VISVESVARAYA TECHNOLOGICAL UNIVERSITY

BELAGAVI – 590 018

A REPORT ON MINI-PROJECT WORK

WASTE CLASSIFICATION USING ARDUINO

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

BACHELOR OF ENGINEERING

in

ELECTRONICS & COMMUNICATION

Project Associates

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2024-2025

BAPUJI INSTITUTE OF ENGINEERING AND TECHNOLOGY DAVANGERE, KARNATAKA – 577004

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Certificate

Certified that the Mini project work entitled **"WASTE CLASSIFICATION USING ARDUINO "**carried out by DARSHAN N S. USN 4BD22EC026**,** DARSHAN S K. USN 4BD22EC028**,**GAGANA K B. USN 4BD22EC030 and GANESH T M. USN 4BD22EC032 bonafide students of this institution in partial fulfillment for the award of degree of **Bachelor of Engineering in Electronics & Communication** by **Visvesvaraya Technological University**, Belagavi during the academic year **2024-25**. It is certified that all corrections / suggestions indicated for continuous internal evaluation have been incorporated in the report.

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Department of Electronics & Communication Engineering

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MISSION OF THE INSTITUTE

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To be in the forefront in providing quality technical education and research in Electronics & Communication Engineering to produce skilled professionals to cater to the challenges of the society.

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M1. To facilitate the students with profound technical knowledge through effective teaching learning process for a successful career.

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MINI-PROJECT WORK (BEC586)

COURSE LEARNING OBJECTIVES:

This course will enable us to:

- Understand and analyze an engineering problem.
- Acquire technical knowledge and collect the information.
- Enhance communication, technical presentation and report preparation skills.
- Provide an opportunity to exercise the creative and innovation ideas in group.

ABSTRACT

This project proposes an automated waste classification system aimed at sorting waste into three categories: dry, wet, and metal, using software logic and data analysis. The system processes input data to classify the waste based on predefined thresholds without the need for physical components such as sensors or motors. The software logic implemented in the Arduino Uno interprets sensor readings to classify waste and decides the appropriate sorting mechanism. The system also integrates with the Blynk IoT platform to display real-time waste classification status remotely, allowing users to monitor and control the process from a distance. The project highlights the potential of automated waste sorting systems and IoT integration to enhance waste management efficiency, reduce manual intervention, and optimize sorting processes through real-time data analysis. Future improvements can include more sophisticated data analysis techniques to improve classification accuracy and scale the system for larger waste management tasks.

ACKNOWLEDGEMENT

We would like to acknowledge the help and encouragement given by various people during the course of this project.

We are deeply indebted and very grateful to the invaluable guidance given by mini project guide **Mrs.Bhagya shanthakumar** , Assistant Professor during this project work.

We would like to thank mini project coordinators **Mrs. Suma K G**, Assistant Professor for the kind co-ordination during the course of the work.

We would like to express our sincere gratitude to **Dr. G S Sunitha**, Professor and Head, Department of Electronics & Communication Engineering, BIET, Davangere, for her kind support, guidance and encouragement throughout the course of this work.

We are thankful to our beloved principal **Dr. H B Aravind** for providing excellent academic climate.

We would like to thank all the teaching and non-teaching staff of Dept. of E&CE for their kind co-operation during the course of the work. The support provided by the college and departmental library is greatly acknowledged.

Finally, we are thankful to our parents and friends, who helped us in one way or the other throughout our project work.

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CHAPTER 1

INTRODUCTION

Today,Waste management is a critical challenge faced by modern societies due to the increasing generation of waste and its impact on the environment. Improper disposal of waste can lead to pollution, health hazards, and resource depletion.

To address these issues, efficient waste segregation and classification systems are essential to facilitate recycling, reduce landfill accumulation, and promote sustainable practices.

Manual waste segregation is inefficient and error-prone, making automation and technology effective solutions for improving waste classification.

This project develops an automated waste classification system using Arduino, integrating sensors and actuators to sort waste into categories like organic, recyclable, and non-recyclable, offering a cost-effective and scalable solution for diverse applications.

The project's goal is to design a prototype that showcases automated waste segregation, aiming to improve waste management efficiency and contribute to environmental conservation and sustainable development.

CHAPTER 2

LITERATURE SURVEY

1. Smart Waste Management System using IoT

The project " Smart Waste Management System using IoT" leverages sensors (ultrasonic, gas, infrared) to monitor bin fill levels and waste composition in real-time. Wireless communication technologies like Wi-Fi, LoRa, and Zigbee transmit data to cloud platforms, enabling centralized management and route optimization.

Cloud computing and AI algorithms analyze data to predict waste patterns and optimize collection schedules. GPS and GIS technologies track waste collection vehicles for efficient routing. This system helps reduce costs, improve sustainability, and enhance urban waste management efficiency. This paper proposes an automated waste management system called "Smart Netbin" to address improper garbage disposal in public areas.

2. IOT based smart waste level monitoring system for smart cities

An IoT-based smart waste level monitoring system for smart cities uses sensors like ultrasonic and infrared to detect bin fill levels in real-time. These sensors communicate with a central platform via wireless technologies (Wi-Fi, LoRa, Zigbee), enabling optimized waste collection schedules and efficient resource allocation.

Data collected is analyzed using cloud computing and AI to predict waste patterns and improve operational efficiency. Such systems contribute to reducing waste overflow, lowering costs, and enhancing sustainability in urban environments.This paper reviews IoT-based waste management solutions in smart cities to support sustainable, healthy communities. By the past five years, it provides a comprehensive look at current smart waste monitoring systems, focusing on technologies and plat forms used

3. Smart Waste Segregation using Arduino Uno

The Smart waste segregation using Arduino Uno typically involves sensors like infrared (IR) for material detection, ultrasonic sensors for measuring waste size, and color sensors to identify recyclable materials. Servo motors are used to sort the waste into different bins based on the detected material. The Arduino Uno processes the data from the sensors and controls the actuators to automate waste sorting.

The system can be enhanced with additional sensors or cameras for more accurate material recognition and categorization.This paper introduces a methodology for efficient waste management in urban areas without constant manual monitoring. An Arduino Uno-based system monitors each dumpster's waste level and uses sensors to separate wet and dry waste. The IR sensor detects waste presence, while a moisture sensor identifies waste type, enabling automated sorting into separate compartments.

SUMMARY OF LITERATURE SURVEY

Paper Authors	Title of Paper	Methodology	Technology Used
1.Tejashree. Pawankumar. Kartikee.	Smart Waste Management System Using IOT Year-2020	The paper presents a smart waste segregation system using Arduino Uno with IR, ultrasonic, and moisture sensors. It automates sorting of wet and dry waste into separate bins using servo motors. The system aims to improve urban waste management with reduced manual intervention.	A Smart Waste Management System using IoT leverages sensors (ultrasonic, gas, infrared) to monitor bin fill levels and waste composition in real-time.
2.A.A.I.Shah. S.S.M.Fauzi. T.R.Razak. M.Jamaluddin.	IOT based smart waste level monitoring system for smart cities Year- 2021	The paper reviews IoT-based smart waste monitoring systems using ultrasonic and infrared sensors for real-time bin tracking. Data analysis with AI optimizes waste collection, reduces overflow, and enhances sustainability in smart cities.	Data collected is analyzed using cloud computing and AI to predict waste patterns and improve operational efficiency.
3.Mr.Dileep J. Ashitha S N A. Thoshitha S N	Smart Waste Segregation using Arduino Uno Year-2021	The paper explores the use of ultrasonic and color sensors in waste segregation, measuring waste size and identifying recyclables. It highlights potential enhancements with advanced sensors or cameras for improved material recognition and sorting efficiency.	Smart waste segregation using Arduino Uno typically involves sensors like infrared (IR) for material detection, ultrasonic sensors for measuring waste size, and color sensors to identify recyclable materials

CHAPTER 3
OBJECTIVES

- To design and develop an automated waste classification system.
- To reduce human effort and error in waste sorting.
- To promote environmental sustainability by improving recycling practices.
- To provide an easy-to-use system that can be scaled for larger applications.

