# SMART WASTE MANAGEMENT

**IoT MINI PROJECT REPORT**

***Submitted by***


**J.Manindra(VTU19769)**

**U.Ramanjaneyulu(VTU24120)**


***Under the Guidance of***

**Mr. VINOTH KUMAR. V**

***in partial fulfillment for the award of the degree***

***of***

**BACHELOR OF TECHNOLOGY**

***in***

**ELECTRONICS & COMMUNICATION ENGINEERING**

**NOVEMBER 2023**

**BONAFIDE CERTIFICATE**

Vel Tech

Rangarajan Dr. Sagunthala
R&D Institute of Science and Technology
(Deemed to be University Estd. u/s 3 of UGC Act, 1956)

Certified that this mini project report entitled **"SMART WASTE MANAGEMENT"** is the bonafide work of **"J.MANINDRA(21UEEC0109),U.RAMANJANEYULU(21UEEC0527)"** who carried out the project work under my supervision.

| | |
|---|---|
| **SUPERVISOR** | **HEAD OF THE DEPARTMENT** |
| **Mr.VINOTH KUMAR** | **Dr.A. SELWIN MICH PRIYADHARSON** |
| Assistant Professor | Professor |
| Department of ECE | Department of ECE |

-------------------------------------------------------------------------------

Submitted for mini project work viva-voice examination held on:----------------------

**INTERNAL EXAMINER** **EXTERNAL EXAMINER**

# ACKNOWLEDGEMENT

We express our deepest gratitude to our Respected Founder President and Chancellor **Col. Prof. Dr. R. Rangarajan**, Foundress President **Dr. R. Sagunthala Rangarajan**, Chairperson and Managing Trustee and Vice President.

We are very thankful to our beloved Vice Chancellor **Dr. S. Salivahanan** for providing us with an environment to complete the work successfully.

We are obligated to our beloved Registrar **Dr. E. Kannan** for providing immense support in all our endeavours. We are thankful to our esteemed Dean Academics **Dr. A. T. Ravichandran** for providing a wonderful environment to complete our work successfully.

We are extremely thankful and pay my gratitude to our Dean SoEC **Dr. R. S. Valarmathi** for her valuable guidance and support on completion of this project.

It is a great pleasure for us to acknowledge the assistance and contributions of our Head of the Department **Dr. A. Selwin Mich Priyadharson**, Professor for his useful suggestions, which helped us in completing the work in time and we thank him for being instrumental in the completion of third year with his encouragement and unwavering support during the entire course.

We are extremely thankful and pay our gratitude to our mini project coordinator(s) **Mr Vinoth Kumar, Dr. Rahul**, for their valuable guidance and support on completing this project report in a successful manner.

We are grateful to our supervisor **Mr.Vinoth Kumar.V**, Assistant Professor for providing me the lo- gistic support and his valuable suggestion to carry out our mini project work successfully.

**j.MANINDRA**

**U.RAMANJANEYULU**

## TABLE OF CONTENTS

# ABSTRACT

Smart waste management emerges as a promising solution that integrates advanced technologies and data-driven strategies to revolutionize how we handle and mitigate waste-related challenges.

This abstract explores the fundamental principles and advantages of smart waste management. At its core, this approach employs a network of sensors, IoT devices, and data analytics to create a connected waste ecosystem.

These sensors are strategically placed in bins, dumpsters, and waste collection vehicles, enabling real-time monitoring of waste levels and optimizing collection routes.

Such monitoring offers several advantages, including efficient resource allocation, reduced operational costs, minimized carbon footprint, and improved overall cleanliness in urban areas.

In conclusion, the adoption of smart waste management systems promises a more sustainable and efficient waste collection and disposal process.

By harnessing technology and real-time data, it not only reduces costs and environmental impact but also engages the community in a shared responsibility for a cleaner, more sustainable future.

As cities worldwide grapple with the challenges of waste management, the smart approach offers a compelling solution that aligns with the demands of our increasingly connected and environmentally-conscious world.

