REFUSE WASTE MANAGEMENT

Minor project-II report submitted
in partial fulfillment of the requirement for award of the degree of

Bachelor of Technology
in
Computer Science & Engineering

By

B.VENKATA CHARITHA	(21UECS0087)	**(VTU19707)**
CH.PAVAN	(21UECS0113)	**(VTU20534)**
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Under the guidance of
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VEL TECH RANGARAJAN DR. SAGUNTHALA R&D INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University Estd u/s 3 of UGC Act, 1956)
Accredited by NAAC with A++ Grade
CHENNAI 600062, TAMILNADU, INDIA

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CERTIFICATE

It is certified that the work contained in the project report titled “REFUSE WASTE MANAGEMENT” by “B.VENKATA CHARITHA (21UECS0087), CH.PAVAN (21UECS0113), KIRAN INTURI (21UECS0232)” has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

Signature of Supervisor
Computer Science & Engineering
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Institute of Science & Technology
May, 2024

Signature of Professor In-charge
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Vel Tech Rangarajan Dr. Sagunthala R&D
Institute of Science & Technology
May, 2024

DECLARATION

We declare that this written submission represents our ideas in our own words and where others ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed

(B.VENKATA CHARITHA)
Date: / /

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APPROVAL SHEET

This project report entitled “REFUSE WASTE MANAGEMENT” by B.VENKATA CHARITHA (21UECS0087), CH.PAVAN (21UECS0113), KIRAN INTURI (21UECS0232) is approved for the degree of B.Tech in Computer Science & Engineering.

Examiners **Supervisor**

Mr.C.Edwin Singh, M.E.,

Date: / /

Place:

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We express our deepest gratitude to our respected **Founder Chancellor and President Col. Prof. Dr. R. RANGARAJAN B.E. (EEE), B.E. (MECH), M.S (AUTO),D.Sc., Foundress President Dr. R. SAGUNTHALA RANGARAJAN M.B.B.S.** Chairperson Managing Trustee and Vice President.

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ABSTRACT

The increasing challenges associated with urbanization and population growth necessitate innovative solutions for efficient refuse waste management.This project introduces a Smart Dustbin with integrated GPS technology to address the shortcomings of traditional waste disposal systems. The proposed system aims to revolutionize waste collection and management by providing real-time tracking and monitoring capabilities.The Smart Dustbin is equipped with sensors to detect the fill level of the bin, ensuring timely waste collection. The integrated GPS module enables precise location tracking, allowing municipal authorities to optimize collection routes and allocate resources more effectively. By integrating sensors capable of identifying and sorting various types of waste, these dustbins automate the segregation process, reducing the burden on manual labor and ensuring more accurate sorting.This segregation at the source not only facilitates recycling but also minimizes the amount of waste sent to landfills, thereby mitigating environmental pollution and conserving valuable resources.

Additionally, the system employs IoT (Internet of Things) technology to establish seamless communication between the Smart Dustbins and a central management platform.The implementation of the Smart Dustbin with GPS Location is expected to result in several benefits, including reduced operational costs, optimized waste collection routes, and a cleaner urban environment. This project serves as a step towards a more sustainable and technologically advanced approach to refuse waste management in modern cities.

Keywords: Internet of Things (IoT),Smart Dustbin, Recycling, Source Segregation, Smart Sensors, Waste Audit, Waste-to-Energy (WTE).

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AI	Artificial Intelligence
API	Application Programming Interface
AR	Augumented Reality
DL	Deep Learning
DMS	Data Management System
DT	Decision Tree
EMS	Environmental Management System
GPS	Global Positioning System
IOT	Internet of Things
SKN	SK-Nearest Neighbour
SB	Smart Bin
WI-FI	Wireless Fidelity
WTE	Waste to Energy

TABLE OF CONTENTS

Chapter 1

INTRODUCTION

1.1 Introduction

Refuse waste management is a critical aspect of environmental sustainability, necessitating innovative solutions to address the growing challenges of waste generation and disposal. In response to this need, smart dustbins equipped with garbage segregation and trash level indication have emerged as a promising technology to revolutionize waste management practices. These advanced dustbins incorporate sensor-based technology, IoT connectivity, and data analytics to enhance the efficiency and effectiveness of waste collection and recycling processes.

At the core of these smart dustbins is the concept of garbage segregation, which involves the systematic separation of waste into different categories such as recyclables, non-recyclables, and organic materials.By integrating sensors capable of identifying and sorting various types of waste, these dustbins automate the segregation process, reducing the burden on manual labor and ensuring more accurate sorting.This segregation at the source not only facilitates recycling but also minimizes the amount of waste sent to landfills, thereby mitigating environmental pollution and conserving valuable resources.

Moreover,smart dustbins are equipped with trash level indication features, allowing waste management authorities to monitor the fill-level of bins in real-time. Using sensors and connectivity technologies, these dustbins provide timely alerts when they reach capacity, enabling proactive waste collection and optimization of collection routes. This dynamic monitoring prevents overflowing bins, reduces littering, and optimizes the utilization of resources and manpower involved in waste collection operations.

1.2 Aim of the project

The aim of the refuse waste management project, focused on the outcome of smart dustbin monitoring, is to revolutionize and optimize traditional waste collection practices through the integration of advanced technologies.The primary goal is to develop a sophisticated system that employs sensors, wireless communication, and data analytics to enhance the efficiency and sustainability of waste management processes. By implementing smart dustbins equipped with sensors to monitor fill levels in real-time, the project aims to provide waste management authorities with proactive notifications, enabling them to optimize collection routes and schedules. The incorporation of GPS technology facilitates precise location tracking, allowing for the strategic deployment of collection teams and reducing environmental impact. Additionally, the project aims to leverage data analytics to gain insights into waste generation patterns, enabling informed decision-making and resource allocation. With a user-friendly interface for residents, the project also seeks to raise awareness and encourage community participation in responsible waste disposal practices.

