International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 07 | July - 2021 ISSN: 2582-3930

Design and Development of Rewarding Bin

Nilay Pedram[a], Muskan Mulani[a], Nishant Markad[a], Prajwal Mondhe[a], Vaishnavi Mundada[a], Rajkumar Bhagat[b]

a-Research Scholar, Department of Mechanical Engineering, VIT, Pune, Maharashtra, India.

b-Professor, Department of Mechanical Engineering, VIT, Pune, Maharashtra, India.

Abstract-

Nowadays with the increasing amount of waste generated and limited landfill space for waste disposal, recycling is one of the important approaches to manage the waste effectively. The current manual recycling practice in which the user needs to bring the waste in bulk to the recycling center might be hassle and hence become a discouraging factor for them to recycle. To overcome such an issue, in this project a bin with reward feature is proposed that is derived from a reverse vending machine (RVM) concept. Basically, the system is implemented in a standard trash bin provided by local municipal corporation that is equipped with microcontroller and collection of sensors. Throughout the process, the sensors are responsible for identifying user information, weight the scale and eventually send a message to user regarding the points he earned by dumping certain amount of waste. Along with rewarding feature, the bin segregates wet and dry garbage also. Once the process is completed, the user can claim their points by using the message sent by bin. All the mentioned process will be controlled by a microcontroller.

Keywords- Easy Access, Microcontroller, Reverse Vending Machine, Rewards, Sensors, Smart City

Introduction

Collection, separation and disposal of waste materials in developing country like India are a major problem. Recycling of waste is one of the important methods adopted to manage the waste effectively. There are no hard and fast rules in our country that force the people to collect and manage the waste. So, creating awareness among the people to collect the waste and separate it into degradable and non-degradable waste is a difficult task. RFID techniques are adopted in developing countries like India, China and Malaysia to manage the waste effectively. This project encourages the people to collect the waste in the particular area by giving rewards to them as points depending on the amount of waste that they have collected. The project uses microcontroller in order to co-ordinate various functions like collecting user data, separating wet and dry garbage, measuring the amount of waste dumped, sending a text message to user about the amount of waste he has dumped. Along with microcontroller, various sensors, stepper motor, simple trash bin and display units are also used.

Razali Tomari, Aeslina Abdul Kadir et al. [1] have developed a Reverse Vending

Machine (RVM) concept which had a recycle bin to collect the waste and then awarded points depending on the type, weight and price of the recycle waste. The recycle bin is equipped with microcontroller and a number of sensors. The sensors are responsible to identify the user information, weigh the amount of waste and convert it into points based on the weight. The user can redeem the points by using RFID point card. This concept has been implemented in a small scale.

Mary Victoria, Bhuvaneswari et al. [2] have developed a system that segregates the recycle waste into glass, plastic, metal, paper and wood and dispose them in their proper bins. The segregation is based on the physical properties of the materials like dielectric strength, reflective, absorption and inductive properties. Here the recycle waste materials are moved through a conveyor in which different sensors are placed at the bottom. Based on the material properties they are separated and moved to the respective bins.

S.M. Dudhal et al. [3] have developed a wastage separation mechanism controlled by Program Logic Controller in which metallic wastes are separated and is dumped into a bin. In this mechanism a robotic arm is moved over the conveyor which carries the waste. An electromagnet is attached to the robotic arm which attracts the metallic wastes and separates it from other wastes.

Ruveena Singh et al. [4] have proposed a waste separation mechanism controlled by a microcontroller which separates waste into bio degradable and degradable wastes. The microcontroller receives the signal depending on the type of waste and the corresponding dust bin lid is open for disposing the waste operated by a servo motor.

M. K. Pushpa et al. [5] have designed an automatic waste segregator using microcontroller. In the proposed mechanism an inductive sensor is used to separate the metallic waste. Also, a blower is implemented to separate dry and wet waste.

