possible future scopes of the said project havebeen discussed in this chapter.

REFERENCES

1. Akhila Joseph, Anjali, Suhaila B.M., Mahesh B.L. “Smart garbage management system”, International Research Journal of Engineering and Technology (IRJET), Volume: 07 Issue: 06 | June 2020.
2. Chethan Siddeshwar K R, Gunasagar, C M, Hemanth S, “Automated Waste Segregator”, Visvesvaraya Technological University, 2020-2021
3. Chetna Kaushal, Anshu Singla "Architecture for Garbage Monitoring System using Integrated Technology"15 September 2020.
4. Lilyan Anthony, Pradnya Chavan, Astrid Ferreira, Prerana Gadhave, Archana Shirke, “Garbage Monitoring System for Smart Cities,” International Journal of Advanced Technology in Engineering and Science, April 2017, Vol. No.5, Issue No.04
5. Mustafa M.R and Ku Azir K.N.F, “Smart Bin: Internet-of-Things Garbage Monitoring System”, MATEC Web of Conferences 140, 01030 (2017)
6. Namratha A M, Nandini S, Nanditha K, “Automatic Waste Management and segregation system using IoT” International Journal of Engineering and Technology, NCCDS-2021 Conference Proceedings.
7. Parkash Tambare, Prabu Venkatachalam, “IoT Based Waste Management for Smart City” Vol. 4 Issue 2 February 2016.
8. Padmakshi Venkateshwara Rao, Pathan Mohammed Abdul Azeez “IoT based waste management for smart cities” International conference on computer communication and information (ICCCI), Coimbatore, India, Jan 22-24, 2020.
9. Puja K. Dhotrel, A. L. Borker “A Review on Smart Garbage Monitoring System Using Internet of Things (IOTs)” September 2017 ISBN:978-93-86171-66-5
10. Saminathan T, Akash Musipatla, “IoT based Automated Waste Segregator for Efficient Recycling”, International Journal of Innovative Technology and Exploring Engineering, Volume-8 Issue-6S, April2019.
11. T. Saminathan, Akash Musipatla, P. Manideep Varma, P. Shahid Khan, G. Mahesh Kumar, “IOT Based Automated Waste Segregator for Efficient Recycling”, Oct 2019
12. Vikrant Bhor, Pankaj Morajkar, Maheshwar Gurav, Dishant Pandya, Amol Deshpande, “Smart Garbage Management System” International Journal of Engineering Research & Technology ISSN: 2278-0181 IJERTV4IS031

ANNEXURE I

```
// include the library code:
#include <LiquidCrystal.h>
#include <SoftwareSerial.h>
#define USE_ARDUINO_INTERRUPTS true    // Set-up low-level
    interrupts for most acurate BPM math.
#include <PulseSensorPlayground.h>     // Includes the
    PulseSensorPlayground Library.
#include <Wire.h>


#define RX 2
#define TX 3

// initialize the library by associating any needed LCD interface pin
// with the arduino pin number it is connected to
const int rs = 13, en = 12, d4 = 11, d5 = 10, d6 = 9, d7 = 8;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);


//int ThermistorPin = A2;
//int Vo;
//float R1 = 1000;
//float logR2, R2, T;
//float c1 = 1.009249522e-03, c2 = 2.378405444e-04, c3 =
    2.019202697e-07;
```

```
String AP = "iot project";       // CHANGE ME
String PASS = "123123123"; // CHANGE ME
String API = "TDO8ZC5F69BCJILX";   // CHANGE ME
String HOST = "api.thingspeak.com";
String PORT = "80";
String field1 = "field1";
String field2 = "field2";
String field3 = "field3";
String field4 = "field4";
int countTrueCommand;
int countTimeCommand;
boolean found = false;

int dry_sensor = A0;
int wet_sensor = A1;
int metal_sensor = A2;

int drylevel_sensor = A3;
int wetlevel_sensor = A4;
int metallevel_sensor = A5;


int relay1 = 7;
int relay2 = 6;
int relay3 = 4;
int relay4 = 5;
```

```
int buzzer = 1;

//  Variables
//const int PulseWire = A3;       // PulseSensor PURPLE WIRE
    connected to ANALOG PIN 0
//const int LED13 = 13;          // The on-board Arduino LED, close to
    PIN 13.
int Threshold = 550;           // Determine which Signal to "count as a
    beat" and which to ignore.