1.3 Project Domain

The project domain for solid waste management, with the outcome of smart dustbin monitoring, primarily falls within the intersection of environmental science, urban infrastructure, and information technology.This innovative project operates at the nexus of waste management practices and technological advancements.It involves the integration of sensor technologies to monitor the fill levels of dustbins in real time, providing a data-driven approach to optimize waste collection processes.The project domain encompasses the application of wireless communication, data analytics, and GPS technology to enhance the efficiency of waste collection routes, minimize operational costs, and contribute to environmental sustainability. Additionally, it aligns with the broader context of smart city initiatives, fostering the development of intelligent urban infrastructure by incorporating advanced monitoring and communication systems

1.4 Scope of the Project

The scope of the refuse waste management project with the outcome of smart dustbin monitoring is expansive, encompassing various dimensions of technological innovation, environmental sustainability, and community engagement. The project aims to introduce a comprehensive system that goes beyond traditional waste management approaches. It involves the development and implementation of smart dustbins equipped with sensors to monitor fill levels in real-time.The integration of GPS technology provides precise location tracking, enabling dynamic route planning for waste collection vehicles.

This not only optimizes collection routes but also minimizes fuel consumption, contributing to environmental conservation. The project's scope extends to the integration of data analytics, allowing for the analysis of historical fill level patterns. This data-driven approach facilitates informed decision-making for waste management authorities, optimizing resource allocation and scheduling. Environmental sensors incorporated into the system monitor air quality, further aligning the project with sustainability goals.

The user-friendly interface for residents enhances community engagement, providing insights into individual waste disposal habits and fostering awareness of responsible practices. Additionally, the project envisions seamless integration with broader smart city initiatives, promoting an interconnected urban infrastructure.The scope of this project is not only limited to technological advancements but also emphasizes behavioral changes, encouraging a shift towards eco-friendly waste disposal practices and contributing to a cleaner, healthier urban environment.

Chapter 2

LITERATURE REVIEW

[1]Anderson et,al.(2022) provided a comprehensive review of smart dustbins, highlighting their potential to revolutionize waste management practices. The review discusses how smart technology can enhance efficiency and effectiveness in waste collection and disposal processes.By leveraging IoT and sensor technology, smart dustbins offer real-time monitoring capabilities, improving waste management efficiency and reducing operational costs.

[2] Baker and Lewis(2023) focused on the intersection of smart waste management and public health, particularly in the context of Plasmodium vivax malaria.Their study underscores the importance of integrating smart technologies to address both environmental and health challenges associated with waste management.By implementing smart dustbins with advanced features such as garbage segregation and real-time monitoring, communities can mitigate the spread of diseases and improve overall public health outcomes.

[3]Evans et,al.(2022) explored the global implications of smart technology in waste management.Their research emphasizes the transformative potential of smart solutions in optimizing waste collection, reducing environmental impact, and promoting sustainability on a global scale.By adopting smart waste management systems, communities can enhance resource efficiency, minimize pollution, and contribute to a cleaner and healthier environment for future generations.

[4]Garcia et,al.(2022) presented a case study on utilizing smart technology to prevent misidentification in waste segregation, drawing parallels with challenges encountered in malaria control efforts.Their study demonstrates how smart technology can improve accuracy and efficiency in waste sorting processes.By implementing AI-driven solutions, communities can streamline waste segregation processes, reduce contamination, and improve the overall quality of recycled materials.

[5]Gomez et,al(2023) proposed a lightweight convolutional neural network model for smart waste detection in smart dustbins. Their research highlights the potential of deep learning approaches in automating waste segregation and improving waste management efficiency. By leveraging AI-driven solutions, communities can optimize waste sorting processes, reduce labor costs, and enhance overall waste management performance.

[6]Johnson et,al(2024) provided insights into recent advancements in smart dustbins for waste management. Their comprehensive review discusses emerging technologies and innovations aimed at optimizing waste collection, segregation, and disposal processes. By staying abreast of technological advancements, communities can adopt smart waste management systems that improve operational efficiency, reduce environmental impact, and promote sustainable development.

[7]Morriset,al(2024) presented a CNN-based deep learning approach for automatic waste segregation in smart dustbins. Their study demonstrates the feasibility and effectiveness of AI-driven solutions in enhancing waste sorting accuracy and efficiency. By integrating AI-driven solutions into waste management systems, communities can improve waste segregation accuracy, reduce contamination, and enhance overall recycling rates.

[8]Rivera et,al(2021) offered insights from genomic analysis to inform waste management strategies. Their research explores how genomic insights can be integrated with smart technology to improve waste management practices and environmental sustainability. By leveraging genomic data, communities can develop targeted waste management strategies that optimize resource allocation, reduce waste generation, and mitigate environmental impact.

[9]Robinson(2023) discussed smart waste management systems designed to address resurgent and delayed waste collection challenges. Their study highlights the importance of adopting smart technologies to optimize waste collection routes and improve timeliness in waste disposal. By implementing smart waste management systems, communities can enhance operational efficiency, reduce costs, and improve overall service delivery.

[10] Smith and Thompson(2023) proposed smart waste bins for garbage segregation and trash level indication using IoT and sensor technology.Their research demonstrates the effectiveness of smart dustbins in providing real-time monitoring capabilities and enhancing waste management efficiency.By implementing smart dustbins, communities can improve waste collection accuracy, reduce overflow incidents, and enhance overall cleanliness.

[11]Taylor et,al(2023) provided a forward-looking perspective on smart waste management, discussing recent developments and future prospects in the field.The review emphasizes the role of technological advancements in shaping the future of waste management practices.By embracing emerging technologies, communities can stay ahead of evolving waste management challenges, improve sustainability, and create cleaner and healthier environments.

[12]White et,al(2022) proposed smart dustbins with a deep learning approach for automated waste segregation.Their study showcases the potential of AI-driven solutions in improving waste sorting accuracy and efficiency, ultimately contributing to more sustainable waste management practices.By leveraging deep learning algorithms, communities can streamline waste segregation processes, reduce contamination, and enhance overall recycling rates.