Methodology

The Rewarding bin works on the basis of the reverse vending machine concept. In this project we have made a Proteus model of the machine. In this Rewarding bin, the waste materials are dumped through the inlet. Then the sensors are used to separate the waste into wet and dry. There are two trays or compartments placed on the either side of the machine. One is used to dump the wet waste and the other is used to dump the dry waste. Based on the nature of the waste material the stepper motor rotates either in clockwise or anti clockwise direction and the corresponding waste material is dumped into the respective bin compartment. The stepper motor is also connected to an Arduino module. The load cell is interfaced with the Arduino through the HX711 load cell module. The load cell module is used to calculate the weight of the waste material dumped. Depending on the amount of waste material collected and its type, reward points are calculated and are sent to the user mobile. The user redeems his reward points in any of the nearby stores. Moreover, ultrasonic sensor is used to intimate the status of the waste bin. If the waste bin is full, the ultrasonic sensor senses it and intimates to the working personnel through SMS to mobile phone.

Our system is different from previous RVM in a way that we implement the developed system into a standard recycle bin and maintaining the conventional procedure for the user to dump the waste. This project evaluates the value of the dumped waste according to its weight and type. This will benefit the users as well as the authorities that are involved in waste management as all the transactions will be recorded in archive of this automated system. Apparently, this product

will emerge "waste to wealth" concept by motivating and encouraging people to recycle as they will be rewarded and eventually increase their awareness on the importance of waste recycling.

This project also emerges to the concepts like "Smart City" and "Swachh Bharat Abhiyan" initiated by the Indian Government by contributing to it and making the city and thus the country clean and a better place to live.

The methodology i.e., the process carried out in the proposed system will be clearer and easier to understand using the flowchart given below.

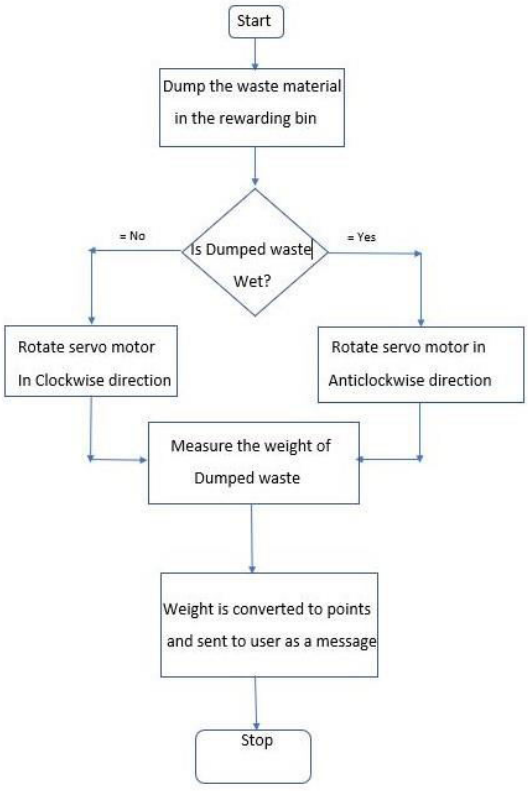

Figure 1: Flowchart of the process carried out in the proposed system.

Components

The different components used in proposed system and their functions are listed below.

1. Arduino UNO

Arduino is an open-source computer hardware and software which is an important tool of this project. The Arduino UNO model is used in this project. The Arduino consists of many pins which act as a transmitter and receiver. It is used for different operations through programming. This is programmed by using the Arduino software based on the requirements. In this project Arduino is used to measure the weight of the waste particles dumped into the bin. This is done by interlinking the load cell module with the Arduino. Finally, the weight is displayed on the screen. Another purpose of this Arduino is it operates the stepper motor based on the type of waste to be dumped into the bin. The signals are transmitted and received with the help of the operation of different pins. This Arduino is interlinked to different modules.

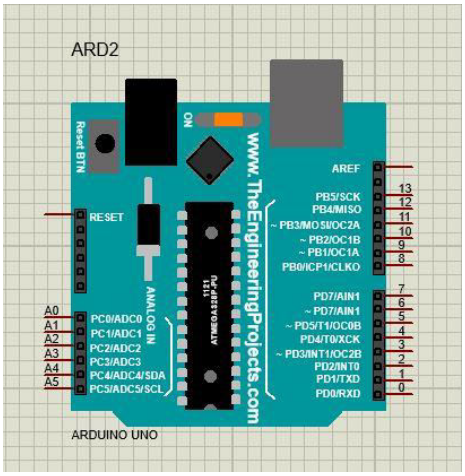

Figure 2: Arduino UNO module

2. GSM Module

GSM means Global System of Mobile Communication. The GSM module is used to communicate with other networks. It is like a modem, which requires an SIM card so that it can send messages to other networks. In this project, the GSM Module is used to send