CHAPTER 4

METHODOLOGY

4.1 BLOCK DIAGRAM WITH DESCRIPTION

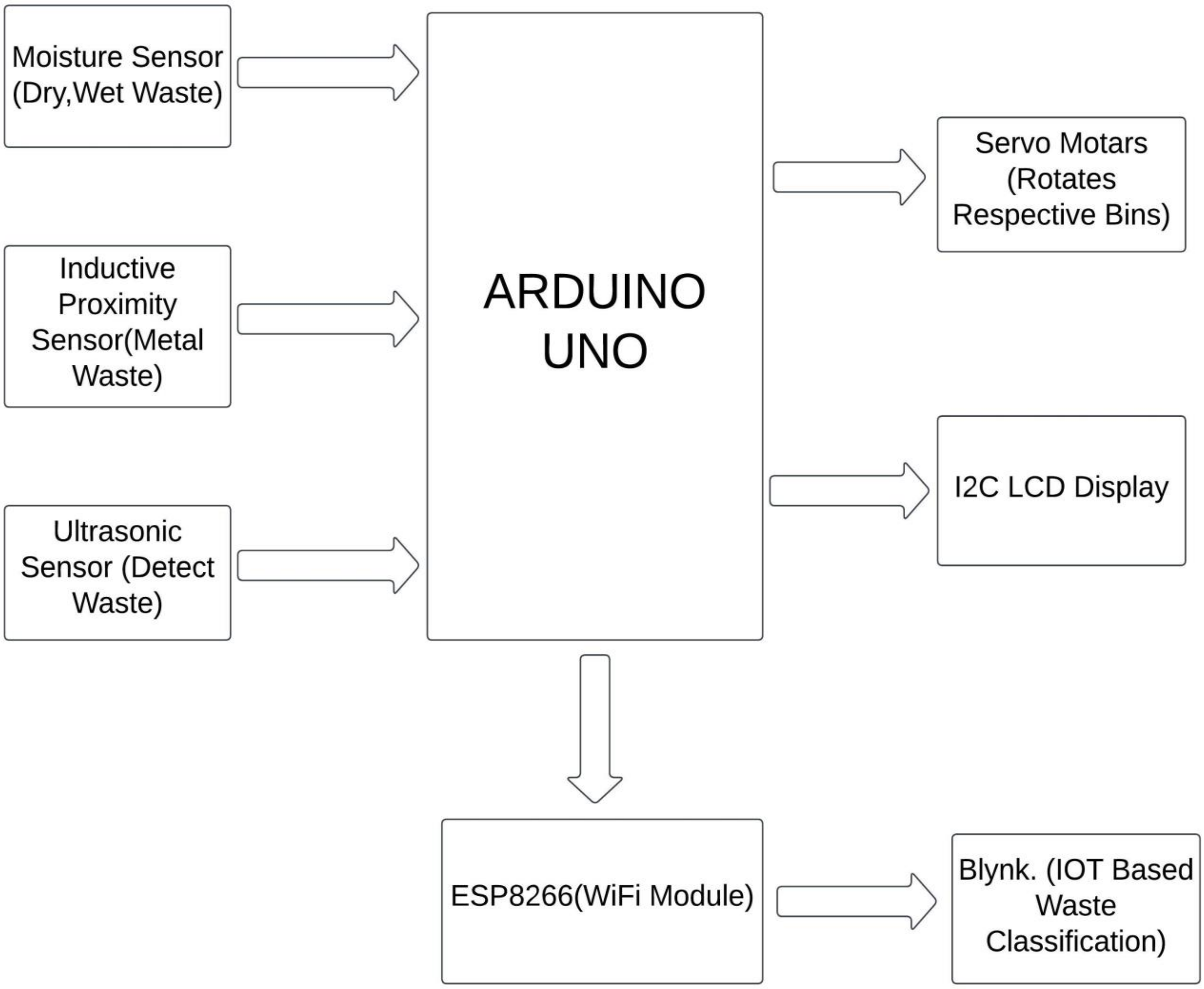

Fig 4.1.1 Block Diagram

- The block diagram represents an IoT-based waste classification system, which uses various sensors and actuators to sort waste into three categories: dry, wet, and metal. The system integrates hardware components like sensors, an Arduino Uno as the main controller, servo motors for waste segregation, and an ESP8266 module for IoT functionality.
- The system begins with sensors for waste classification. A moisture sensor measures the moisture content of the waste. If the moisture level is high, the waste is classified as wet; otherwise, it is classified as dry. An inductive proximity sensor detects the presence of metallic objects, such as cans or wires, and classifies the waste as metal. Additionally, an ultrasonic sensor detects the presence of any waste in the system by measuring the distance between the sensor and the waste. This triggers the sorting process.

- The Arduino Uno serves as the central controller for the system. It collects data from the sensors, processes it, and determines the type of waste. Based on this classification, the Arduino controls the servo motors, which rotate to guide the waste into the appropriate bin—one for dry waste, another for wet waste,and a separate bin for metal waste. The Arduino also sends classification data to an I2C LCD display, which provides real-time feedback about the system’s operation, such as the type of waste detected or the system status.
- The system includes an ESP8266 WiFi module, which enables IoT functionality. The ESP8266 connects to the Blynk platform, where the waste classification results are uploaded in real-time. This allows users to monitor the system remotely through a smart phone or computer. The IoT integration enhances the system’s usability, providing data transparency and remote accessibility.
- A reliable power supply is essential for the system, ensuring all components, including sensors, servo motors, the Arduino, and the ESP8266 module, operate smoothly. The combination of sensors, actuators, and IoT integration makes the system an efficient solution for automated waste segregation.