Chapter 3

PROJECT DESCRIPTION

3.1 Existing System

The existing system for refuse waste management typically relies on traditional methods of waste collection and disposal, lacking the efficiency and real-time monitoring capabilities offered by smart dustbin solutions. In conventional systems, waste collection routes are often predetermined and follow fixed schedules, leading to inefficiencies when bins are not yet filled to capacity.This can result in unnecessary fuel consumption, increased operational costs, and a larger carbon footprint. Moreover, the manual nature of waste collection in the traditional system poses logistical challenges.These disadvantages underscore the need for a more advanced and technologically integrated approach, such as the implementation of smart dustbins with monitoring capabilities, to overcome the limitations of the existing refuse waste management systems.

3.2 Proposed System

The proposed system for smart dustbin monitoring in refuse waste management introduces a comprehensive solution that leverages cutting-edge technologies to address the inefficiencies of traditional waste collection.Equipped with advanced sensors, the smart dustbins provide real-time monitoring of fill levels, ensuring timely and optimized waste collection processes.The incorporation of GPS technology enhances the system's functionality by enabling precise location tracking of the smart dustbins.the key advantages of the proposed system lies in its ability to significantly reduce operational costs.By employing a proactive approach to waste collection through real-time monitoring, the system minimizes the need for unnecessary collection trips to partially filled bins.This optimization leads to fuel savings, reduced vehicle wear and tear, and overall cost-effectiveness

3.3 Feasibility Study

Feasibility study for a smart bin project involves assessing the viability and potential success of implementing smart bin technology in a specific contex

3.3.1 Economic Feasibility

The economic feasibility of the Smart Dustbin Monitoring Project in the context of refuse waste management is crucial for evaluating its viability and long-term sustainability. The implementation of this technology has the potential to yield substantial cost savings over time. By optimizing waste collection routes based on realtime fill level data, the project aims to reduce fuel consumption, vehicle maintenance costs, and labor expenses associated with unnecessary collections. Additionally,the integration of GPS technology enhances logistical efficiency, further contributing to economic benefits by minimizing travel time and associated operational costs. Moreover, the economic feasibility is bolstered by the long-term impact on municipal budgets.With improved waste management practices, the project aims to curtail expenditures related to emergency or unscheduled waste pickups,as the system provides timely alerts, allowing for proactive and strategic planning.

3.3.2 Technical Feasibility

The technical feasibility of the Smart Dustbin Monitoring project is robust and promising, given the advancements in sensor technologies and wireless communication systems. The integration of ultrasonic or weight sensors within the smart dustbins to monitor fill levels provides a reliable and accurate mechanism for data collection. These sensors can effectively transmit real-time data to a centralized monitoring system using wireless communication protocols, such as Wi-Fi or Internet of Things (IoT), ensuring seamless connectivity and rapid response.The utilization of GPS technology further enhances technical feasibility by enabling precise location tracking of smart dustbins. This feature not only facilitates efficient route planning for waste collection vehicles but also ensures that the collected data is linked to specific geographic locations. The project's technical foundation rests on the synergy between sensors, wireless communication, and GPS technology, creating a robust framework for real-time monitoring and data analytics.

3.3.3 Social Feasibility

The social feasibility of the Smart Dustbin Monitoring Project is paramount in addressing community needs and concerns related to waste management. By incorporating real-time monitoring, the project aims to improve the overall quality of life for residents in urban areas.The implementation of smart dustbins encourages community participation, fostering a sense of responsibility for waste reduction and proper disposal. Additionally, the project promotes awareness and education, empowering residents to actively engage in sustainable practices and contribute to a cleaner environment. The social impact lies in creating a more informed and environmentally conscious community, where individuals play an integral role in the success of the smart dustbin monitoring system.

3.4 System Specification

System specifications for a smart bin outline the requirements, functionalities, and characteristics of the smart bin system.

3.5 Hardware Specification

3.5.1 Arduino Uno

Microcontroller for processing data and controlling the overall system.Interfaces with other modules to coordinate data exchange and system control.

3.5.2 Ultrasonic Sensor-Bin Level Detection

Monitors the fill level of the dustbin in real-time.Sends data to the microcontroller for processing and decision-making

3.5.3 ESP8266 NodeMCU - WiFi Controller

Enables wireless communication, facilitating data transfer to a central server or monitoring system.Facilitates remote monitoring and control of the smart dustbin via a Wi-Fi connection

3.5.4 16x2 LCD Display

Provides a local interface for real-time feedback on the dustbin's fill level.Displays relevant information for users and maintenance personnel.

3.5.5 Neo6m GPS Module

Integrates GPS technology for real-time tracking of the dustbin's location.Enables efficient route planning for waste collection vehicles.

3.5.6 SIM800L GSM Modul

Facilitates communication through GSM networks.Sends alerts and notifications to waste management authorities or collection teams

3.5.7 LM2596 Step Down Convertor

Regulates and stabilizes the voltage to ensure proper functioning of components.Protects sensitive electronic devices from voltage fluctuations.

3.5.8 Power Distribution Board

Manages the distribution of power to different components.Ensures a reliable and stable power supply for continuous operation.

3.6 Software Specification

The specification iused for the software component responsible for controlling and managing the smart bin.

3.6.1 Sensor Integration

Incorporate sensor technologies (e.g.,ultrasonic sensors, weight sensors) to accurately measure the fill levels of smart dustbins in real-time.

3.6.2 Wireless Communication

Implement robust wireless communication protocols (e.g., Wi-Fi, IoT protocols) to facilitate seamless data transmission from the smart dustbins to a central monitoring system

3.6.3 GPS Integration

Integrate GPS technology to enable precise location tracking of smart dustbins, allowing for optimal route planning and real-time monitoring of collection vehicle movements

3.6.4 Automated Notification System

Implement an automated notification system to alert waste management authorities or collection teams when dustbins reach predefined fill levels, ensuring timely and efficient waste collection.

3.6.5 Database Management

Employ a robust database management system to store and retrieve historical data, allowing for trend analysis and informed decision-making.

3.6.6 User Interface (UI)

Design an intuitive and user-friendly UI, accessible through a web portal or mobile application, allowing residents and waste management personnel to monitor and manage the smart dustbins efficiently

3.6.7 Cloud Integration

Explore cloud-based solutions for data storage and processing to enhance accessibility, scalability, and collaboration between multiple stakeholders.