points to the mobile phones of the person who dumps the waste materials into smart bins. Once the user dumps the waste into the smart bin, it is separated into degradable and nondegradable wastes with their weights calculated. Depending on their weight points are calculated. To send this reward points to the user mobile a query is generated with Arduino and is displayed on the front panel of the machine and it requests the user to enter his phone number. Once the user has entered his phone number the points he has earned is transmitted to his mobile.

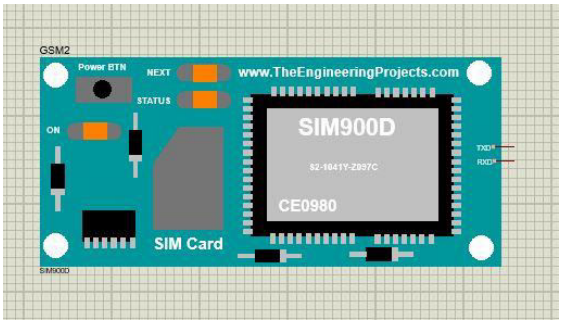

Figure 3: GSM module

3. Ultrasonic Sensor

An Ultrasonic sensor is a device that measures the distance of an object by using sound waves. It measures distance by sending a sound wave at a specific frequency and listening for that sound wave to return back. By recording the elapsed time between the sound wave being generated and the sound wave returning back, it is possible to calculate the distance between the sonar sensor and the object. The ultrasonic sensor is used to indicate that the dustbin is full. The ultrasonic sensor sends the sound waves inside the dust bin. If the dustbin is full, the sound waves will return immediately. Through this the user is able to find the status of the bin.

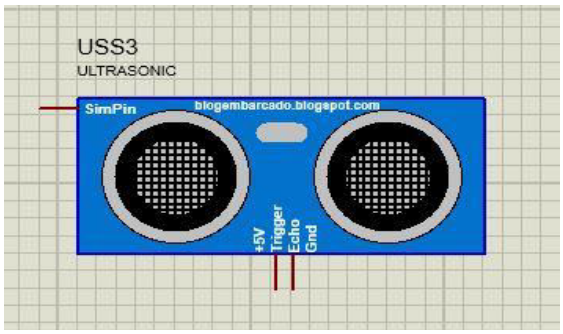

Figure 4: Ultrasonic Sensor

4. Load Cell Module

A load cell is used to measure the weight. When an object is placed on the load cell, a proportional force is created. Normally, a transducer converts this force into its equivalent electrical quantity. The magnitude of the electrical quantity is directly proportional to the force produced on it. The HX711 module is used to interlink the load cell with the Arduino. The output of the load cell is of analog signal which is converted into a digital signal. HX711 amplifies the two analog input channels. It amplifies the low electrical output of load cell and then this amplified and digitally converted signal is fed into the Arduino to derive the weight.

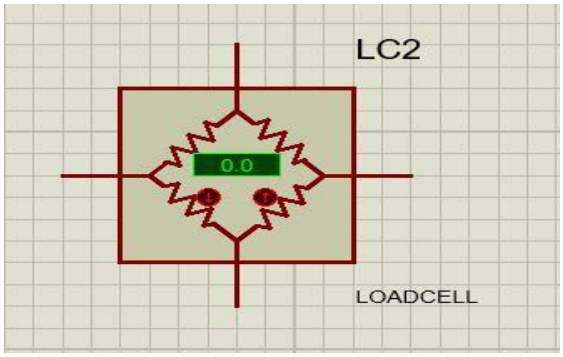

Figure 5: Load Cell Module

5. Servo Motor

A Servo motor is a rotary actuator or linear actuator that allows for precise control of

angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. Servo motors are used to rotate the tray either in clockwise or anti clockwise direction so that the separated waste is dumped into dry or waste bins respectively.