In the face of rapidly growing urban populations and the associated increase in waste generation, traditional waste management systems are struggling to keep pace. Smart Waste Management (SWM) emerges as an innovative and sustainable approach to address this challenge. SWM leverages advanced technologies, such as Internet of Things (IoT), data analytics, and automation, to optimize the collection, transportation, and disposal of waste in urban environments

**Key Words:** Arduino UNO, Ultrasonic sensor, Servo motor, Jumper Wires, Bucket.

## LIST OF FIGURES

## CHAPTER 1

# INTRODUCTION

Smart waste management is a modern and innovative approach to handling and optimizing the collection, transportation, and disposal of waste and recyclables in urban environments. This method leverages advanced technologies and data-driven solutions to enhance the efficiency, sustainability, and overall management of waste and recycling processes.

In contrast to traditional waste management systems, which are often inefficient and lack real-time monitoring and control, smart waste management introduces a comprehensive and integrated framework for addressing the challenges of urban waste management.

In a rapidly urbanizing world, the proliferation of waste generated in cities poses significant environmental, economic, and public health challenges.

Traditional waste management systems often rely on fixed schedules and routes for waste collection, which can lead to inefficient resource allocation, increased operational costs, traffic congestion, and environmental pollution.

Moreover, these systems often lack the ability to respond to dynamic changes in waste generation patterns or unexpected events, such as overflowing bins or maintenance issues.

In summary, smart waste management represents a forward-looking and holistic approach to the challenges posed by urban waste. By incorporating advanced technologies, data analytics, and real-time monitoring, this approach not only offers more efficient and sustainable waste management but also contributes to the overall well-being and environmental health of urban communities.

## 1.1 PROBLEM STATEMENT

Smart waste management involves the use of technology and data-driven solutions to optimize waste collection, reduce costs, and minimize environmental impact. Here are some problem statements in the field of smart waste management:

Inefficient Waste Collection: Traditional waste collection methods often follow fixed schedules, leading to unnecessary pickups from half-empty bins and missed collections when bins are full. How can we optimize waste collection routes to reduce fuel consumption and operational costs.

Overflowing Bins: Overflowing trash bins are unsightly and can lead to litter and environmental pollution. How can we develop sensors or systems to alert waste management authorities when bins are nearing capacity and need emptying.

Environmental Impact: Excessive waste collection and transportation contribute to greenhouse gas emissions and air pollution. How can we reduce the environmental footprint of waste management operations, especially in urban areas.

Waste Sorting: Inefficient sorting of recyclables from non-recyclables leads to valuable materials being sent to landfills. How can we improve automated waste sorting processes to maximize recycling rates?

Illegal Dumping: Illegal dumping of waste is a significant problem in many areas. How can we use technology to detect and deter illegal dumping activities.

Public Awareness and Engagement: Many residents are not fully aware of proper waste disposal practices or the benefits of recycling. How can we use technology to educate and engage the public in responsible waste management.

Data Management and Analysis: Smart waste management generates a vast amount of data from sensors and collection routes. How can we effectively collect, store, analyze, and utilize this data to make informed decisions and continuously improve waste management processes.

Cost Efficiency: Municipalities and waste management companies need to balance efficient waste collection with cost savings. How can technology help reduce the overall cost of waste management while maintaining or improving service quality.

Waste Composition Analysis: Understanding the composition of waste is crucial for developing effective recycling and waste reduction strategies. How can we use technology to accurately analyze the types and quantities of waste in different areas.

## CHAPTER 2

# LITERATURE REVIEW

Mohammad Aazam, Marc St-Hilaire, Chung-Horng Lung, Ioannis Lambadaris (2016) [1] provides the idea of sensors-based waste bins, capable of notifying waste level status. An automatic waste bin and make use of cloud computing paradigm to evolve a more robust and effective smart waste management mechanism. Waste management is linked to different stakeholders, including recyclers, importers and exporters, food industry, healthcare, research, environment protection and related organizations, and tourism industry Mohammad Aazam et al proposed Cloud SWAM, in which each bin is equipped with sensors to notify its waste level. Different bins for each category of waste, namely: organic, plastic/paper/bottle, and metal.