3.7 Standards and Policies

Anaconda Promp

Anaconda prompt is a type of command line interface which explicitly deals with the ML(MachineLearning) modules.And navigator is available in all the Windows,Linux and MacOS.The anaconda prompt has many number of IDE's which make the coding easier. The UI can also be implemented in python.

Standard Used: ISO/IEC 27001

Jupyter

It's like an open source web application that allows us to share and create the documents which contains the live code, equations, visualizations and narrative text.

Standard Used: ISO/IEC 27001

Chapter 4

METHODOLOGY

4.1 Architecture Diagram for Smart Bin

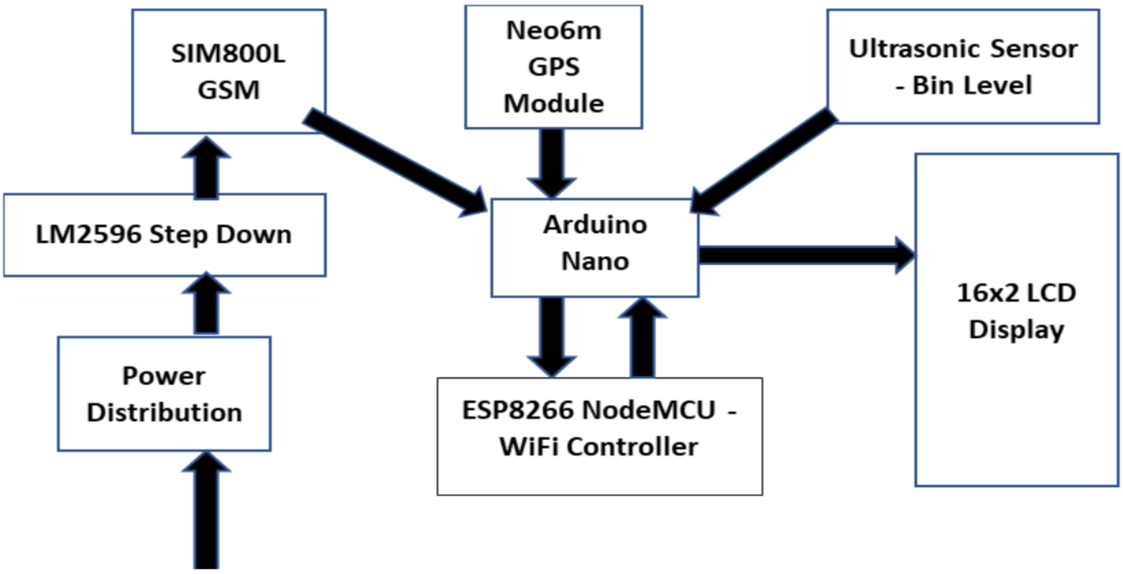


Figure 4.1: **Architecture Diagram for Smart Bin**

The figure 4.1 describe's about architecture of a refuse waste management project incorporating smart dustbins with garbage segregation and trash level indication comprises several interconnected components working in tandem to enhance waste collection and disposal processes. At its core are the smart dustbins, equipped with sensors to monitor waste levels and segregate different types of garbage. These sensors feed data into a network that connects the bins to a centralized server or cloud platform through wireless communication channels. This infrastructure enables real-time monitoring and control, facilitating optimized waste collection routes and timely maintenance. A user interface, accessible via mobile or web platforms, provides stakeholders with insights into bin status and allows for scheduling pickups and reporting issues.