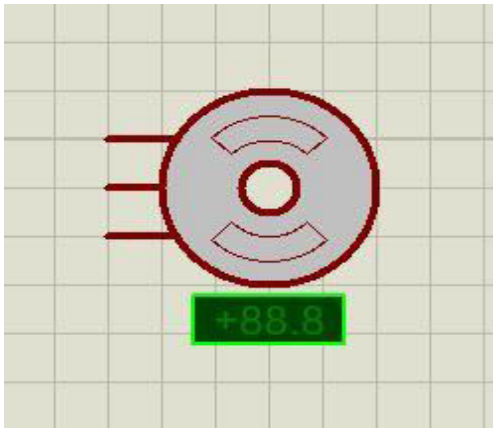

Figure 6: Servo Motor Module

6. Moisture Sensor

The Moisture sensor are used to measure the water content in the waste. The sensors are inserted in the bin to sense the waste accordingly.

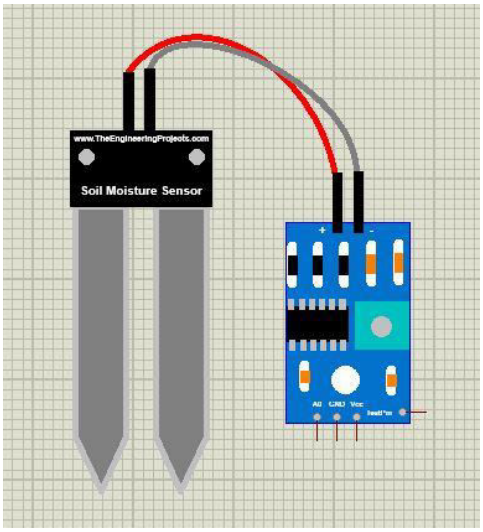

Figure 7: Moisture Sensor

7. Buzzer

A Buzzer is an audio signally device, which is basically a tiny speaker that is connected directly to the Arduino, which produces a sound on reverse of the piezoelectric effect.

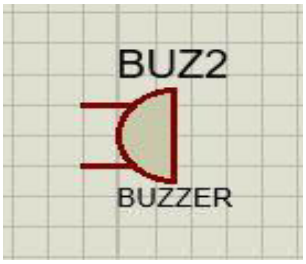

Figure 8: Buzzer

8. Infrared Sensor

An Infrared Sensor (IR Sensor) is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor measures the heat of the waste as well as detects the motion.

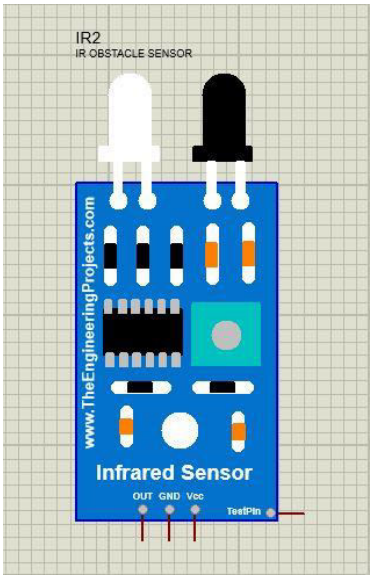

Figure 9: Moisture Sensor

9. HX711 Module

The HX711 Module is a load cell amplifier breakout board for the HX711 IC that allows easily to read the load cells to measure the weight of the waste which is dumbed in the bin.

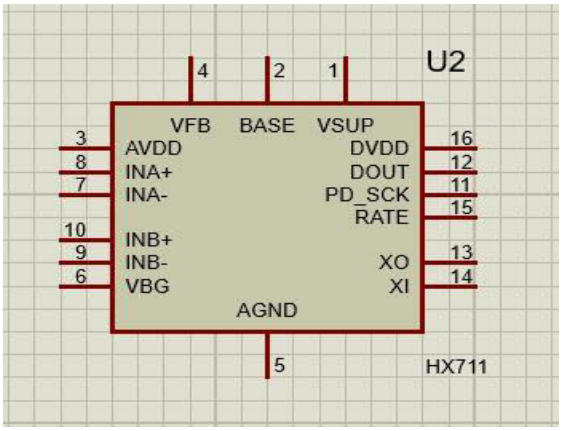

Figure 10: HX711 Module

10. LCD Screen Module

An LCD Screen module is a flat panel display which is electrically modulated optical device which displays the weight of the waste which Is been dumped in the bin.