In this way, each type of waste is already separated and through the status, it is known that how much of waste is collected and of what type. The availability of data stored in the cloud can be useful for different entities and stakeholders in different ways. Analysis and planning can start from as soon as waste starts gathering and up to when recycling and import/export related matters are conducted. The system Cloud SWAM provides Timely waste collection. Timely and efficient way of collecting waste leads to better health, hygiene, and disposal. The system provides shortest path to the location of waste bins. So the collectors can plan a better and fuel efficient route. Recycling and disposal by the system s uses separate smart bins for each type of waste. So the stakeholders will be able to see through the cloud and analyze type of waste and its magnitude. So they can do better arrangements and efficient ways of recycling can be adopted in a dynamic way. Resource management by Cloud SWAM is based on the waste generation trends of a particular city and/or area, resources can be effectively managed since the data is available live through the cloud. Food industry planning can done through the Cloud SWAM.

CHAPTER 3

# BLOCK DIAGRAM AND COMPONENTS

## 3.1 BLOCK DIAGRAM

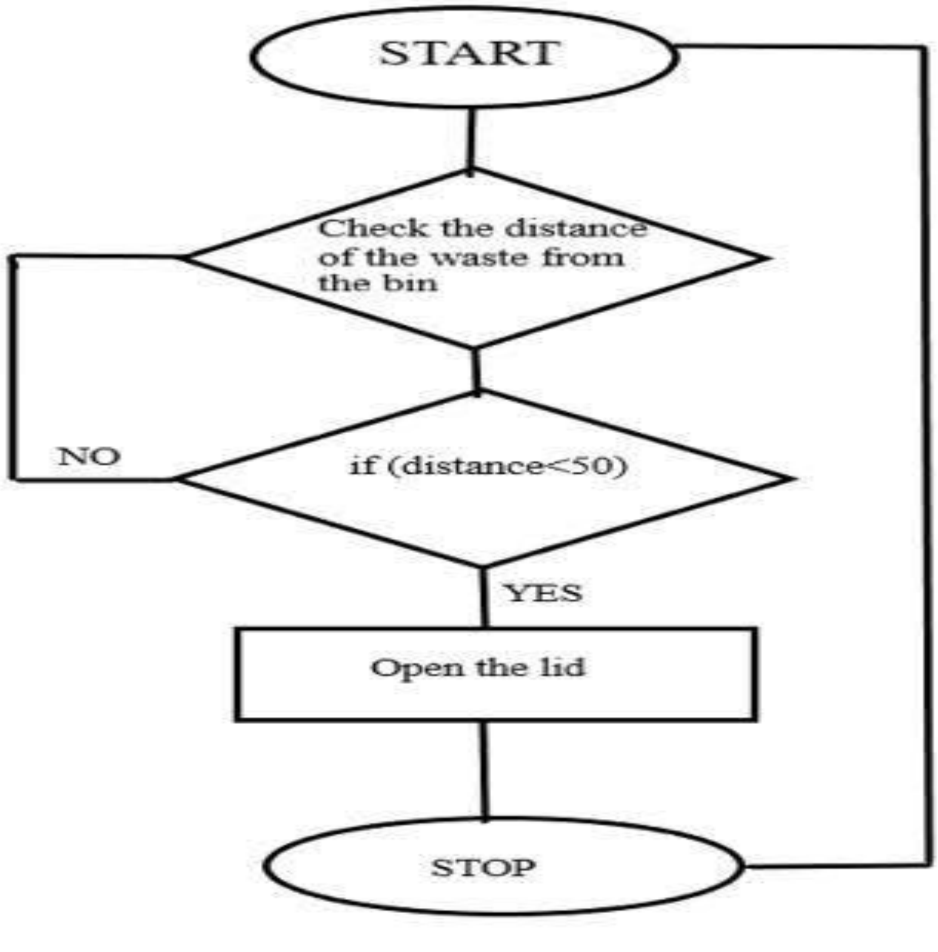



Figure 3.1: Block diagram of the Proposed System

A block diagram for a smart dustbin is a graphical representation that illustrates the key components and functional modules of a technologically advanced waste management system. Smart dustbins incorporate various sensors, data processing units, and connectivity options to optimize waste collection and management