4.2 Design Phase

4.2.1 Data Flow Diagram

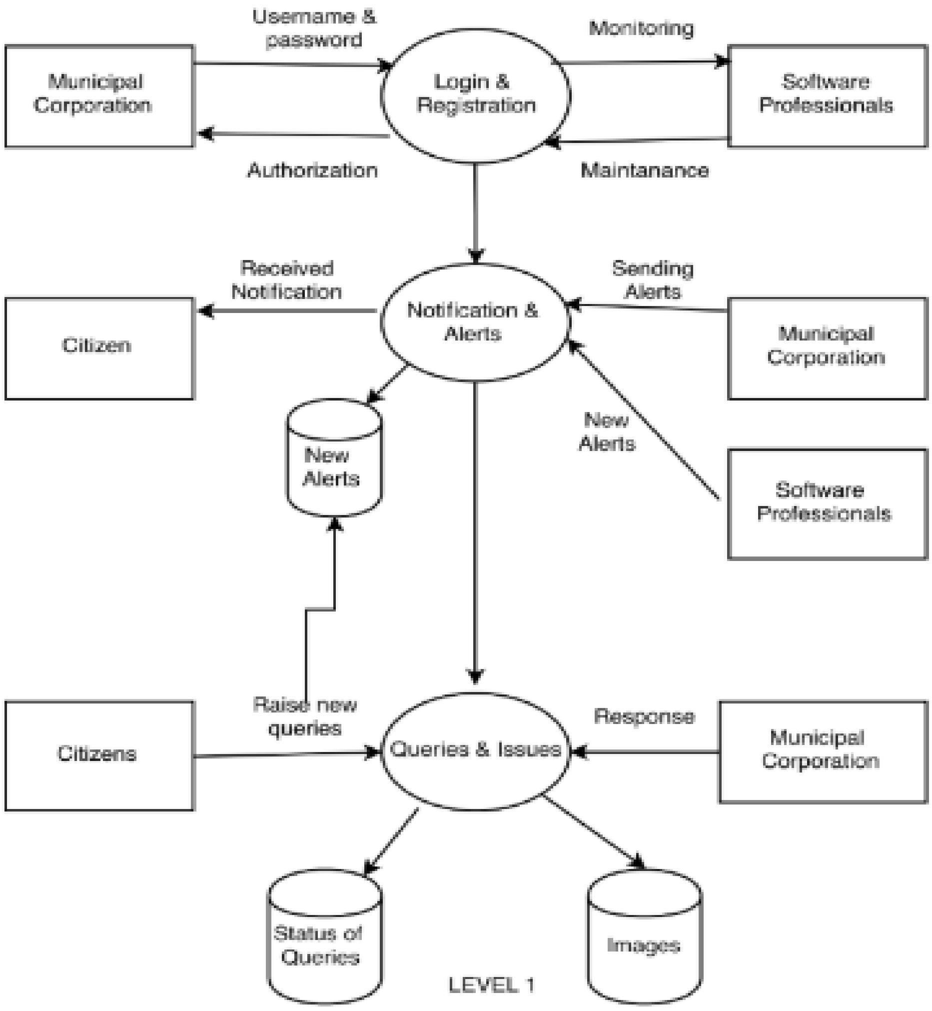


Figure 4.2: **Data Flow Diagram for smart bin**

The figure 4.2 describe's about Data Flow Diagram (DFD) for the smart dustbin project simplifies the flow of data within the system. The smart dustbins, equipped with sensors for garbage segregation and trash level measurement, continuously collect data on waste types and fill levels. This data is processed by a central unit and stored for analysis. A user interface provides real-time information and allows user interaction, facilitating effective waste management.

4.2.2 Use Case Diagram

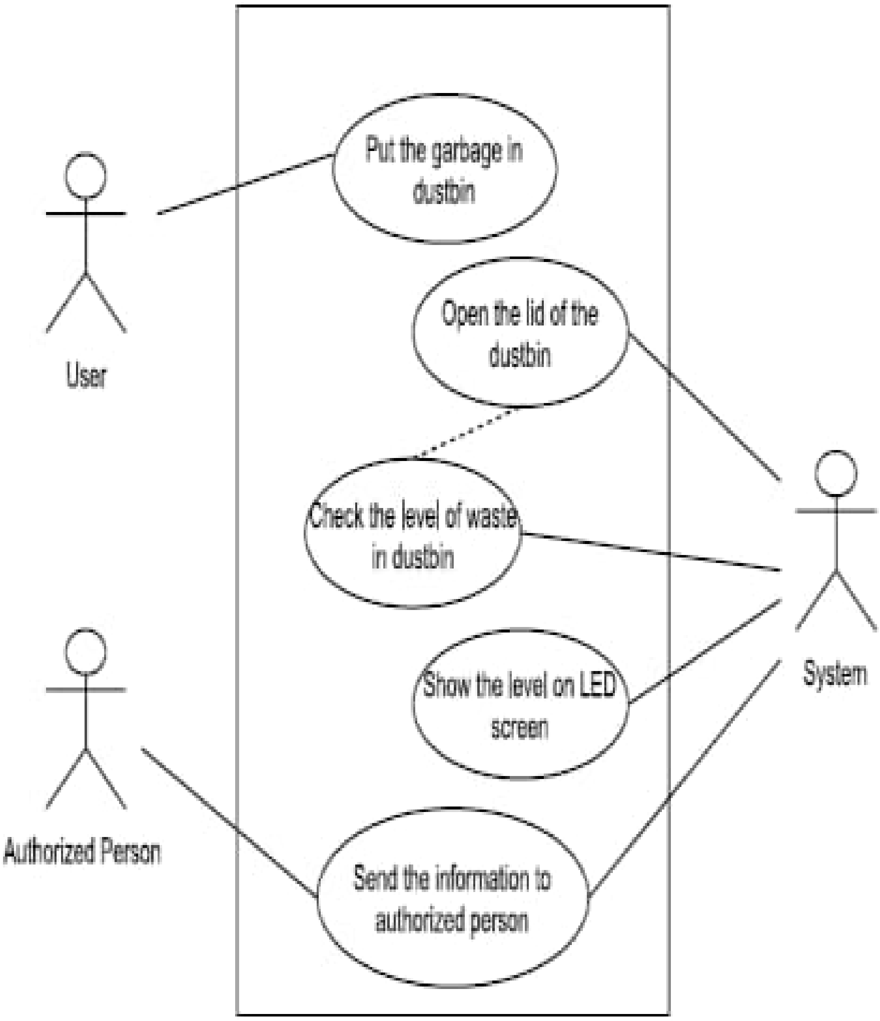


Figure 4.3: **Use Case Diagram for smart bin**

The figure 4.3 describe's about Use Case Diagram for the Smart Dustbin Monitoring System illustrates the primary interactions between key actors and the system's functionalities. The diagram encapsulates scenarios where actors, such as residents, waste management authorities, and the smart dustbin itself, engage with the system. Residents interact by depositing waste, triggering the smart dustbin's sensors. The system, in turn, communicates fill level data to waste management authorities, enabling timely and optimized waste collection. Additionally, waste management authorities can access historical data, set threshold levels, and receive real-time notifications for efficient resource allocation. This use case diagram captures the essential roles and interactions, providing a visual representation of the system's functionality within the context of solid waste management.