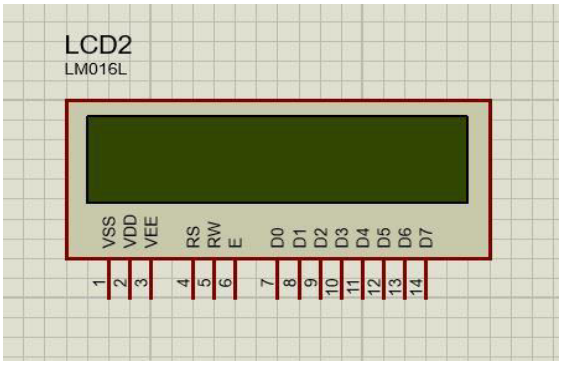

Figure 11: LCD Screen Module

Implementation

The important steps involve in the implementation of the proposed system are Code Development and Hardware Design.

Coding Compiled in Arduino IDE

The coding compiled in Arduino IDE software is one of the most important aspects of this project. Arduino is used to control the smart bin. Through proper coding of Arduino, the objective is accomplished. The code is compiled and uploaded to the Arduino through the serial port. The entire code is shown below;

```
#include <HX711_ADC.h>
#include <Wire.h>
#include <SoftwareSerial.h>
#define rxPin 10
#define txPin 11

// set up a new serial port
SoftwareSerial mySerial =  SoftwareSerial(rxPin, txPin);

HX711_ADC LoadCell(6, 7); // parameters: dt pin, sck pin

#include <LiquidCrystal.h>
LiquidCrystal lcd(8,9,10,11,12,13);//RS,EN,D4,D5,D6,D7
#include <Servo.h>
#define irl 4
#define sen1 A0 // moisture
#define buzzer 5

#define trigPin1 A2////right
#define echoPin1 A3

#define trigPin2 A4  //// front
#define echoPin2 A5

long duration, distance,sensor1,sensor2; // us variable
int onetime=0,onetime1=0 ;

int wet=0,moisture=0,object=0,cabin2=0,c1=0,c2=0;
const int threshold = 50;

Servo myservo;  // create servo object to control a servo
// twelve servo objects can be created on most board

void setup()
{
 LoadCell.begin(); // start connection to HX711
 LoadCell.start(2000); // load cells gets 2000ms of time to stabilize
```

```
LoadCell.setCalFactor(999.0); // calibration factor for load cell
lcd.begin(16, 2);//initializing LCD
lcd.setCursor(0,0);
Serial.begin(9600);
Serial.println("GSM  BEGIN");
lcd.print("Automatic WASTE");
lcd.setCursor(0,1);
lcd.print("Segregation sys");
delay(3000);
pinMode(irl,INPUT);
pinMode(sen1,INPUT);
pinMode(buzzer,OUTPUT);
pinMode(trigPin1, OUTPUT);
pinMode(echoPin1, INPUT);
pinMode(trigPin2, OUTPUT);
pinMode(echoPin2, INPUT);
myservo.attach(5);  // attaches the servo on pin 9 to the servo object
myservo.write(90);
delay(3000);
}

void loop()
{
moisture=analogRead(sen1);
Serial.print("moisture = ");
Serial.println(moisture);
delay(500);
////////////////////////////////////////////////////
ultrasensor(trigPin1, echoPin1);
sensor1 = distance;
delay(10);

 ultrasensor(trigPin2, echoPin2);
 sensor2 = distance;
 delay(10);
```

```
 ultrasensor(trigPin2, echoPin2);
 sensor2 = distance;
 delay(10);

 Serial.println(sensor1);
 Serial.println(sensor2);

 int lvl1=(16-sensor1)*7;
 int lvl2=(16-sensor2)*7;
  Serial.println(lvl1);
 Serial.println(lvl2);
  if(lvl1<0){lvl1=0;}
 if(lvl2<0){lvl2=0;}
 if(lvl1>100){lvl1=100;}
 if(lvl2>100){lvl2=100;}
 lcd.clear();
 lcd.setCursor(0,0);
 lcd.print("moisture: ");
 lcd.setCursor(12,0);
 lcd.print(moisture);
 delay(1000);
 lcd.clear();
 lcd.setCursor(0,1);
 lcd.print("DL= ");
 lcd.setCursor(4,1);
 lcd.print(lvl1);
 lcd.setCursor(8,1);