4.2 FLOW CHART

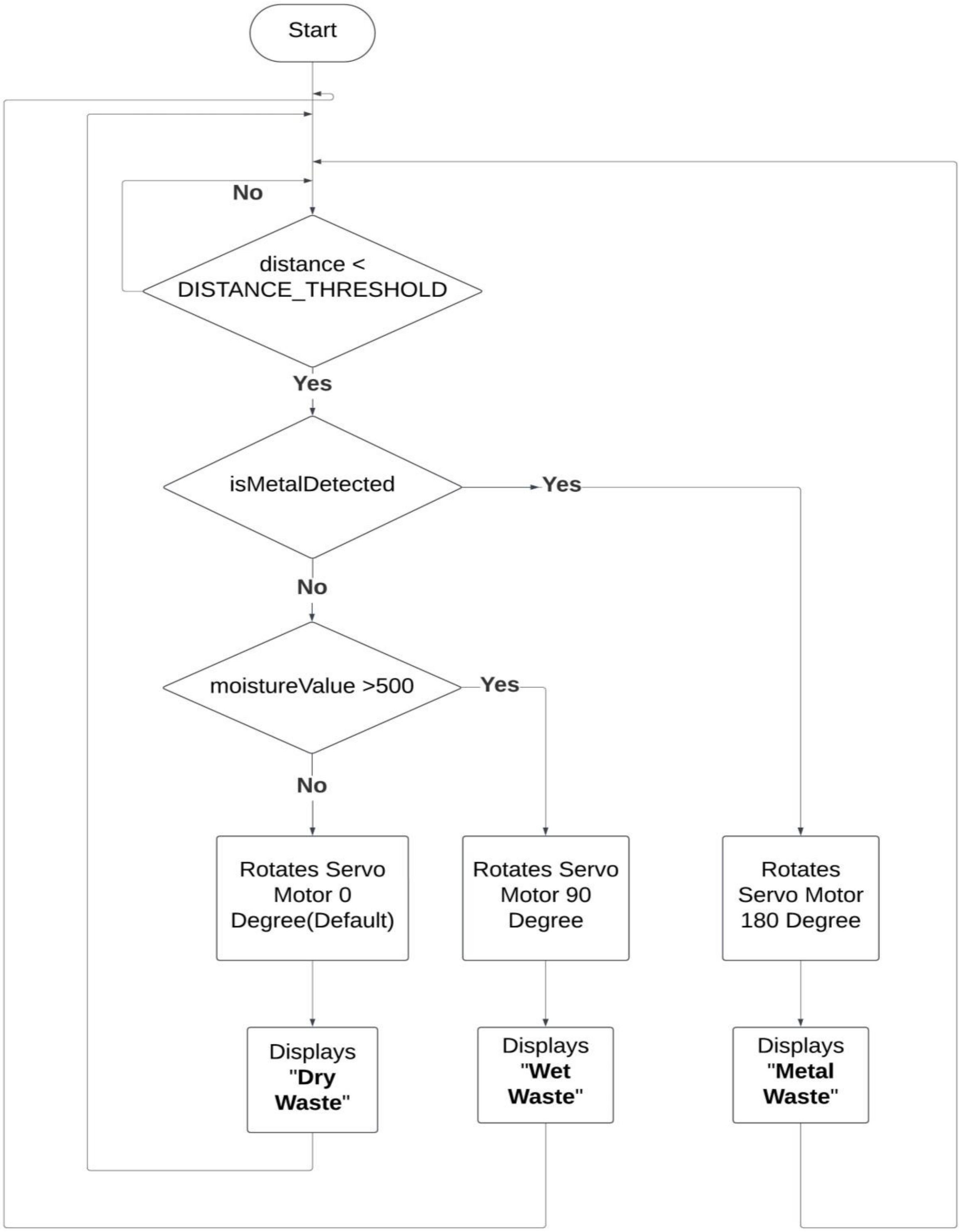

Fig 4.2.1 Flow chart

1. Distance Check

The ultrasonic sensor to detect the presence of waste.

The condition distance < DISTANCE_THRESHOLD ensures waste is present before classification begins.

Action in Project:

If waste is detected, the system proceeds to classify it. Otherwise, it remains idle.

2. Metal Detection

Using a metal sensor to detect metal waste.

If the sensor detects metal, the system directs the waste to the metal waste bin.

Action in Project:

The servo motor rotates 180° to align the metal waste bin for disposal.

3. Moisture Value Check

The project uses a soil moisture sensor to classify waste as wet or dry.

If the moisture value is above 500, it classifies the waste as wet; otherwise, it's dry.

Action in Project:

Wet Waste: Servo motor rotates 90° to align the wet waste bin.

Dry Waste: Servo motor remains at its default position (0°) for the dry waste bin.

4. Cloud Monitoring (IoT Integration)

Additional Feature in Your Project:

While the flowchart does not include this, your project involves sending real-time waste classification data (wet, dry, metal) to a cloud platform like Blynk via the ESP8266.

5. Bins and Servo Control

Servo Actions:

0°: Dry waste bin.

90°: Wet waste bin.

180°: Metal waste bin.

CHAPTER 5
HARDWARE REQUIREMENTS

5.1 ARDUINO UNO:

Fig 5.1.1 Arduino uno

The Arduino Uno acts as a microcontroller that processes inputs from sensors and controls outputs like motors, displays, and other devices.

The Arduino Uno is a popular microcontroller board based on the ATmega328P microcontroller, designed for both beginners and advanced users to build interactive electronic projects. It has 14 digital input/output pins, 6 analog input pins, and operates at 5V. The board is programmable using the Arduino IDE and connects to a computer via a USB interface for easy programming and power supply. The Arduino Uno is widely used for tasks ranging from simple automation to complex robotics and IoT applications, offering compatibility with a variety of sensors, motors, and displays. Its ease of use, extensive community support, and versatility make it a go-to choice for prototyping and experimentation in various fields of electronics.

SPECIFICATIONS

1. **Microcontroller:** ATmega328P
2. **Operating Voltage:** 5V
3. **Input Voltage (recommended):** 7-12V
4. **Input Voltage (limit):** 6-20V
5. **Digital I/O Pins:** 14 (6 of these support PWM output)
6. **Analog Input Pins:** 6
7. **Clock Speed:** 16 MHz

5.2 ESP8266 Wi-Fi MODULE:

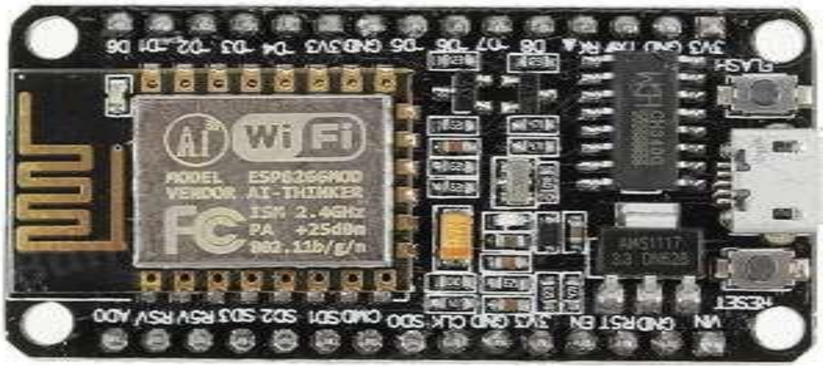

Fig 5.2.1 ESP8266 Wi-Fi module

It handles Wi-Fi connectivity, allowing remote monitoring and control of waste classification data through the Blynk cloud platform.

An The ESP8266 Wi-Fi module , compact microcontroller designed for Internet of Things (IoT) applications, providing built-in Wi-Fi connectivity to enable devices to connect to wireless networks and transmit data. Powered by the Tensilica L106 32-bit CPU, it is capable of functioning as both a Wi-Fi client and an access point, offering flexibility for different network setups.the ESP8266 is energy-efficient, featuring sleep modes that are ideal for battery-powered IoT devices.

SPECIFICATIONS

1. **Wi-Fi Standard:** 802.11 b/g/n.
2. **Operating Voltage:** 3.3V.
3. **Serial Communication:** UART, SPI, and I2C.
4. **GPIO Pins:** 17 configurable General Purpose I/O pins.
5. **Range**: Varies by environment (usually around 50-100 meters).