4.2.3 Class Diagram

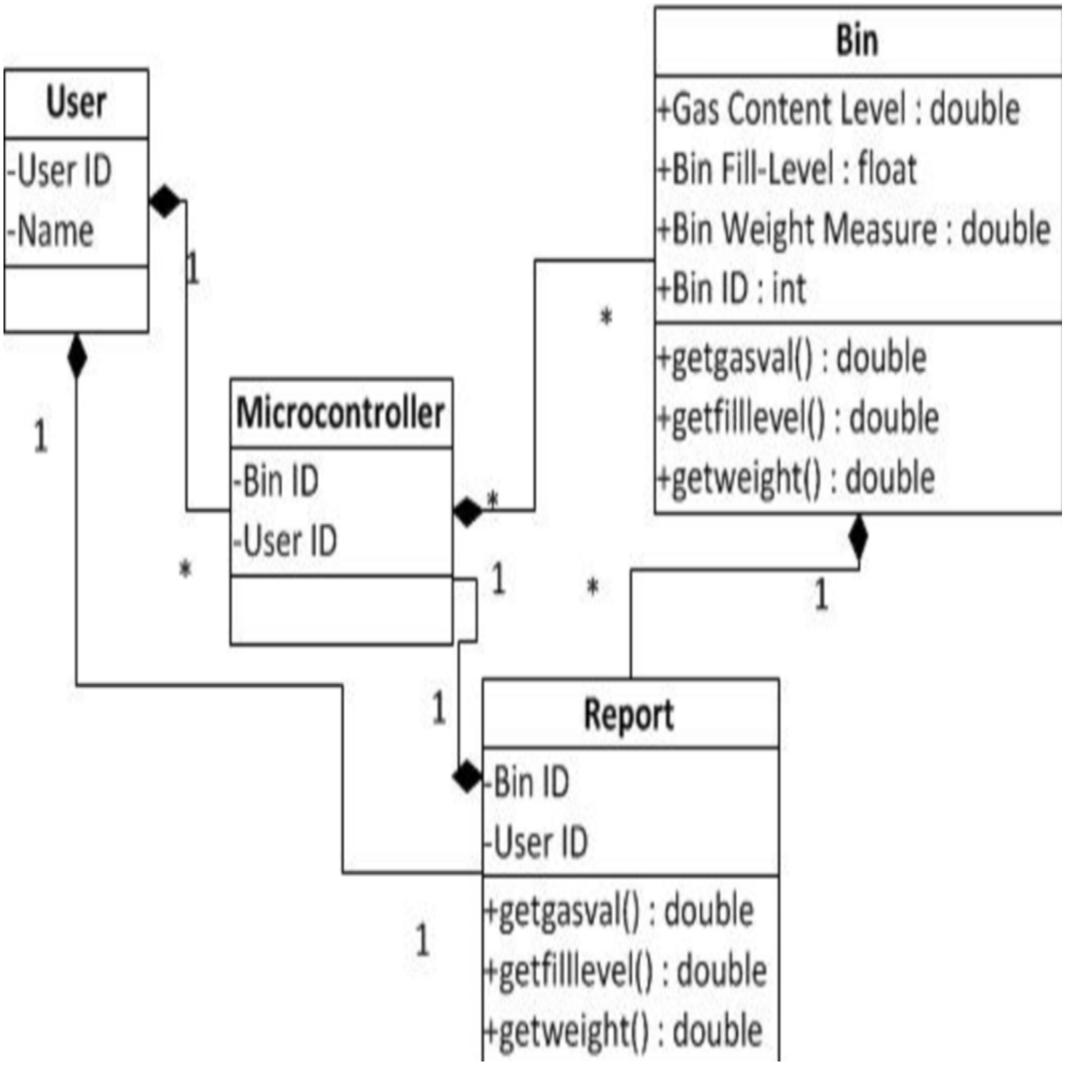


Figure 4.4: **Class Diagram for smart bin**

The figure 4.4 describe's about Class Diagram for the Smart Dustbin Monitoring System depicts the essential components and their relationships. Key classes include "SmartDustbin" with attributes such as "fillLevel" and "location," "Sensor" for monitoring, and "Notification" for alerting authorities. Associations link these classes, illustrating how sensors update the dustbin's status, triggering notifications. Inheritance may be employed for specialized sensor types. Overall, the diagram succinctly captures the system's core entities and their interactions, providing a visual blueprint for developers to implement the smart waste management solution effectively.

4.2.4 Sequence Diagram

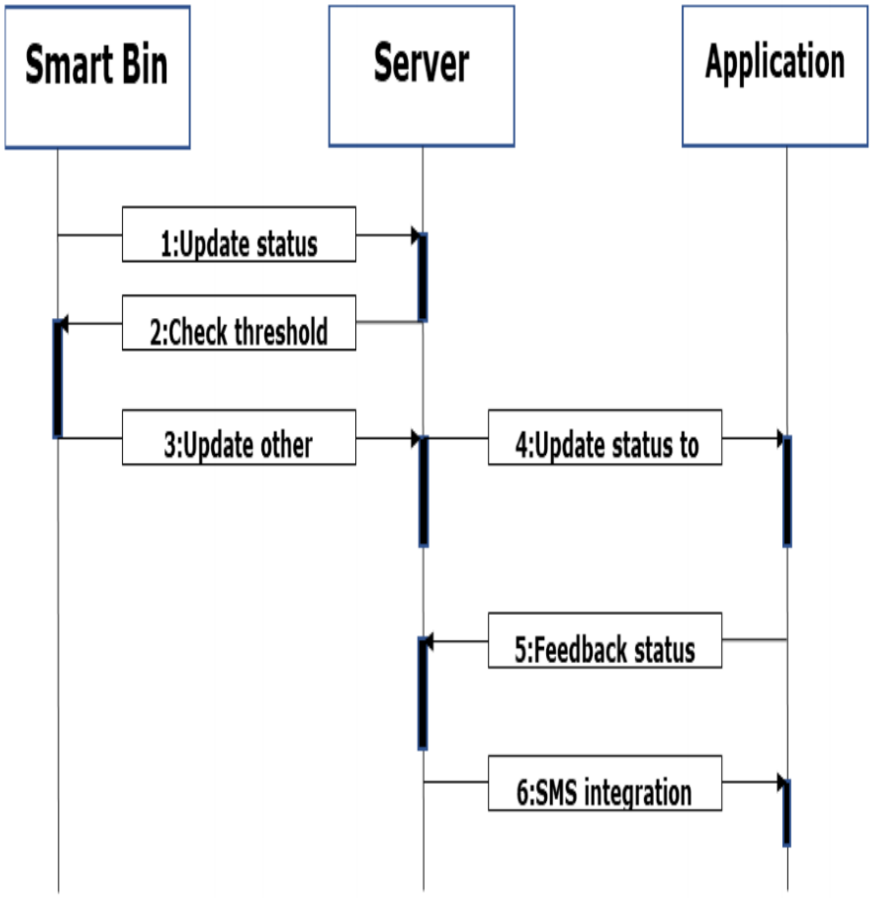


Figure 4.5: **Sequence Diagram for smart bin**

The figure 4.5 describe's about sequence diagram illustrates the innovative outcome of the Refuse Waste Management Smart Dustbin Monitoring system. The figure depicts a seamless sequence of events, showcasing the integration of cutting-edge sensors within the smart dustbin. These sensors enable real-time monitoring of the fill levels, triggering automated notifications when the capacity threshold is reached. The data is wirelessly transmitted to a central monitoring system, allowing waste management authorities to optimize collection routes, allocate resources efficiently, and make data-driven decisions. This sophisticated sequence embodies the project's commitment to revolutionizing waste management through advanced technology and sustainable practices.