 lcd.print("WL= ");
 lcd.setCursor(13,1);
 lcd.print(lvl2);
 delay(1000);
 if(lvl1 <= 100 && lvl1 >= 70)
 {
   digitalWrite(buzzer,HIGH);
 }
```

```
  else if (lvl2 <= 100 && lvl2 >= 70)
  {
     digitalWrite(buzzer,HIGH);

  }
else
{
 digitalWrite(buzzer,LOW);
}
////////////////////////////////////////////////////
  object=digitalRead(irl);
  moisture=analogRead(sen1);
  if(object==LOW)
  {
   moisture=analogRead(sen1);
   lcd.setCursor(0,0);
   lcd.print("-GARBAGE SENSE-");
   digitalWrite(buzzer,HIGH);
   delay(150);
   digitalWrite(buzzer,LOW);
   delay(1000);
   moisture=analogRead(sen1);
   Serial.print("moisture = ");
   Serial.println(moisture);
   delay(500);
   moisture=analogRead(sen1);
   Serial.print("moisture = ");
   Serial.println(moisture);
   delay(500);
   //delay(2000);
   if(moisture>=40)
   {
    lcd.setCursor(0,0);
    lcd.print(" WET  GARBAGE");
    myservo.write(20);
    delay(5000);
```

```
   myservo.write(102);
   delay(2000);
   Serial.println("wet");
  }
  else if(moisture<100)
  {
   lcd.setCursor(0,0);
   lcd.print(" dry  GARBAGE");
   myservo.write(165);
   delay(5000);
   myservo.write(102);
   delay(2000);
   Serial.println("moisture");
   lcd.clear();
  }

 }

}

void ultrasensor(int trigPin,int echoPin)
{
 digitalWrite(trigPin, LOW);  // Added this line
 delayMicroseconds(2); // Added this line
 digitalWrite(trigPin, HIGH);
 delayMicroseconds(10); // Added this line
 digitalWrite(trigPin, LOW);
 duration = pulseIn(echoPin, HIGH);
 distance = (duration/2) / 29.1;
}



void load() {
 lcd.setCursor(0, 0);
 lcd.print("Measure Weight");
 LoadCell.update(); // retrieves data from the load cell
 float i = LoadCell.getData(); // get output value
 lcd.setCursor(0, 0); // set cursor to first row
 lcd.print("Weight[g]:"); // print out to LCD
 lcd.setCursor(0, 1); // set cursor to secon row
 lcd.print(i); // print out the retrieved value to the second row

 if (i >= threshold) {
   Serial.println("msg 1");
   mySerial.println("AT+CMGF=1");    //Sets the GSM Module in Text Mode
   delay(1000);  // Delay of 1000 milli seconds or 1 second
   mySerial.println("AT+CMGS=\"+91          \"\r"); // Replace x with mobile number
   delay(1000);
   mySerial.println("1 point credited");// The SMS text you want to send
   delay(100);
   mySerial.println((char)26);// ASCII code of CTRL+Z
   delay(1000);
   Serial.println("msg 1 sent");
 }

 else if (i<threshold) {
   Serial.println("msg 2");
   //mySerial.println("AT+CMGF=1");    //Sets the GSM Module in Text Mode
   delay(1000);  // Delay of 1000 milli seconds or 1 second
   mySerial.println("AT+CMGS=\"+91          \"\r"); // Replace x with mobile number
   delay(1000);
   mySerial.println("2 point credited");// The SMS text you want to send
   delay(100);
   mySerial.println((char)26);// ASCII code of CTRL+Z
   delay(1000);
   }

}
```