INTERFACING DIAGRAM

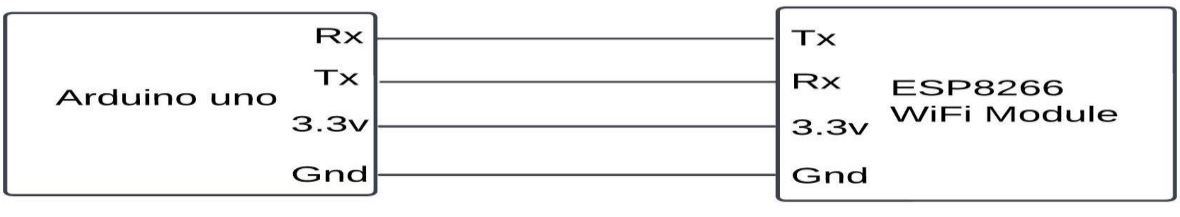

Fig 5.2.2 Interfacing of arduino uno with ESP8266

5.3 SERVO MOTOR:

Fig 5.3.1 Servo motor

The servo motor precisely controls the rotation of an object within a specified angle, based on PWM signals

The servo motor is a type of motor designed to provide precise control over angular position, velocity, and acceleration. It consists of a small motor coupled with a sensor and a control circuit, allowing it to rotate to a specified angle within a defined range, typically from 0° to 180°. The motor is controlled using Pulse Width Modulation (PWM) signals, where the duration of the pulse determines the angle of rotation. Servo motors are widely used in applications requiring precise movement, such as robotic arms, steering systems, camera autofocus mechanisms, and automated machinery. Their ability to provide accurate, controlled movements with relatively low power consumption makes them ideal for a wide range of tasks in both simple and complex systems.

SPECIFICATIONS

1. **Rotation Angle:** Typically 0° to 180° (for standard servo motors).
2. **Speed:** 0.12s/60°.
3. **Operating Voltage:** 4.8V to 6.0V (varies with the model).
4. **Weight:** Around 9-15 grams.

INTERFACING DIAGRAM

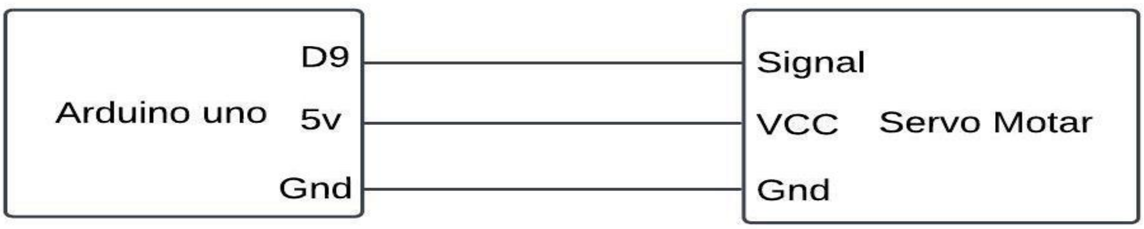

Fig 5.3.2 Interfacing of arduino uno with Servo motor

5.4 INDUCTIVE PROXIMITY SENSOR

Fig 5.4.1 Inductive proximity sensor

The inductive proximity sensor detects the presence of metallic objects by sensing changes in the electromagnetic field when the object comes near.

An inductive proximity sensor is used to detect metal objects by sensing changes in the electromagnetic field when a metal the sensor can be placed in a waste sorting system to identify and segregate metal items from other materials. The sensor emits an electromagnetic field and detects the presence of a metal object based on the disruption of this field. When metal waste enters the detection area, the sensor sends a signal to the control system, allowing the waste management system to identify and sort the metal waste automatically. This type of sensor is highly reliable, resistant to dirt, dust, and moisture, making it ideal for use in industrial and automated waste sorting applications.

SPECIFICATIONS

1. **Operating Voltage:** 10V to 30V DC (varies by model).
2. **Output Type:** Digital.
3. **Sensing Range:** Typically 2 mm to 10 mm.
4. **Response Time:** Typically 1 ms to 2 ms.

INTERFACING DIAGRAM

Fig 5.4.2 Interfacing of arduino uno with inductive proximity sensor

5.5 SOIL MOISTURE SENSOR

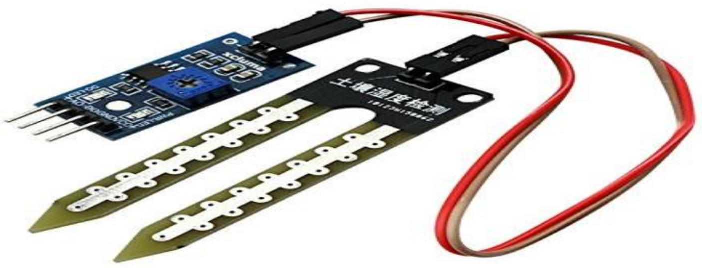

Fig 5.5.1 Moisture sensor

The soil moisture sensor detects the level of moisture in waste to classify it as wet or dry.

A soil moisture sensor can be used to classify waste, specifically for distinguishing between wet and dry waste, based on the moisture content. In a waste classification system, the soil moisture sensor detects the level of moisture in the waste material. If the moisture level is high, indicating wet waste, the sensor sends a signal to the controller (such as an Arduino or ESP8266) to categorize it as wet waste. If the moisture level is low, it is classified as dry waste. This method is particularly useful for sorting organic waste or other materials that vary in moisture content, enabling automated systems to efficiently segregate waste types for better recycling or disposal.

SPECIFICATIONS

1. **Operating Voltage:** 3.3V–5V DC.
2. **Output:**Analog (A0): Proportional voltage to moisture level (0–3V).
3. **Digital (D0):** High/Low based on threshold.
4. **Current Consumption:** <20mA.
5. **Dimensions:** Probe ~60mm x 20mm, Control Board ~30mm x 20mm.

INTERFACING DIAGRAM

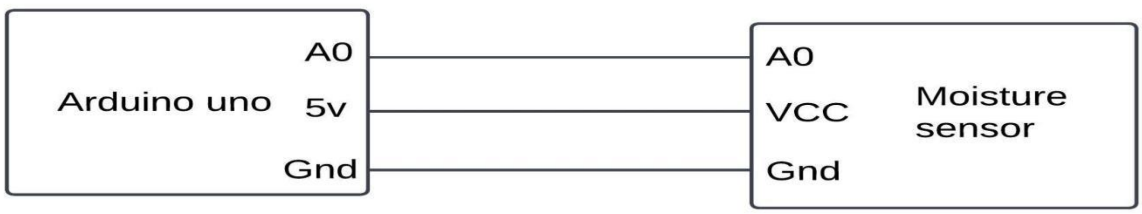

Fig 5.5.2 Interfacing of arduino uno with soil moisture sensor

5.6 ULTRASONIC SENSOR

Fig 5.6.1 Ultrasonic sensor

The ultrasonic sensor measures the distance to an object by emitting sound waves and timing how long it takes for the waves to return.

An ultrasonic sensor is a device that measures distance by emitting high-frequency sound waves and detecting the reflected waves from an object. It consists of a transmitter that sends out sound waves and a receiver that detects the echoes. The sensor calculates the distance to the object based on the time it takes for the sound waves to return. Ultrasonic sensors are widely used for applications like object detection, level sensing, and distance measurement. They are reliable, non-contact, and work well in various environmental conditions, making them ideal for tasks like waste detection, where they can measure the level or presence of waste in bins.

SPECIFICATIONS

1. **Operating Voltage:** 5V.
2. **Measuring Range:** 2 cm to 400 cm.
3. **Interface:** Digital (uses two pins: Trigger and Echo).
4. **Trigger Pulse Width:** 10 µs.

