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# "AUTOMATIC WASTE SEGREGATION"

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***Abstract*:** Effective waste management is crucial in urban areas to prevent disease and environmental harm. India generates around 42 million tons of municipal waste annually. This automated waste segregator (AWS) system helps by classifying waste into wet, dry, and metallic categories. Using IR, capacitive, and impedance sensors, the system detects the type of waste and directs it to the appropriate bin via a servo motor mechanism. This method improves recycling and reduces pollution by enabling proper segregation at the source.

***Indence Terms - Smart Bins, Sensors, Arduino UNO, Model***

➢ **Introduction :** Waste segregation involves separating waste to make recycling easier, saving time and money. Developed countries like Germany, the Netherlands, and the USA use advanced methods such as mobile sorting and enhanced resolution to improve recycling and reduce landfill use. Germany, for example, achieved a 62% recycling rate by 2010 and nearly eliminated landfilling by enforcing strict laws on waste treatment. These efforts are supported by Mechanical Biological Treatments (MBTs), which process biodegradable waste into biogas through composting and fermentation, contributing significantly to sustainable waste management.

➢ **Literature Review :** With rising waste generation due to economic and population growth, efficient waste management is essential. Traditional waste handling is largely manual, posing health risks and requiring labor. Several studies propose automated solutions. An Automated Waste Segregator (AWS) uses capacitive sensors to separate wet and dry waste for household use. Another system employs Arduino and Zigbee to automate indoor waste collection using mobile robots and ultrasonic sensors to detect bin fill levels. An IoT-based model monitors garbage levels via Wi-Fi and GSM for better municipal coordination. Additionally, a waste robot using Fuzzy Logic Control was developed to enhance indoor waste disposal through machine learning. Lastly, an Automated Waste Control Management System (AWCMS) integrates IR sensors, GPS, GSM, and GUI-based software to monitor and manage bins citywide, ensuring timely waste collection and disposal.

➢ ***Problem*** **Deifination :** Improper waste disposal, mainly through unplanned open dumping, harms the environment, humans, animals, and plants. In India, traditional segregation by rag pickers is time-consuming and hazardous to health. Additionally, the economic value of waste is lost if not properly recycled. Therefore, there is a need for a low-cost, user-friendly solution for effective household waste segregation.

➢ **Objective :** The main goal is to automate solid waste monitoring and management using IoT. The system includes Smart Trash Systems (STS), Local Base Stations (LBS), Vehicle Systems (VS), and a Smart Monitoring and Controlling Hut (SMCH) to track bin fill levels and send alerts. It also aims to separate dry and wet waste at the household level using sensors and RF modules. Automation reduces human effort and cost while improving hygiene. The system targets proper handling of all types of solid waste—domestic, industrial, commercial, and medical—to prevent environmental pollution and protect human health.

➢ **Proposed System :** The smart bin is divided into three compartments for waste segregation. The first uses an IR sensor and metal detector, the second has an IR sensor and moisture sensor to identify dry and wet waste, and the third holds separate bins for sorted waste. A microcontroller controls the entire system, with all components connected to it. The code, written in Embedded C, is compiled and uploaded via an IDE. An LCD displays the microcontroller's decisions, ensuring transparency in the segregation process.

➢ **COMPONENTS :**

**Mechanical :**

1. Supporting Frame
2. Collecting Bins
3. Flaps
4. Joints and Screws

**Electrical :**

1. IR Sensor
2. Metal Sensor
3. Liquid Crystal Display
4. Servo Motor
5. Circuit board
6. Inductive Proximity (Moisture) Sensor
7. power supply

➢ **Supporting Frame :**

Fig. 1 - Supporting Frame

A frame is often a structural system that supports other components of a physical construction and/or steel frame that limits the construction's extent. Here the Frame allows us to mount all other components on it.

➢ **Collecting Bins :**

Fig. 2 - Collecting bins

The collecting bins are used to collect the segregated waste in the respective bins

➢ **Moving disc :**

Fig..3 - Moving disc

Moving Disc is the component whose primary task is to collect trash in the respective bin with the help of the servo motor. All the trash collecting bins will be placed on it.

➢ **Screws and Joints :**

Fig .4 - Screw

Fig. 5

Screws and joints are used to withheld the physical components firmly.