## 3.2 HARDWARE COMPONENTS

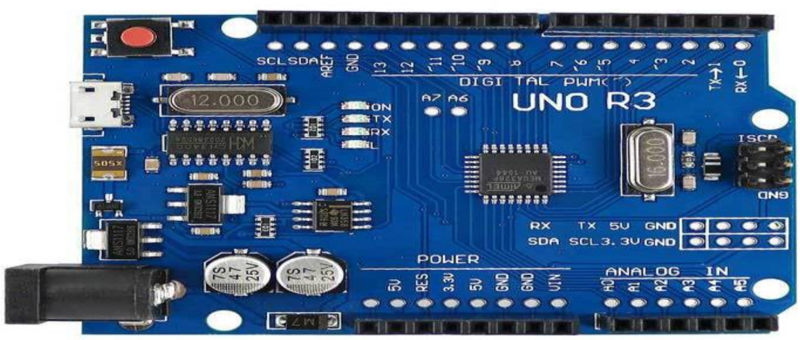
1. **Arduino Uno :** Arduino Uno is a micro-controller board based on 8-bit AT mega328P micro controller. Along with AT-mega328P, it consists other components such as crystal oscillator. serial communication, voltage regulator. etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out ofwhich 6 can be used as PWM outputs), 6 analog input pins. a USB connection. A Power barrel jack. an ICSP header and a reset button.

   (a) Microcontroller : The heart of the Arduino Uno is the ATmega328P microcontroller. It is an 8-bit processor responsible for executing the code and controlling all connected components.

   (b) Serial Communication : The board supports serial communication, which is essential for interfacing with other devices, sensors, or computers. It features a USB connection that allows you to program and communicate with the board via a computer. Serial Communication: The board supports serial communication, which is essential for interfacing with other devices, sensors, or computers. It features a USB connection that allows you to program and communicate with the board via a computer.

   (c) Voltage Regulator : A built-in voltage regulator ensures a stable and reliable power supply to the microcontroller and connected peripherals. It allows you to power the board using an external power source, such as a battery or an external power adapter.

   (d) Digital Input/Output Pins : Arduino Uno offers 14 digital input/output (I/O) pins. These pins can be configured to either read digital inputs (e.g., from sensors or switches) or generate digital outputs (e.g., to control LEDs or relays). Out of these 14 pins, 6 can function as Pulse Width Modulation (PWM) outputs, allowing for precise control of analog- like signals.



2.**Ultrasonic sensor:**

Ultrasonic sensors are devices that use high-frequency sound waves (ultrasonic waves) to detect and measure distances to objects. These sensors are commonly used in various applications, including industrial automation, robotics, automotive, and smart devices. The main components of an ultrasonic sensor typically include:

(a)Transducer/Transmitter:

The transducer is a key part of the ultrasonic sensor. It is responsible for generating the high-frequency sound waves, typically in the ultrasonic range (above the human hearing range). The transducer converts electrical energy into mechanical vibrations. It typically consists of a piezoelectric crystal that expands and contracts when an electric current is applied, producing sound waves.

(b)Receiver:

The receiver is another crucial component of the ultrasonic sensor. It captures the sound waves that bounce off objects in the sensor's field of view and converts them back into electrical signals. Similar to the transmitter, it also contains a piezoelectric crystal or a microphone to detect the returning sound waves.

(c)Control Circuitry:

The control circuitry of the ultrasonic sensor includes electronic components such as microcontrollers, amplifiers, and signal processors. These components manage the generation of ultrasonic pulses, trigger the transmitter, and process the signals received by the receiver. They are responsible for measuring the time it takes for the sound waves to travel to an object and back, allowing the sensor to calculate distances.

(d)Transmitter/Receiver Housing:

The transducer and receiver elements are typically housed in a protective casing, which may be designed to be waterproof or resistant to environmental factors. This housing shields the delicate components from external conditions and mechanical damage.