INTERFACING DIAGRAM

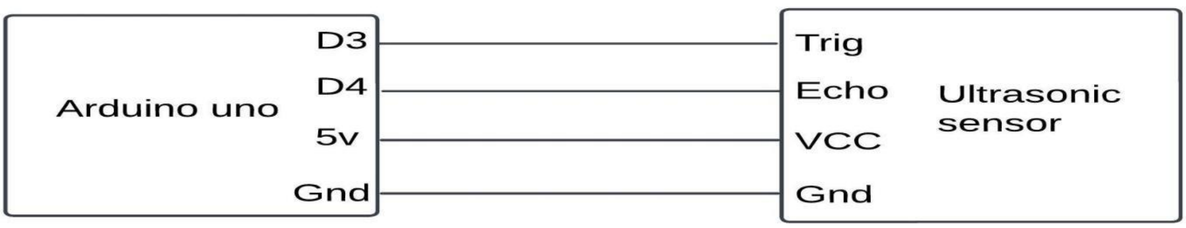

Fig 5.6.2 Interfacing of arduino uno with Ultrasonic sensor

5.7 I2C LCD DISPLAY

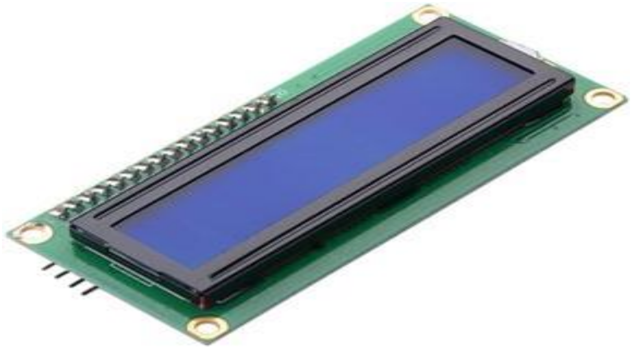

Fig 5.7.1 I2C LCD display

The I2C LCD display shows waste classification results and system status using the I2C protocol for efficient data transfer

An I2C LCD display is a type of LCD screen that uses the I2C (Inter-Integrated Circuit) communication protocol for data transfer, simplifying the wiring process by requiring only two wires: SDA (data) and SCL (clock). It is commonly used in embedded systems, offering a compact and efficient way to display information in projects. The I2C protocol allows multiple devices to communicate over the same two wires, making it ideal for projects with limited I/O pins. The display typically supports characters and can show text, numbers, and basic symbols.

SPECIFICATIONS

1. **Size:** 16x2 or 20x4 characters (16 or 20 columns and 2 or 4 rows).
2. **Voltage:** 5V or 3.3V.
3. **Interface:** I2C communication (uses only 2 data lines: SDA for data and SCL for clock).
4. **Display:** LCD (Liquid Crystal Display) with backlight.
5. **Current consumption:** Typically 20-40mA (depending on the display size and backlight).
6. **Resolution:** 5x8 dot matrix per character.