// Use the "Gettting Started Project" to fine-tune Threshold Value
    beyond default setting.
// Otherwise leave the default "550" value.

PulseSensorPlayground pulseSensor;  // Creates an instance of the
    PulseSensorPlayground object called "pulseSensor"

SoftwareSerial esp8266(RX, TX);
 int dry,wet,metal,level,t,g,s,location;
void setup() {
  //Serial.begin(9600);
  esp8266.begin(115200);

  pinMode(relay1, OUTPUT);
  pinMode(relay2, OUTPUT);
  pinMode(relay3, OUTPUT);
  pinMode(relay4, OUTPUT);
  pinMode(buzzer, OUTPUT);
```

```
  lcd.begin(16, 2);

    digitalWrite(buzzer, LOW);
    digitalWrite(relay1, LOW);
    digitalWrite(relay2, LOW);
    digitalWrite(relay3, LOW);
    digitalWrite(relay4, LOW);

  lcd.setCursor(0, 0);
  lcd.print(" SMART  DUSTBIN ");
  lcd.setCursor(0, 1);
  lcd.print("    SYSTEM      ");
  delay(2000);
  lcd.setCursor(0, 0);
  lcd.print("CONNECTING...   ");
  lcd.setCursor(0, 1);
  lcd.print("                ");
  sendCommand("AT", 5, "OK");
  sendCommand("AT+CWMODE=1", 5, "OK");
  sendCommand("AT+CWJAP=\"" + AP + "\",\"" + PASS + "\"", 20,
    "OK");

}

void loop() {
```

```
  lcd.clear();



//  int temp = map(analogRead(temp_sensor), 0, 1023, 100, 0);
//  int gas = map(analogRead(gas_sensor), 0, 1023, 100, 0);
//  int sound = map(analogRead(sound_sensor), 0, 1023, 100, 0);

 dry = digitalRead(dry_sensor);
 wet = digitalRead(wet_sensor);
 metal = digitalRead(metal_sensor);

//  t=(temp/2);
//  g=(gas/10);



  int drylevel; digitalRead(drylevel_sensor) == LOW ? drylevel = 1 :
    drylevel = 0;
  int wetlevel; digitalRead(wetlevel_sensor) == LOW ? wetlevel = 1 :
    wetlevel = 0;
  int metallevel; digitalRead(metallevel_sensor) == LOW ? metallevel =
    1 : metallevel = 0;

  lcd.setCursor(0, 0);
  lcd.print("D:");
  lcd.setCursor(5, 0);
```

```
lcd.print("W:");
lcd.setCursor(10, 0);
lcd.print("M:");

lcd.setCursor(0, 1);
lcd.print("DL:");
lcd.setCursor(6, 1);
lcd.print("WL:");
lcd.setCursor(12, 1);
lcd.print("M:");

 if (dry == LOW)
   {
    lcd.setCursor(2, 0);
    lcd.print("YS");
    digitalWrite(buzzer, HIGH);
    delay(200);
    digitalWrite(buzzer, LOW);
    vopen();
    delay(2000);
    vclose();
    }
    else
    {
      lcd.setCursor(2, 0);
      lcd.print("NO");
```

```
      digitalWrite(buzzer, LOW);
     }

if (wet == LOW)
    {
     lcd.setCursor(7, 0);
     lcd.print("YS");
     digitalWrite(buzzer, HIGH);
     delay(200);
     digitalWrite(buzzer, LOW);
     motor_fwd();
     delay(1500);
     motor_stop();
     delay(2000);
     vopen();
     delay(2000);
     vclose();
     delay(500);
     motor_rws();
     delay(1500);
     motor_stop();
     }
     else
     {
      lcd.setCursor(7, 0);
      lcd.print("NO");
```

```
    digitalWrite(buzzer, LOW);
}
 if (metal == LOW)
   {