Figure 12: Arduino Code

Proteus Model

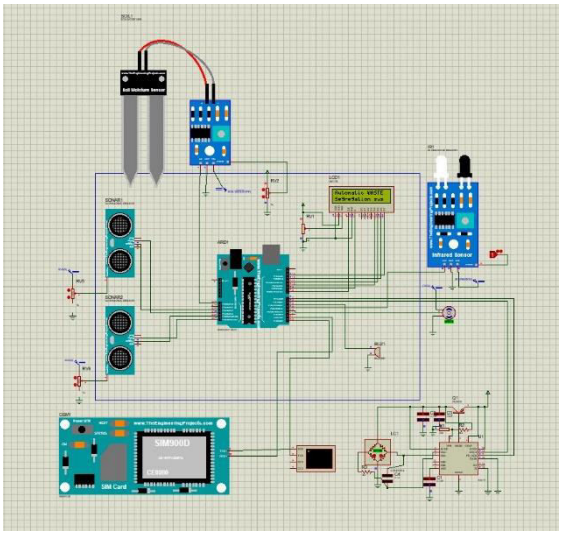

Figure 13: Proteus Model of Proposed System

Hardware Implementation

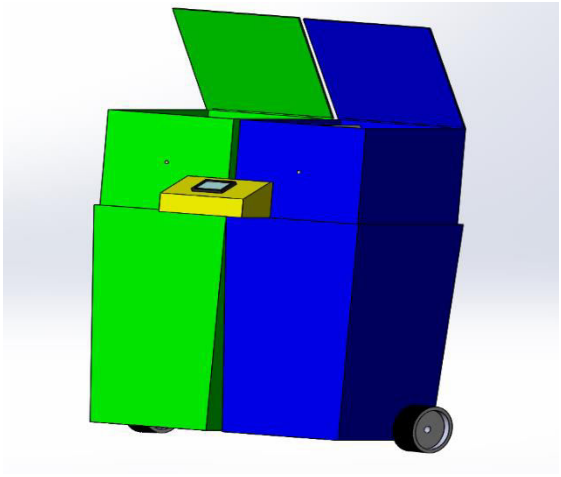

Figure 14: Solidworks Model of Proposed System

Results

To begin with, when we export the Arduino IDE code into the Proteus software and run the code the system gets initialized.

Figure 15: Result1

Now if a user dumps the waste into the bin, the moisture sensor will detect the amount of moisture content in the waste and display the value on the screen.

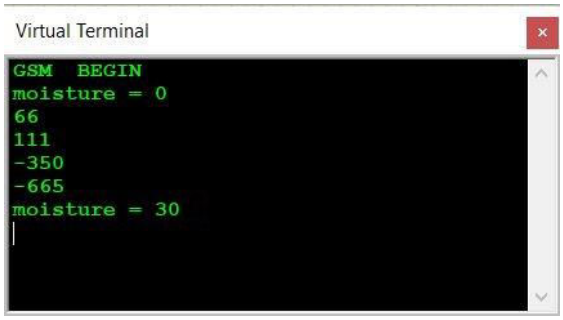

Figure 16: Result2

Now, the moisture content is '30' which is considered as dry (condition applied in the code, <40: Dry & >=40: Wet) So the screen shows 'Dry Garbage' and the counter for dry waste 'DL' will go '1'.

Figure 17: Result3

Now, the load sensor will calculate the weight of the dumped waste (here, 1000g) and display it on the screen. Thus, the reward will be

generated according to the weight and a message will be sent to the user to the registered mobile number depicting the reward points.

Figure 18: Result4

Conclusions

The main focus of this project is to create awareness among the people about recycling of plastic wastes. It is also aimed to support the Indian Government campaign Clean India or Swatch Bharath. By implementing these types of projects Clean India will be a reality in few years.

The smart dustbin and point rewarding system concept which is proposed and designed in this paper are an optimal solution for Municipal council to manage their waste collection in an efficient way.

As the ineffective waste management is due to lack of methodology to categorize waste and collect them in an effective time schedule, the system designed will influence the people to categorize their waste by their own and municipal council can collect the waste on a proper plan with the notifications they get from the smart dustbins when they are about to get full and overflow.

Furthermore, there is a scope of improvement for this project. Some of the improvisations are suggested below by the authors of this paper.