INTERFACING DIAGRAM

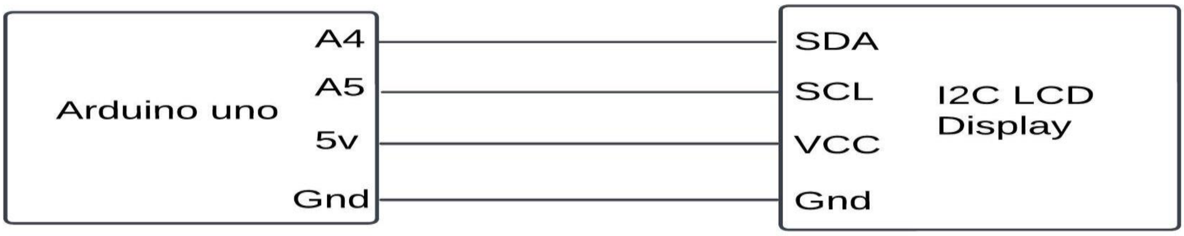

Fig 5.7.2 Interfacing of arduino uno with I2C LCD Display

5.8 SCHEMATIC DIAGRAM

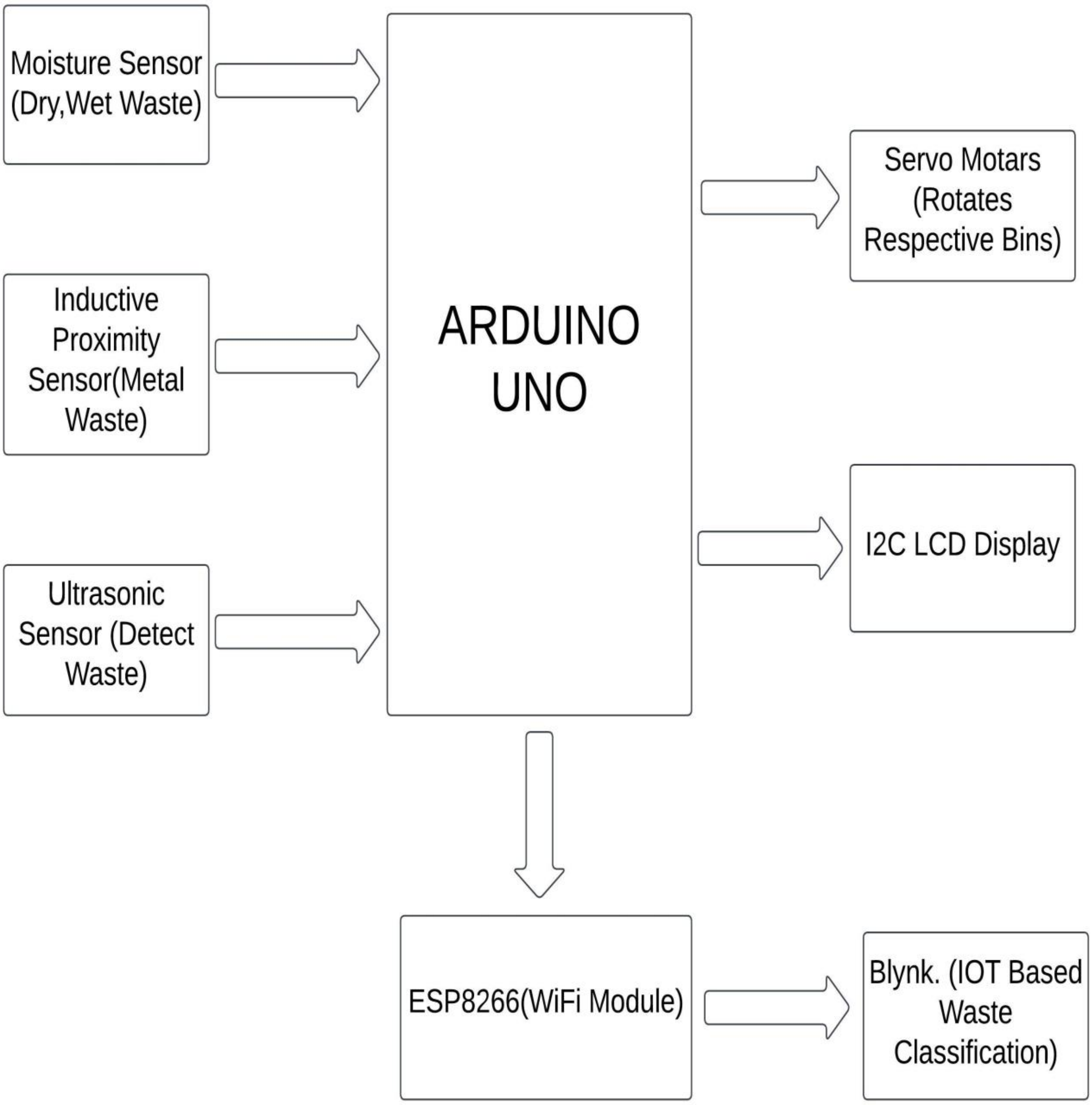

Fig 5.8.1 Block diagram

CHAPTER 6

SOFTWARE REQUIREMENTS

6.1 ARDUINO IDE

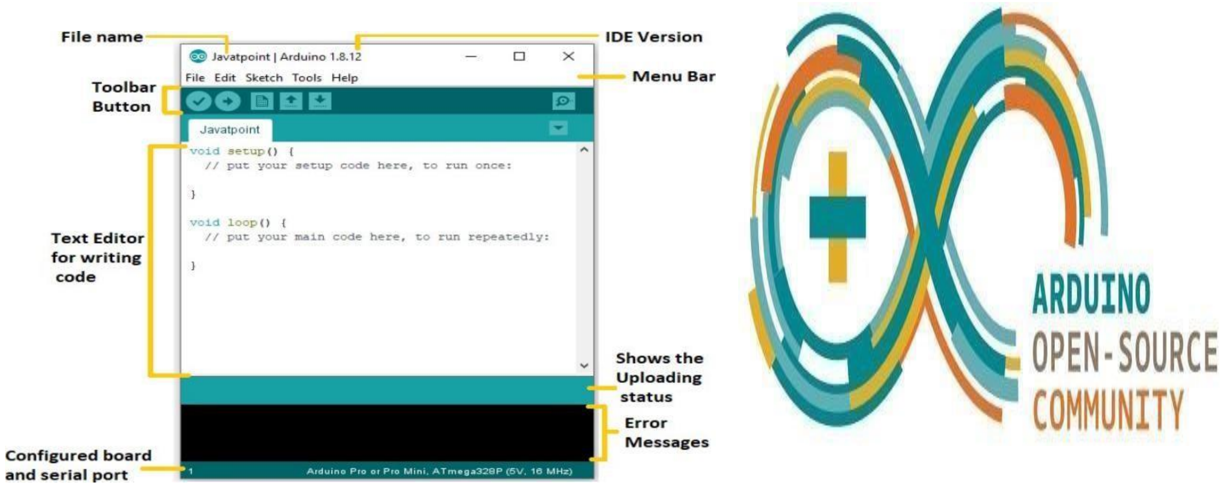

Fig 6.1.1 Arduino IDE

The Arduino IDE (Integrated Development Environment) is a software application used to write, compile, and upload code to Arduino microcontrollers. It is a user-friendly interface that simplifies the process of programming and prototyping electronic devices. The IDE is open-source and available for free download on the Arduino website.

The Arduino IDE supports the C++ programming language and includes a code editor, compiler, and uploader. It also includes a library of pre-written code examples that can be used as a starting point for projects. The IDE is compatible with a wide range of Arduino boards, including the popular Uno, Nano, and Mega models.

The IDE includes a serial monitor that allows for real-time communication between the Arduino board and the computer. This can be used for debugging and for displaying output from the Arduino board. The IDE also supports the use of third-party libraries, which can be used to add additional functionality to Arduino projects. Overall, the Arduino IDE is a powerful tool for anyone interested in developing and prototyping electronic devices, from beginners to experienced developers. Its user-friendly interface and extensive documentation make it an accessible platform for learning and experimentation.

6.2 BLYNK

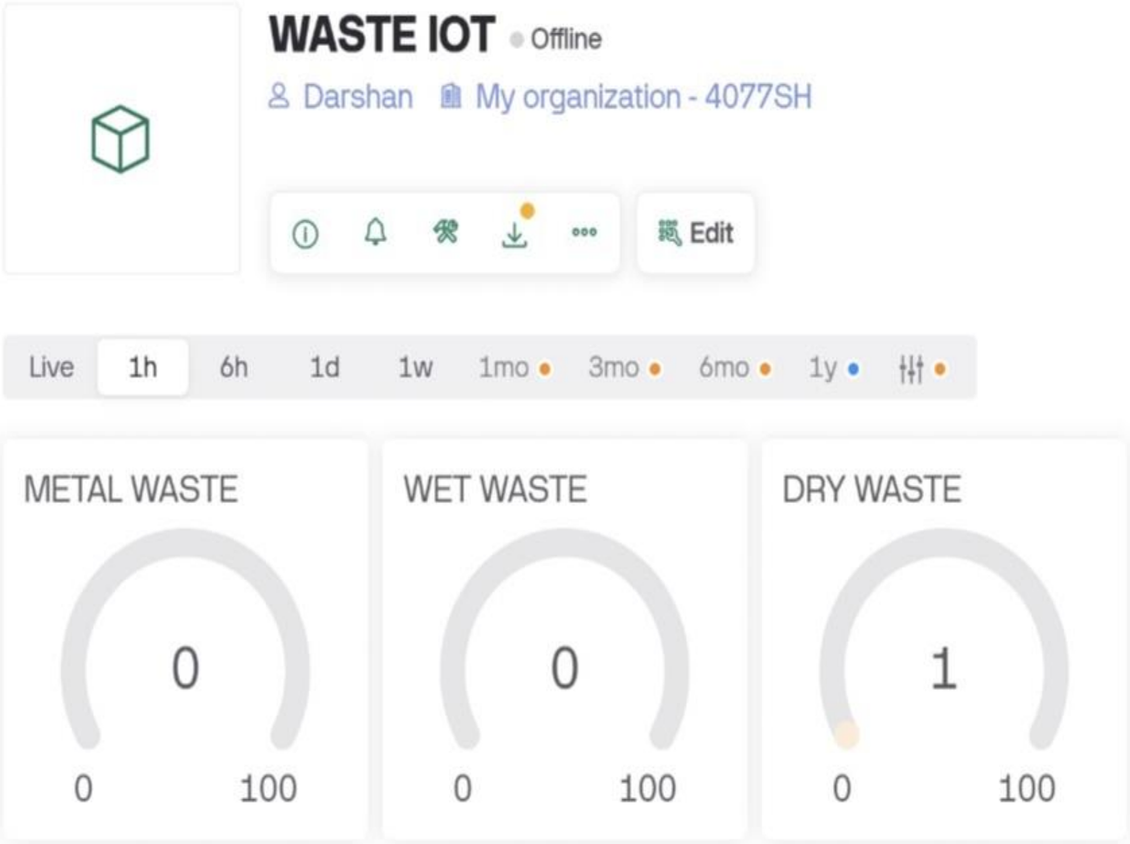

Fig 6.2.1 Blynk

Blynk is a platform designed for building IoT (Internet of Things) applications that allows users to control and monitor hardware remotely. It is widely used in DIY projects, smart home systems, and industrial IoT applications due to its ease of use, versatility, and compatibility with various microcontrollers and IoT devices.