➢ **IR Sensor :**

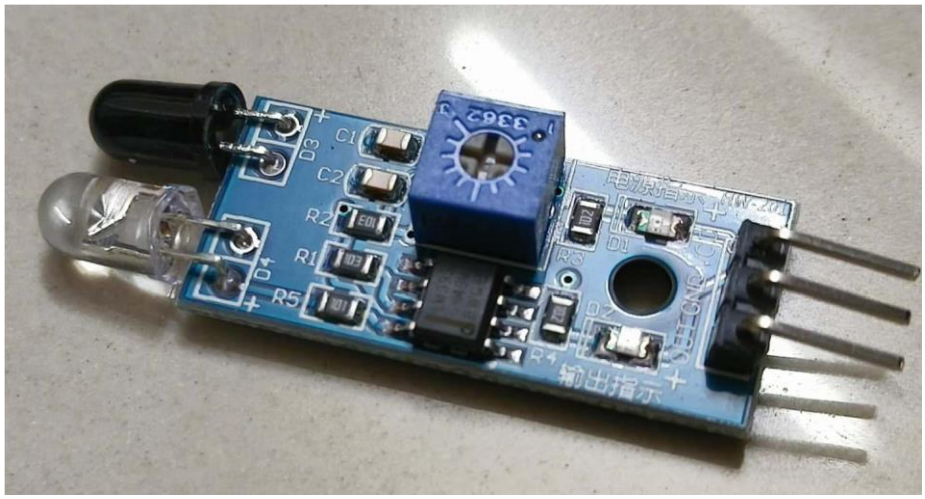

Fig..6 - IR sensor

IR sensor is one of the most commonly used sensors in the field of electronics; it has a large number of applications at the domestic as well as at the industrial level. IR module is a sensor module that consists of both IR transmitter and a receiver. Operating voltage of this module is 5 volts and the obstacle detection range is 5 cm that can be increased by 15 cms. An IR sensor can detect the heat of an object as well any motion in the surrounding. Here this is used to detect the trash in the inlet. The functioning of an IR module is pretty straightforward. As the module contains both transmitter and receiver. When powered, IR transmitter starts to transmit continuous IR waves, if an obstacle is placed in the path of the waves, they get reflected back from the obstacle and are received by the receiver.

➢ **Metal Sensor :**

Fig.7 - Metal sensor

An Inductive Proximity Sensor is a non-contact electronic proximity sensor used for the detection of metals. Sensing range of this sensor completely depends upon the metal being detected. Their working principle is based on a coil and an oscillator that generates an electromagnetic field in the surrounding of the sensing range. Presence of any metallic substance in the sensing range causes dampening of oscillation amplitude. Rise and fall of amplitudes is detected by a threshold circuit that causes a corresponding change in the output of the sensor. If a metal contains some percentage of ferrous, the sensing range is longer, while non-ferrous metals like copper reduce the sensing range by 60 percent. There are two possible outputs of this sensor, hence it is also called inductive proximity switch. Common applications of inductive sensors include metal detectors, traffic lights, etc and a plethora of industrial automated processes.

➢ **Moisture Sensor :**

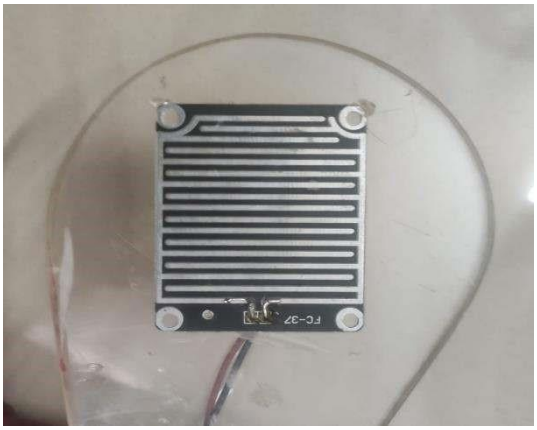

Fig. 8 - Moisture sensor

As the name indicates, this sensor is used to measure the moisture content in a given material. These sensors use the volumetric water content indirectly by making use of some other properties like electrical resistance, dielectric constant. In general cases, the sensor generates a voltage proportional to the dielectric permittivity and therefore measures the moisture content of a material.