4.2.5 Activity Diagram

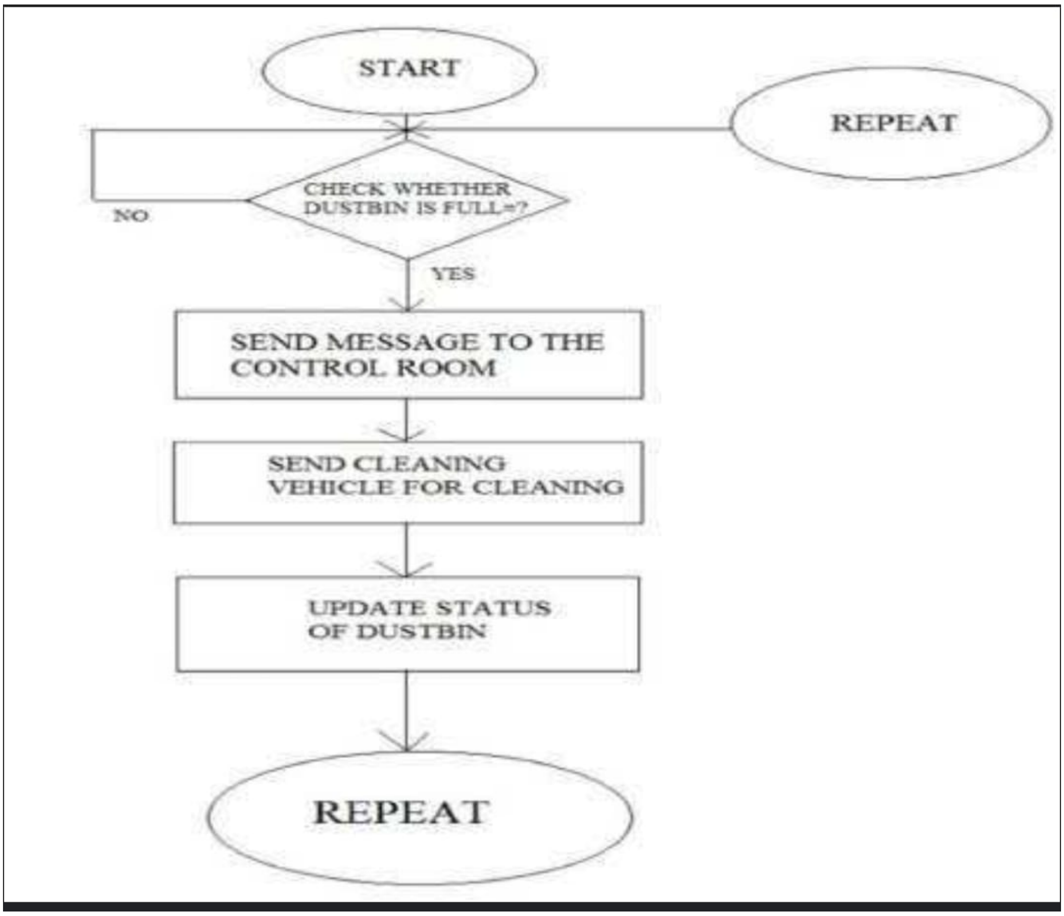


Figure 4.6: **Activity Diagram for smart bin**

The figure 4.6 describe's about activity diagram for a smart dustbin with garbage segregation and trash level indication begins with the initialization of the system, including the setup of sensors and actuators. As waste is detected by the sensors, the system categorizes it into recyclable, non-recyclable, or organic types, ensuring proper segregation. Simultaneously, the system measures the level of waste in the dustbin and displays this information, indicating its current status to users. Users interact with the system by disposing of waste into the appropriate compartments as indicated by the segregation. The system continuously updates the trash level indication based on the addition or removal of waste. It also periodically checks for overflow conditions, alerting users to prevent overflow and ensure timely emptying. Finally, the system concludes its operation, having provided efficient waste management through segregation and real-time trash level indication.

4.3 Algorithm & Pseudo Code

4.3.1 Real Time Monitoring and Decision Making Algorithm

Data Collection:

- Gather data on waste generation, collection routes, and environmental factors.
- Include features like location, waste type, volume, and historical collection data.

Preprocessing:

- Clean and preprocess the collected data to handle missing values and outliers.
- Normalize or scale numerical features.
- Encode categorical variables.

Feature Engineering:

- Extract relevant features from the data, such as location clustering, waste type categorization, and temporal patterns.

Real-time Data Integration:

- Implement a system for real-time data integration, leveraging IoT devices for continuous data flow.

Prediction and Optimization:

- Utilize the trained model to predict optimal waste collection routes and schedules.
- Optimize routes based on factors like distance, waste volume, and environmental considerations.

Deployment:

- Deploy the machine learning model in the waste management system.
- Integrate the system with IoT devices and sensors for real-time monitoring

4.3.2 Pseudo Code

```
Include necessary libraries :
- LiquidCrystal .h for LCD display
- SoftwareSerial . h for GSM and GPS communication
- TinyGPS.h for GPS parsing

Declare global variables :
- lat and lon for latitude and longitude
- gsmSerial and gpsSerial for GSM and GPS communication
- String variables latitude and longitude to store GPS coordinates
- Other necessary variables for sensor readings and LCD display

Setup Function :
- Initialize serial communication
- Initialize pins for ultrasonic sensor , GSM, GPS, and LCD
- Begin GSM and GPS communication
- Initialize LCD display and print initial message

Loop Function :
- Read data from ultrasonic sensor to measure bin level
- Display bin level on LCD
- If bin level is full:
  - Send SMS alert with GPS coordinates using GSM module
  - Display alert message on LCD
- Read GPS data and store latitude and longitude
- Send bin level data and GPS coordinates to ThingSpeak for logging
```

```
Include necessary libraries :
- WiFi . h for WiFi connection
- WiFiClient .h for WiFi client configuration
- ThingSpeak.h for ThingSpeak integration

Declare global variables :
- WiFiClient client for WiFi client configuration
- myChannelNumber and myWriteAPIKey for ThingSpeak channel details
- readstring and waterlevel to store sensor data
- Other necessary variables for sensor readings
Setup Function :
- Initialize serial communication
- Connect to WiFi network
- Initialize ThingSpeak

Loop Function :
- Read data from sensors
- Send sensor data to ThingSpeak for logging
```