The smart dustbin is used to handle the waste dumped by the users. The user can be given a RFID tag and the user is identified by the given RFID tag. Once the user taps the RFID tag in the RFID reader, the lid of the dustbin is opened by verifying the user ID through the database. Then the user can dump garbage into the bin.

Also linking the smart waste bins to internet and controlling them through IOT. This can also be extended to separate E-waste and biomedical waste through image processing techniques.

To design an application (smartphones/laptops) which includes a database of people using bin and notify the authorities about the status of bin can be a scope to improvise this project further.

Techniques like generating a QR code or a card like ATM card can be used which will include all the information of a person using the bin to receive the rewards in their particular account. The users can redeem their points at any nearby shops or stations.

The above-mentioned techniques can be used to make this project spread worldwide. The authors of this paper are working on the same. This project can help make our cities, states, countries and the world cleaner, happier, and a better place to live.

References

[1] Razali Tomari, Aeslina Abdul Kadir, Wan Nurshazwani wan zakaria, Mohd Fauzi zakaria, Mohd Helmy Abd Wahab, Mohammad Hairol Jabbar, "Development of Reverse Vending Machine (RVM) Framework for Implementation to a standard recycle bin", IEEE International Symposium on Robotics and Intelligent Sensors, Vol. 105, (2017), pp:75-80.

[2] Mary Victoria, M. Bhuvaneshwari, S. Gayathri, M. Ramya, "Segregation of Recyclable waste materials", International Journal of Advance Research and Innovative Ideas in Education", Vol. 2, No. 2, (2016), pp:639-647.

[3] S.M. Dudhal, B.S. Jonwal, Prof. H.P. Chaudhari, "Waste Segregation using Programmable Logic Controller", International Journal for Technological Research in Engineering, Vol. 1, No. 8, (2014).

[4] Ruveena Singh, Dr. Balwinder Singh, "Design and Development of Smart Waste Sorting System", International Journal of Research in Electronics and Computer Engineering, Vol. 3, No. 4, (2015), pp:14.

[5] M.K. Pushpa, Aayushi Gupta, Shariq Mohammed Shaikh, Stuti Jha, Suchitra V, "Microcontroller based Automatic Waste Segregator", International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering", Vol. 3, No. 5, (2015), pp:104-108.

[6] N. Karuppiah, S. Senthil Kumar, S. Ravivarman, P. Joel Joshuva, A. Prabhu, R. Arun Kumar, "Wastage Pay Smart Bin", International Journal of Engineering and Technology. (2018)

[7] Aditya Gaur, Dilip Mathuria, Dr. Rashmi Priyadarshini, "A Simple Approach to Design Reverse Vending Machine", International Journal of Electronics, Electrical and Computational System, Vol. 7, Issue 3. (2018)

[8] Wong, K. K., Abu Samah, N. A., Sahimi, M. S., & Othman, W. (2019). "Development of Reverse Vending Machine using Recycled Materials and Arduino Microcontroller" International Journal of Engineering Creativity & Innovation, 1(1), 7-16.

[9] Daegi Kim, Sangyub Lee, Minsoo Park, Kawnyong Lee & Do-Yong Kim (2021), "Designing of reverse vending machine to improve its sorting efficiency for recyclable materials for its application in convenience stores", Journal of the Air & Waste Management Association, DOI: 10.1080/10962247.2021.1939811

[10] Sambhi, S., Dahiya, P., "Reverse vending machine for managing plastic waste", Int J Syst Assur Eng Manag 11, 635–640 (2020).

[11] A. N. Kokoulin and D. A. Kiryanov, "The Optical Subsystem for the Empty Containers Recognition and Sorting in a Reverse Vending Machine," *2019 4th International Conference on Smart and Sustainable Technologies (SpliTech)*, 2019, pp. 1-6, doi: 10.23919/SpliTech.2019.8782990.

[12] W. G. P. Dumpayan, M. L. M. De Mesa, N. D. F. Yucor, E. T. Gabion, J. D. Reynoso and G. R. M. Geslani, "Two-way powered microcontroller-based plastic bottles 'drop-and-tap' reverse vending machine with stored value system using radio frequency identification (RFID) scanner technology," *2017 IEEE 9th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM)*, 2017, pp. 1-8, doi: 10.1109/HNICEM.2017.8269433.