➢ Liquid Crystal Display

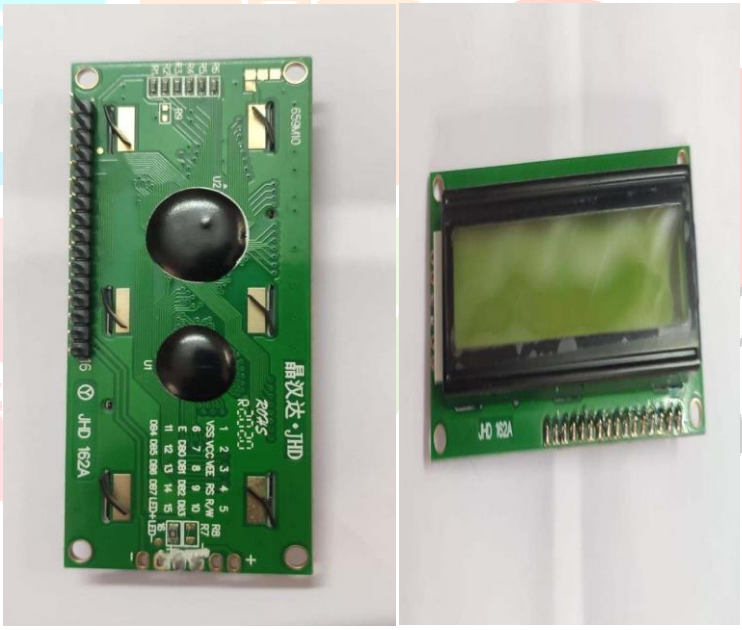


Fig. 9 - Liquid crystal display

This is a flat panel display that uses properties of liquid crystals. LCD displays do not emit light directly, instead, they use a backlight to develop images in single color. LCD displays are used in a wide range of applications like television panel, computer monitors and instrument panels as well. Here the LCD Displays the status the result of the trash detected.

➢ **Servo Motor :**

Fig. 10 - Servo motor

A servomotor is an actuator that precisely controls position, speed, and acceleration using a motor with position feedback and a dedicated controller. Commonly used in robotics and automation, it plays a key role in this system by rotating the disk to drop waste into the correct bin, with its rotation angle predefined in the embedded code.

➢ **Arduino UNO :**

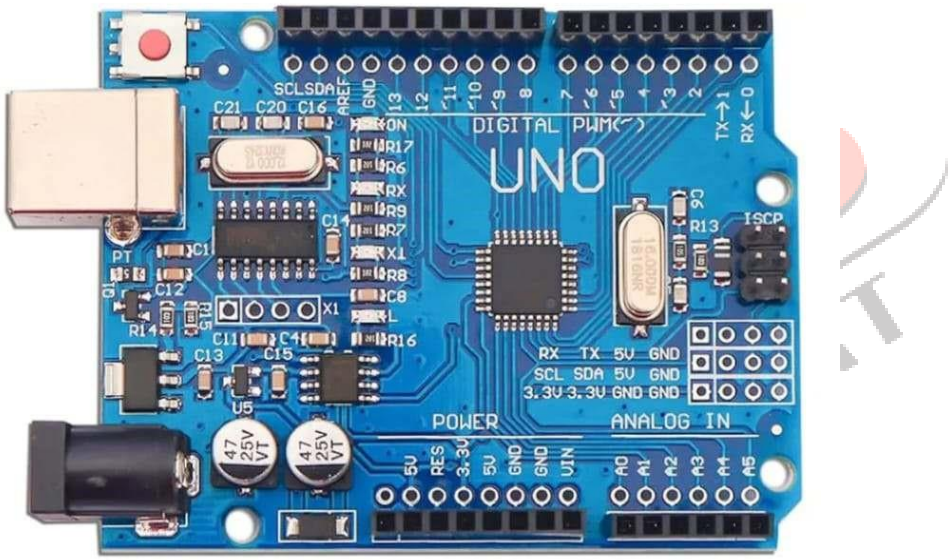


Fig. 11 - Ardui UNO

The Arduino Uno is the central controller in an automatic waste segregation system, responsible for identifying and sorting different types of waste. It receives input from various sensors such as metal detectors, moisture sensors, and IR sensors to detect whether the waste is dry, wet, or metallic. Based on the sensor data, the Arduino processes the information and activates servo motors or conveyor mechanisms to direct the waste into the appropriate bin. Its affordability, ease of programming, and compatibility with multiple sensors make it an ideal choice for smart waste management projects.