CHAPTER 7

RESULTS AND DISCUSSION

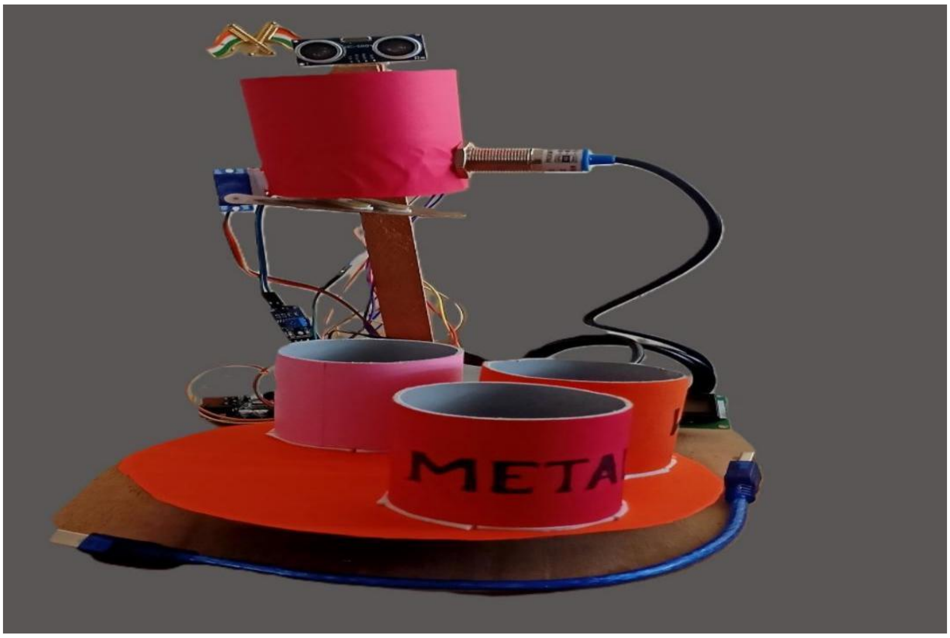

Fig 7.1.1 Waste classification using arduino uno

- This project involves waste classification using a soil moisture sensor to detect wet or dry waste, a metal sensor to identify metal waste, and an ultrasonic sensor to detect the presence of waste.

- The waste is then sorted into respective bins using a servo motor.

- The results are displayed on an I2C LCD, and the waste classification data is monitored and controlled through a cloud platform via Blynk, utilizing the ESP8266 as the main controller.

- This setup provides real-time tracking and management of waste classification, ensuring efficient sorting and monitoring remotel

CHAPTER 8

APPLICATIONS

Waste classification using arudino uno has various potential applications, including:

1. **Smart Home Waste Management:** Automates waste sorting in homes, reducing manual sorting effort. Promotes recycling by efficiently separating dry, wet, and metal waste.

2. **Municipal Waste Management:** Scales the system for city-wide use to automate waste sorting at the municipal level. Enhances recycling rates and reduces landfill waste.

3. **Schools and Universities:** Automates waste sorting in educational institutions, supporting sustainability. Serves as an educational tool to raise awareness about waste management.

4. **Offices and Commercial Spaces:** Installs in office buildings to manage waste more effectively. Promotes recycling and reduces the environmental footprint of businesses.

5. **Smart Cities:** Integrates into smart city systems for automated waste sorting across urban areas. Improves waste management, tracking, and recycling at the city level.

6. **Retail Stores and Supermarkets:** Used in retail environments to segregate waste, ensuring proper disposal. Supports sustainability goals and improves recycling efforts in commercial spaces.

7. **Event Waste Management:** Deploys at large events like festivals or conferences to automatically sort waste. Increases recycling rates and reduces waste sent to landfills during events.

CHAPTER 9

ADVANTAGES

1. **Automated Waste Sorting:** The system automates the process of classifying waste into dry, wet, and metal categories, eliminating the need for manual sorting. This ensures faster and more accurate waste handling, reducing human error and improving overall efficiency in waste management.
2. **Efficient Waste Management:** Accurate waste classification ensures that different types of waste are correctly sorted for recycling or disposal. This leads to more effective recycling efforts, reduces contamination, and optimizes the waste management process for better resource recovery.
3. **Real-Time Monitoring:** The Blynk platform integration allows users to monitor waste classification data in real-time via cloud-based connectivity. This provides instant updates, enabling timely intervention if necessary, and offering greater visibility into waste management performance.
4. **Labor and Cost Reduction:** By automating the waste sorting process, the system significantly reduces the need for human labor, leading to cost savings in waste management operations. Automation also minimizes errors, which can result in costly mistakes during manual sorting.
5. **User-Friendly Interface:** The I2C LCD display provides an easy-to-understand visual representation of the waste classification results. This user-friendly interface makes it simple for individuals to interact with the system and monitor waste disposal status without complex technical knowledge.
6. **Cloud Integration:** Cloud-based integration via Blynk offers users the ability to monitor and control the system remotely. This feature provides an overview of waste management performance, enabling data collection for analysis and making it easy to troubleshoot or adjust settings from anywhere.

LIMITATIONS

1. **Limited Waste Type Classification:** The current system can only classify waste into three categories dry, wet, and metal. It lacks the ability to classify other types of waste, such as plastics, glass, or e-waste.

2. **Sensor Accuracy:** Sensor sensitivity might lead to incorrect classification due to varying waste properties or environmental conditions.

3. **Environmental Impact:** External factors like temperature and humidity can affect Sensor readings, reducing system reliability.

4. **Cost of Implementation:** The cost of sensors and components for the system may limitation for large-scale deployment in resource-constrained areas.

CONCLUSION

The waste classification project using Arduino Uno, along with IoT integration via ESP8266 and sensors, offers a practical solution for automated waste management. The project employs sensors like soil moisture, metal, and ultrasonic to effectively categorize waste into dry, wet, and metal types. The Arduino Uno serves as the primary microcontroller, controlling the sensors and the servo motor to sort waste into the appropriate bins. The system is enhanced with an I2C LCD display that provides real-time feedback, while the ESP8266 enables cloud-based monitoring through the Blynk platform.

This project significantly reduces manual sorting and increases accuracy in waste classification. By utilizing the ESP8266 for cloud interfacing, it provides remote access to waste management data, offering valuable insights for better waste disposal and tracking. The use of a servo motor allows automatic bin rotation, making waste sorting more efficient.

Future enhancements could include the addition of advanced sensors, AI-driven sorting, and mobile app integration. The system has strong potential for scalability in smart cities, promoting efficient and sustainable waste management solutions. This project lays the groundwork for intelligent waste sorting systems that contribute to environmental conservation and more effective recycling processes.

FUTURE SCOPE

The future scope for the Waste classification using arudino uno includes several potential avenues for enhancement and application:

1. Integration with Smart City Systems: Extend the project to work with city-level waste management systems, allowing real-time monitoring of waste levels, smart scheduling for collection, and optimizing waste disposal routes.

2. Automated Waste Sorting Enhancement: Implement additional sorting methods using advanced sensors, like infrared or near-infrared spectroscopy, to classify materials based on their composition, such as plastics, glass, or organic waste.

3. AI and Machine Learning for Waste Detection: Use machine learning algorithms to analyze and identify different types of waste based on patterns, improving the accuracy of waste classification and enabling the system to learn and adapt over time.

4. Mobile Application Integration: Develop a mobile app that allows users to track waste classification results in real-time, receive notifications, and provide feedback, promoting user engagement and better waste management practices in households or communities.

5. IoT-Based Waste Monitoring in Public Spaces: Expand the system for use in public areas such as parks, malls, or office buildings. This could involve setting up smart bins that automatically classify and sort waste while providing real-time monitoring to waste management authorities.