3.**Servo Motor:**

A servo motor is a specialized type of electric motor designed for precise control of position, speed, and acceleration in various applications. It is widely used in industries such as robotics, automation, manufacturing, and even in consumer electronics like radio-controlled vehicles and drones. Servo motors are popular because of their ability to provide accurate and controlled motion, making them suitable for tasks that require precision and feedback control.

Here are the key components and principles behind how a servo motor operates:

(a)Motor:

At the core of a servo motor is a regular electric motor, often a brushless DC (BLDC) motor or a stepper motor. These motors are known for their efficiency and precise control characteristics.

(b)Feedback Device (Position Sensor):

Servo motors are equipped with a feedback device, typically an encoder or a potentiometer, that continuously measures the motor's current position. This feedback allows the control system to make real-time adjustments and corrections.

(c)Control Electronics:

Servo motors are connected to control electronics, which interpret signals from an external controller (such as a microcontroller or a PLC) and determine how the motor should move. The control electronics take into account the desired position, speed, and acceleration.

(d)Amplifier:

The control electronics send a signal to an amplifier that boosts the power supplied to the motor. This amplification ensures that the motor has sufficient torque to reach and maintain the desired position.

(e)Drive Mechanism:

Servo motors can be connected to various drive mechanisms, depending on the specific application. These mechanisms can include gears, belts, or direct drive connections, which convert the motor's rotary motion into linear or angular motion.

## 3.3 SOFTWARE

**Arduino IDE 1.8.15 :** The Arduino Integrated Development Environment, commonly referred to as the Arduino IDE, is a powerful open-source software tool central to the world of Arduino micro-controller programming. Its primary function is to facilitate the writing and compilation of code for Arduino modules, making it an indispensable resource for both seasoned developers and beginners alike.

One of the standout features of the Arduino IDE is its user-friendliness. It is the official software endorsed by Arduino, and its interface is designed to simplify the complex process of coding for mi-crocontrollers. This approach ensures that even individuals with limited technical knowledge can dive into the world of Arduino with ease. The Arduino IDE empowers beginners to take their first steps in programming and electronics, serving as a stepping stone for learning and experimentation.

Moreover, the Arduino IDE is highly accessible, compatible with various operating systems includ-ing MAC, Windows, and Linux. This cross-platform support ensures that a diverse range of users can leverage its capabilities. It's a versatile tool suitable for a wide audience of enthusiasts, students, hobbyists, and professionals.

Under the hood, the Arduino IDE runs on the Java platform, which grants it significant flexibility and extensibility. The software comes equipped with a robust set of inbuilt functions and commands that prove invaluable during the software development process. These functions and commands sim-plify the tasks of debugging, editing, and compiling code, significantly enhancing the development workflow. Whether you are writing your first lines of code or working on a complex project, the Ar-duino IDE's features and tools streamline the process and contribute to a more efficient development cycle.

CHAPTER 4

# SYSTEM IMPLEMENTATION

Implementing a smart waste dustbin involves a combination of hardware and software components to efficiently manage and monitor waste collection and disposal. Here's an outline of the key components and steps to implement a smart waste dustbin system:

Hardware Components:

1.Smart Dustbin: Use a dustbin equipped with sensors and communication modules to collect data and communicate with the central system.

Sensors: Various sensors are essential, including:

2.Fill-level Sensors: Ultrasonic or infrared sensors to measure the waste level.

Temperature and Humidity Sensors: To monitor the environmental conditions.

Weight Sensors: To measure the weight of waste in the bin.

Gas Sensors (optional): To detect harmful gases from waste.

Communication Modules: Use Wi-Fi, Bluetooth, LoRa, or cellular connectivity to transmit data to the central server.

3.Central Server and Software:

Cloud-Based Server: Use cloud computing resources to store and process data.

Database: Store historical and real-time data about waste levels, locations, and other relevant information.

Web Application or Mobile App: Create an interface for users, waste management personnel, and administrators. The app should display dustbin status, collection schedules, and notifications.