➢ **Power Supply :**



Fig 12.2 HLW battery Fig 12.1 - Volt adapter

The power adapter of 12V – 2A and HLW High Power Battery of 9 V are used to power this

**3.3 WORKING :**

1) Drop the waste into the pipe.

2) IR sensor will sense the waste and it will rest on the bottom plate

3) Now the sensor on the plate will sense the waste as in 3 categories Metallic or wet

4) Now the algorithm is so made that if the waste is metallic then the mechanism will bring the metal collecting bin below the pipe and the servo will let the waste fall into the bin.

5) Similarly, the process will be repeated for wet test.

6) If the sensor does not activate then the waste will be detected as dry waste.

➢ **CODE EMBEDDED IN MICROCONTROLLER :**

```
#include <LiquidCrystal.h> #include
<Servo.h> Servo myservo1. Servo
myservo2.
const unsigned int led=4; const unsigned int
buzzer=A3; const unsigned int rain_drop = A5;
const unsigned int metal_detector = 3; const
unsigned int proximity = A4; bool sensor_1 = 0;
bool sensor_2 = 0; unsigned int sensor_3 = 0;
LiquidCrystallcd(5, 6, 8, 7, 9, 10); void setup() {

myservo1.attach(12);

myservo2.attach(13); lcd.begin(16, 2);
lcd.print(" AUTOMATED ");
lcd.setCursor(0,1); lcd.print(" SEGREGATOR
"); delay(2000); pinMode(led,OUTPUT);
pinMode(buzzer,OUTPUT);
digitalWrite(LED_BUILTIN, LOW);
pinMode(rain_drop,INPUT);
pinMode(metal_detector,INPUT);
pinMode(proximity, INPUT);
 } void loop()
{
lcd.clear(); lcd.print("Monitoring
.."); delay(2000);  while (1)  {
 sensor_1    =    digitalRead(proximity);        if
(sensor_1 == 0)
 { lcd.clear();
lcd.print("Object
Detected");
delay(1000);
sensor_2 =
digitalRead(metal_de
tector);  sensor_3 =
analogRead(rain_dro
p);  if (sensor_2 ==
1)
 { lcd.clear();
lcd.print("METAL DETECTED");
delay(2000);  myservo2.write(180);
delay(4000);
[1:24 am, 10/4/2025] Krishna Daivatraj: myservo1.write(180);
delay(4000);  myservo1.write(0); lcd.clear(); lcd.print("Monitoring ..");
myservo2.write(0); delay(3000);  }  else if(sensor_3 < 700 )
 { lcd.clear();
lcd.print("WET DETECTED");
delay(2000);  myservo2.write(60);
delay(4000);  myservo1.write(180);
```

```
delay(4000);  myservo1.write(0);
lcd.clear(); lcd.print("Monitoring ..");
 myservo2.write(0);[1:24 am, 10/4/2025] Krishna Daivatraj: delay(3000);
 }  else  { lcd.clear();
lcd.print("DRY                DETECTED");
delay(2000);          myservo1.write(180);
delay(3000);            myservo1.write(0);
lcd.clear(); lcd.print("Monitoring ..");
```