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APPENDIX A

DATASHEET

DATA SHEET OF ARDUINO UNO

Section	Description
Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage	7-12V (recommended), 6-20V (limit)
Digital I/O Pins	14 (6 PWM outputs)
PWM Digital I/O Pins	6
Analog Input Pins	6 (A0-A5)
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB used by bootloader)
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz
LED_BUILTIN	13
Dimensions	Length: 68.6 mm, Width: 53.4mm
Weight	25 g
Digital I/O Pins	Pins 0-13
PWM Pins	Pins 3, 5, 6, 9, 10, 11
Analog Input Pins	A0-A5 (10-bit ADC)
Power Pins	VIN, 5V, 3.3V, GND
Communication	Serial: 0 (RX) and 1 (TX), I2C: A4 (SDA), A5 (SCL), SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK)
Regulator	Onboard voltage regulator for stable 5V output
External Power Supply	6-20V via VIN pin or barrel jack
Website	https://www.arduino.cc/

DATA SHEET OF Node MCU ESP8266 V3.

Section	Description
Microcontroller	ESP8266EX
Operating Voltage	3.3V
Input Voltage	4.5V – 9V (via VIN pin)
Digital I/O Pins	11 (GPIO pins, configurable as input or output)
Analog Input Pin	1 (ADC0, 10-bit resolution)
Wi-Fi Standards	IEEE 802.11 b/g/n
Flash Memory	4MB
RAM	64KB instruction RAM + 96KB data RAM
Clock Speed	80MHz (can be overclocked to 160MHz)
Communication Protocols	UART, SPI, I2C, PWM, GPIO
Wi-Fi Modes	Station, SoftAP, SoftAP + Station
Programming Language	Lua, C/C++ (via Arduino IDE other compatible software)
USB Interface	Micro-USB for power supply and programming
Dimensions	Approx. 58mm x 31mm x 13mm
Weight	~8 grams
Operating Temperature	-40°C to 125°C
Applications	IoT devices, smart home automation, remote sensing, wireless data communication.

APPENDIX B

SOURCE CODE

```
//program code for Waste Classification System
#include <Servo.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// Define pin connections
#define MOISTURE_PIN A0
#define METAL_PIN 2
#define TRIG_PIN 3
#define ECHO_PIN 4
#define MOISTURE_THRESHOLD 700
#define DISTANCE_THRESHOLD 5

Servo servo1;
Servo servo2;

LiquidCrystal_I2C lcd(0x27, 16, 2);

int metalCount = 0;
int wetCount = 0;
int dryCount = 0;

void setup() {
  Serial.begin(9600);

  servo1.attach(9);
  servo2.attach(10);

  pinMode(MOISTURE_PIN, INPUT);
  pinMode(METAL_PIN, INPUT_PULLUP);
  pinMode(TRIG_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);


  // Initialize LCD
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("Waste Sorting");
  delay(2000);
  Serial.println("Setup Complete. Waiting for waste detection...");
}
```

```
void loop() {
  long duration = measureDistance();

  float distance = duration * 0.034 / 2;

  int moistureValue = analogRead(MOISTURE_PIN);
  bool isMetalDetected = !digitalRead(METAL_PIN);

  String wasteType = "";

  Serial.print("Distance: ");
  Serial.print(distance);
  Serial.println(" cm");

  Serial.print("Moisture Value: ");
  Serial.println(moistureValue);

  if (distance < DISTANCE_THRESHOLD) {
    lcd.setCursor(0, 0);
    lcd.print("Waste Detected!  ");
    delay(2000;

    if (isMetalDetected) {
      servo1.write(180);
      lcd.setCursor(0, 0);
      lcd.print("Metal Detected!  ");
      wasteType = "Metal";
      metalCount++;
      Serial.println("Metal Waste Detected!");
      delay(1000);
      servo2.write(0);
    } else if (moistureValue < MOISTURE_THRESHOLD) {
      servo1.write(90);
      lcd.setCursor(0, 0);
      lcd.print("Wet Waste!       ");
      wasteType = "Wet";
      wetCount++;
      Serial.println("Wet Waste Detected!");
      delay(1000);
      servo2.write(0);
    } else {
      servo1.write(0);
      lcd.setCursor(0, 0);
      lcd.print("Dry Waste!       ");
      wasteType = "Dry";
      dryCount++;
```

```
    Serial.println("Dry Waste Detected!");
    delay(1000);
    servo2.write(0);

   }
  }

else {
   lcd.setCursor(0, 0);
   lcd.print("No Waste Found   ");
   wasteType = "None";
   servo1.write(0);  // Reset servo1 position
   servo2.write(90);  // Reset servo2 position
   Serial.println("No Waste Detected");
  }

  Serial.println("---- Waste Status ----");
  Serial.print("Waste Type: ");
  Serial.println(wasteType);
  Serial.print("Metal Waste Count: ");
  Serial.println(metalCount);
  Serial.print("Wet Waste Count: ");
  Serial.println(wetCount);
  Serial.print("Dry Waste Count: ");
  Serial.println(dryCount);

  Serial.print("Data: ");
  Serial.print(wasteType);
  Serial.print(",");
  Serial.print(metalCount);
  Serial.print(",");
  Serial.print(wetCount);
  Serial.print(",");
  Serial.println(dryCount);

  delay(1000);
}

long measureDistance() {
  digitalWrite(TRIG_PIN, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIG_PIN, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIG_PIN, LOW);
  return pulseIn(ECHO_PIN, HIGH);
```

BLYNK CODE

```
#define BLYNK_TEMPLATE_ID "TMPL3zc5J7Ktd"
#define BLYNK_TEMPLATE_NAME "WASTE IOT"
#define BLYNK_AUTH_TOKEN "6ZKIIY7vRD16WowADFTEeSEK71Lr36dy"

#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

char auth[] = "6ZKIIY7vRD16WowADFTEeSEK71Lr36dy";
char ssid[] = "Darshan";
char pass[] = "12345678";

BlynkTimer timer;

String wasteType = "None";
int metalCount = 0;
int wetCount = 0;
int dryCount = 0;

void setup() {
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);

  timer.setInterval(1000L, sendWasteDataToBlynk);
}

void loop() {
  Blynk.run();
  timer.run();
}

void readWasteData() {
  if (Serial.available()) {
    String data = Serial.readStringUntil('\n');
    if (data.startsWith("Data: ")) {
      data = data.substring(6); // Remove "Data: " prefix
      int firstComma = data.indexOf(',');
      int secondComma = data.indexOf(',', firstComma + 1);
      int thirdComma = data.indexOf(',', secondComma + 1);

      wasteType = data.substring(0, firstComma);
      metalCount = data.substring(firstComma + 1, secondComma).toInt();
      wetCount = data.substring(secondComma + 1, thirdComma).toInt();
      dryCount = data.substring(thirdComma + 1).toInt();
    }
  }
```

```
}

void sendWasteDataToBlynk() {
  readWasteData();

  Blynk.virtualWrite(V1, metalCount);
  Blynk.virtualWrite(V2, wetCount);
  Blynk.virtualWrite(V3, dryCount);
}
```

APPENDIX C

COST ESTIMATION

Sl. No.	Name of Components	Quantity	Rate	Amount
1	Arduino Uno	1	349	349
2	SG90 Micro servo motor	2	156	156
3	I2C	1	349	349
4	LJ18A3-8-Z-BX Inductive Proximity	1	299	299
5	ESP8266	1	380	380
6	Soil Moisture Sensor	1	99	99
7	Jump Wires & Breadboard	1	199	199
8	USB A to B cable	1	120	120
9	Ultrasonic sensor	1	139	139
	TOTAL	10		2090
	TAXES			174
	TOTAL	10		2264

COURSE OUTCOMES

On completion of this course, we are able to

1. Solve the identified problems.
2. Analyze the available resources and their utilization.
3. Present the work carried out and prepare the report.
4. Work in a team to find the solutions societal and technical problems

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