   lcd.setCursor(12, 0);
   lcd.print("YS");
   digitalWrite(buzzer, HIGH);
   delay(200);
   digitalWrite(buzzer, LOW);
   motor_rws();
   delay(1500);
   motor_stop();
   delay(2000);
   vopen();
   delay(2000);
   vclose();
   delay(500);
   motor_fwd();
   delay(1500);
   motor_stop();
   }
   else
   {
    lcd.setCursor(12, 0);
    lcd.print("NO");
    digitalWrite(buzzer, LOW);
```

```
 }
 if (drylevel == HIGH)
{
 lcd.setCursor(3, 1);
 lcd.print("FL");
 digitalWrite(buzzer, HIGH);
 delay(200);
 digitalWrite(buzzer, LOW);
 }
 else
 {
  lcd.setCursor(3, 1);
  lcd.print("NR");
  digitalWrite(buzzer, LOW);
 }
  if (wetlevel == HIGH)
{
 lcd.setCursor(9, 1);
 lcd.print("FL");
 digitalWrite(buzzer, HIGH);
 delay(200);
 digitalWrite(buzzer, LOW);
 }
 else
 {
  lcd.setCursor(9, 1);
```

```
      lcd.print("NR");
      digitalWrite(buzzer, LOW);
     }
   if (metallevel == HIGH)
    {
     lcd.setCursor(14, 1);
     lcd.print("FL");
     digitalWrite(buzzer, HIGH);
     delay(200);
     digitalWrite(buzzer, LOW);
     }
     else
     {
      lcd.setCursor(14, 1);
      lcd.print("NR");
      digitalWrite(buzzer, LOW);
     }
String getData = "GET /update?api_key=" + API + "&" + field1 + "="
  + String(drylevel)  + "&" + field2 + "=" + String(wetlevel) + "&" +
  field3 + "=" + String(metallevel);
sendCommand("AT+CIPMUX=1", 2, "OK");
sendCommand("AT+CIPSTART=0,\"TCP\",\"" + HOST + "\"," +
  PORT, 3, "OK");
sendCommand("AT+CIPSEND=0," + String(getData.length() + 4), 2,
  ">");
esp8266.println(getData); delay(1); countTrueCommand++;
sendCommand("AT+CIPCLOSE=0", 2, "OK");
```

```
}

void sendCommand(String command, int maxTime, char readReplay[])
   {
 Serial.print(countTrueCommand);
 Serial.print(". at command => ");
 Serial.print(command);
 Serial.print(" ");
 while (countTimeCommand < (maxTime * 1))
 {
  esp8266.println(command);//at+cipsend
  if (esp8266.find(readReplay)) //ok
  {
   found = true;
   break;
  }
  countTimeCommand++;
 }
 if (found == true)
 {
  Serial.println("OYI");
  countTrueCommand++;
  countTimeCommand = 0;
 }

 if (found == false)
```

```
  {
    Serial.println("Fail");
    countTrueCommand = 0;
    countTimeCommand = 0;
  }

  found = false;
}

void motor_fwd()
{
      digitalWrite(relay1, HIGH);
      digitalWrite(relay2, LOW);
}
void motor_rws()
{     digitalWrite(relay1,LOW);
      digitalWrite(relay2, HIGH);
}
void motor_stop()
{
      digitalWrite(relay1, LOW);
      digitalWrite(relay2, LOW);
}
void vopen()
{
      digitalWrite(relay3, LOW);
```

```
    digitalWrite(relay4, HIGH);
    delay(2500);
    digitalWrite(relay3, LOW);
    digitalWrite(relay4, LOW);
 }
 void vclose()
 {
    digitalWrite(relay3, HIGH);
    digitalWrite(relay4, LOW);
    delay(2500);
    digitalWrite(relay3, LOW);
    digitalWrite(relay4, LOW);
}
```