Machine Learning Algorithms (Optional): Implement predictive algorithms to optimize waste collection routes and schedules.

Notifications and Alerts: Set up notifications for users and maintenance staff based on fill levels or other critical events.

Integration with Waste Collection Vehicles:

Equip collection vehicles with GPS and communication modules to receive optimized routes from the central system.

Integrate the vehicle tracking system with the central server for real-time monitoring of waste collection progress.

4.User Interface:

Users should be able to interact with the smart dustbin system through a mobile app or web portal.

Users can request waste collection, check bin status, and receive alerts when bins are full.

5.Data Analytics and Reporting:

Use data analytics to generate reports on waste collection efficiency, trends, and cost savings.

Monitor the environmental impact of waste and its composition.

6.Security and Privacy:

Implement robust security measures to protect the system from unauthorized access and data breaches.

Ensure that user privacy is maintained, especially if personal data is collected.

7.Maintenance and Support:

Regularly maintain and update the system to ensure its proper functioning.

Provide customer support for users and administrators.

Compliance with Regulations:

Ensure that the system complies with local regulations and standards related to waste management and data privacy.

8.Pilot Testing and Scaling:

Start with a small-scale pilot project to fine-tune the system and work out any issues.

Once the system is proven to be effective, scale it to cover a larger area or more waste bins.

Sustainability and Environmental Impact:

Consider the environmental impact of the smart waste dustbin system and strive to make it more sustainable.

Implementing a smart waste dustbin system can improve waste collection efficiency, reduce costs, and contribute to a cleaner environment. It requires a combination of hardware, software, and ongoing maintenance to be successful.


UNO

### 4.1 PROGRAM

```
#include    //servo library
Servo servo;
int trigPin = 5;
int echoPin = 6;
int servoPin = 7;
int led= 10;
long duration, dist, average;
long aver[3];   //array for average


void setup() {
   Serial.begin(9600);
   servo.attach(servoPin);
   pinMode(trigPin, OUTPUT);
   pinMode(echoPin, INPUT);
   servo.write(0);         //close cap on power on
   delay(100);
   servo.detach();
}

void measure() {
 digitalWrite(10,HIGH);
digitalWrite(trigPin, LOW);
delayMicroseconds(5);
digitalWrite(trigPin, HIGH);
delayMicroseconds(15);
digitalWrite(trigPin, LOW);
```

```
pinMode(echoPin, INPUT);
duration = pulseIn(echoPin, HIGH);
dist = (duration/2) / 29.1;    //obtain distance
}
void loop() {
  for (int i=0;i<=2;i++) {   //average distance
    measure();
   aver[i]=dist;
    delay(10);              //delay between measurements
  }
 dist=(aver[0]+aver[1]+aver[2])/3;

if ( dist<50 ) {
//Change distance as per your need
 servo.attach(servoPin);
  delay(1);
 servo.write(0);
 delay(3000);
 servo.write(150);
 delay(1000);
 servo.detach();
}
Serial.print(dist);
}
```

CHAPTER 5

# RESULT AND CONCLUSION

A "smart waste Management" typically refers to a garbage or trash bin equipped with technology to optimize waste management. In such a context, the result and conclusion may relate to the performance, benefits, or findings associated with the use of smart waste dustbins. Here's how you can frame the result and conclusion sections of a report or study on smart waste dustbins.

In conclusion, the adoption of smart waste dustbins represents a promising step towards more efficient and sustainable waste management in urban environments. The real-time data and automation provided by these bins result in a range of benefits, including reduced operational costs, improved public hygiene, and a more environmentally friendly waste collection process.

It is evident that the implementation of technology in waste management has the potential to revolutionize the way we handle and dispose of waste. However, to fully harness the advantages of smart waste dustbins, it is crucial for municipalities and waste management agencies to invest in the necessary infrastructure, such as IoT sensors and data analytics capabilities.

While the results of our study have been largely positive, further research and continuous monitoring of the long-term impacts of smart waste dustbins are essential. This technology has the potential to make our cities cleaner and more sustainable, but its effectiveness depends on proper maintenance, data analysis, and the engagement of local communities.