➢ **BLOCK DIAGRAM :**

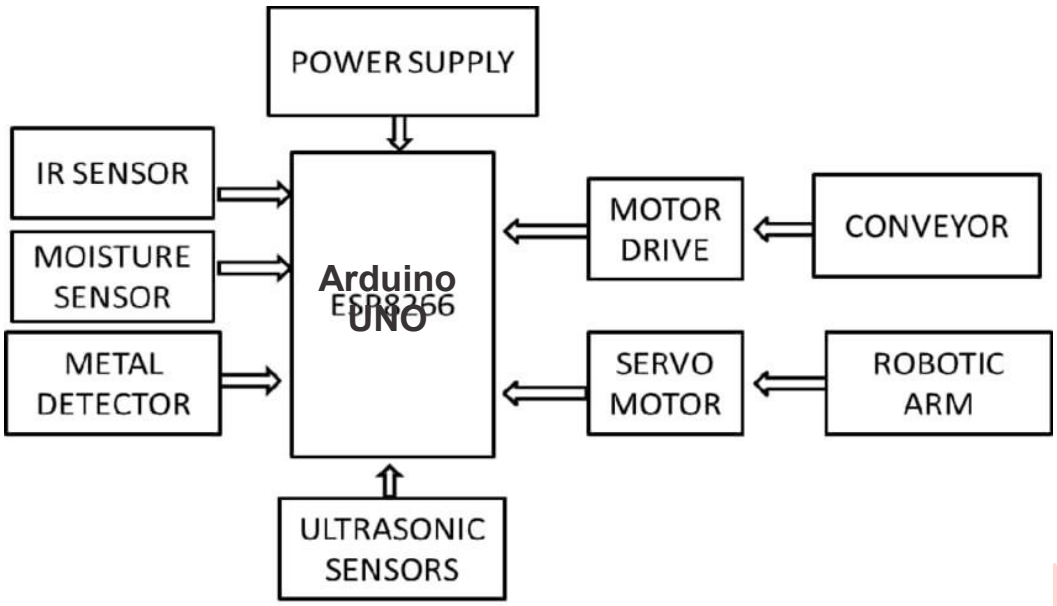


Fig.13 - Block diagram

➢ **WORKING PROTOTYPE :**

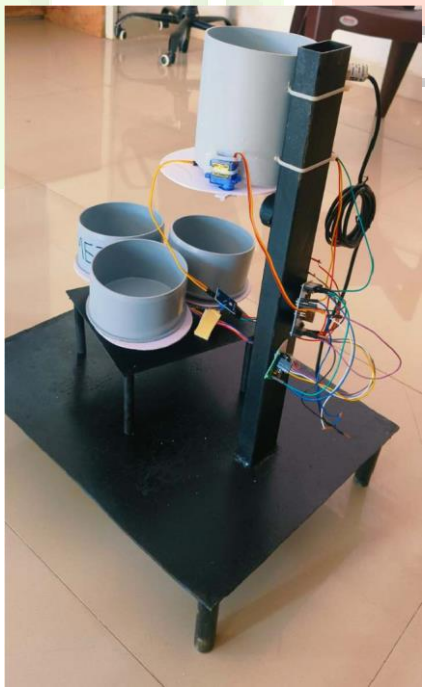

Fig 14 - Working Prototype

## ➢ Results and Discussion :

The proposed system successfully segregates household waste into metal, plastic, and wet (organic) categories. Testing showed effective sorting of common household waste, improving waste handling at the source. The system enables timely waste collection and efficient monitoring using reliable technology, making it a practical solution for maintaining a cleaner and greener environment.

**Table 1:** Result of Metallic Waste Separation.

| Sl. No. | Type of Metal Waste | Discarded or Not |
|---|---|---|
| 1 | Safety pin | Yes |
| 2 | Paper clip | Yes |
| 3 | Battery | Yes |
| 4 | Nail | Yes |

**Table 2:** Result of Organic Waste Separation.

| Sl. No. | Types of Organic Waste | Discarded or Not |
|---|---|---|
| 1 | Kitchen waste | Yes |
| 2 | Leftover food | Yes |
| 3 | Vegetable peel/Fruit peel | Yes |
| 4 | Rotten fruits and Vegetables | Yes |

**Table 3:** Result of Dry Waste Separation.

| Sl. No. | Type of Dry Waste | Discarded or Not |
|---|---|---|
| 1 | Paper | Yes |
| 2 | Small bottles | Yes |
| 3 | Heavy cartons | No |
| 4 | Milk cover | Yes |
| 5 | Dry leaves | Yes |
| 6 | Clothes | Yes |
| 7 | Tetra pack | No |

## ➢ Conclusion and Scope of Future Work :

The system effectively segregates waste into dry, wet, and metallic categories, contributing to cleaner surroundings and efficient waste management. It can be enhanced by adding a

crusher, on-spot wet waste decomposition, and solar power. Future improvements may include robotic arms, conveyor belts, and additional sensors to sort biodegradable, recyclable, e-waste, and medical waste. Due to its cost-effectiveness, it has potential for large-scale use in homes, offices, and societies.

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