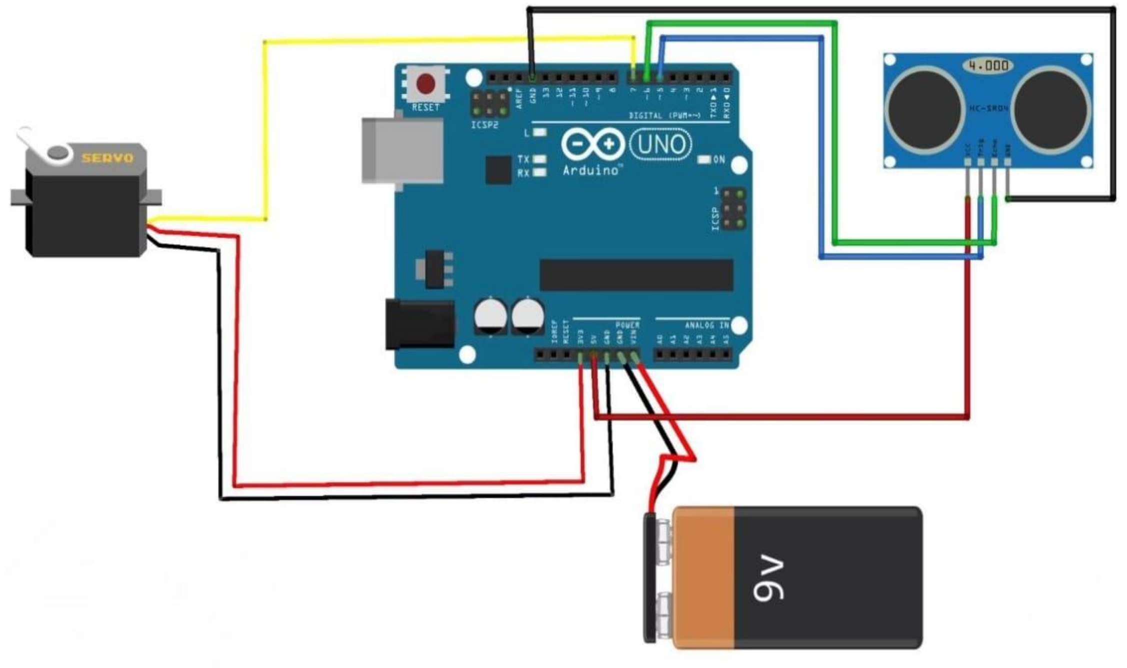



Figure 5.1: Simulation Circuit Diagram

## CHAPTER 6

# FUTURE SCOPE

The future scope of smart waste management is both promising and essential as the world grapples with growing urbanization and environmental challenges.

The Internet of Things (IoT) will play a pivotal role in smart waste management. In the future, we can expect to see even more advanced sensors and devices integrated into waste bins to collect real-time data on waste levels, temperature, and even types of waste. This data will be used to optimize waste collection routes and schedules.

Data analytics and artificial intelligence (AI) will be increasingly employed to process the massive amount of data generated by smart waste management systems. Advanced algorithms will provide actionable insights, helping municipalities and waste management companies make informed decisions, reduce operational costs, and improve overall efficiency.

Smart waste bins could evolve to include waste sorting mechanisms. These bins would automatically separate recyclables from general waste, making recycling more efficient and reducing the burden on landfills. AI and robotics could be used to further improve waste sorting accuracy.

Smart waste management systems may expand to include environmental monitoring capabilities, such as air and water quality sensors. This data can be used to understand the broader environment.

## REFERENCES

[1] https://youtu.be/9yrP1CZN3Ds?feature=shared

[2] "Smart Cities and Waste Management" by Barlow, D

[3] "Internet of Things in Solid Waste Management: Current Status and Future Prospects" by Khan, M. A. and Madani, S. A.

[4] Internet

[5] You tube

[6] "Smart Waste Collection System Using Internet of Things (IoT)" by Gubbi, J., et al.