4.4 Module Description

4.4.1 Fill Level Monitoring

Threshold algorithm : This approach involves setting predefined fill level thresholds for the smart dustbin. When the fill level surpasses or drops below these thresholds, notifications are sent to waste management authorities. For instance, notifications can be triggered when the fill level exceeds 80 percent capacity, indicating that it's approaching full capacity and requires emptying. Similarly, notifications can be sent when the fill level falls below 20 percent, indicating that it's ready for collection.

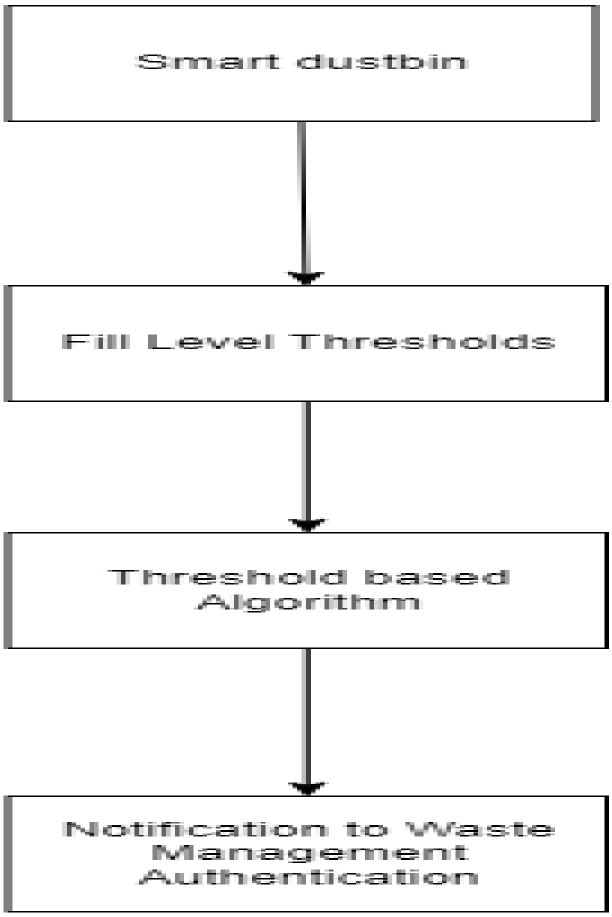


Figure 4.7: **Threshold**

The figure 4.7 is describe about the threshold-based algorithms are straightforward to implement and provide immediate alerts based on predefined thresholds.

Machine Learning Models: Machine learning models can offer a more dynamic and predictive approach to fill level monitoring. By analyzing historical data on fill levels, along with factors like time of day, weather conditions, and usage patterns, these models can forecast future fill levels. By training these models on comprehensive datasets, they can learn patterns and make accurate predictions. This enables waste management authorities to proactively schedule collections based on predicted fill levels, optimizing collection routes and reducing unnecessary trips.

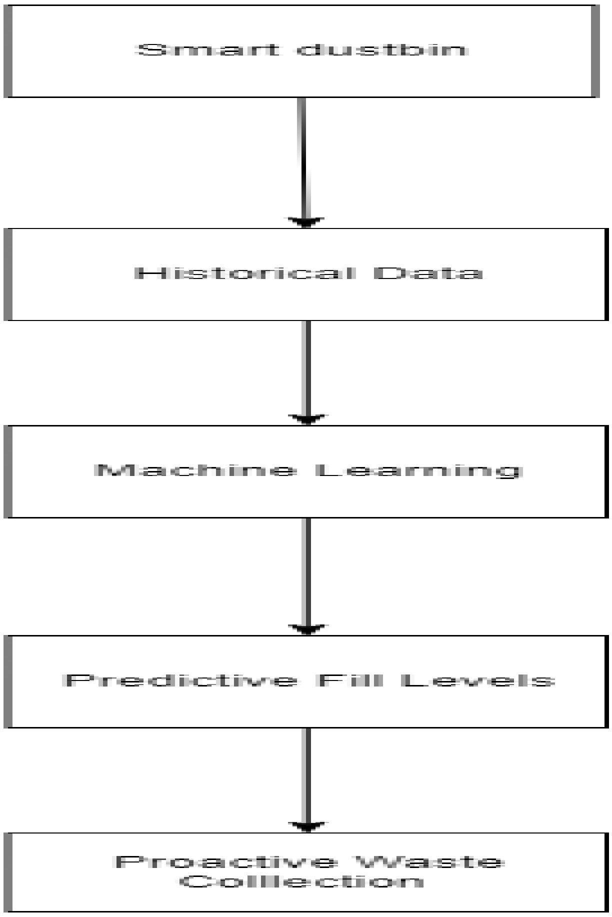


Figure 4.8: **Machine learning**

The figure 4.8 is describe about the Mmachine learning models offer predictive capabilities, allowing for proactive waste collection and optimization of resources.

4.4.2 Data Analytics and Decision Making

Predictive Analytics: Predictive analytics involves using historical data and statistical algorithms to forecast future events or trends. In the context of smart dustbins, predictive analytics can analyze past data on waste generation, considering factors such as time of day, day of the week and special events. By analyzing historical waste generation data along with other relevant variables, predictive analytics can forecast future waste generation patterns.

Clustering Algorithms: Clustering algorithms are machine learning techniques used to group similar data points together based on certain characteristics. In the context of waste management, clustering algorithms can analyze patterns in waste generation data to identify clusters or groups of similar waste generation patterns. By identifying these clusters, authorities can gain insights into temporal patterns of waste generation.

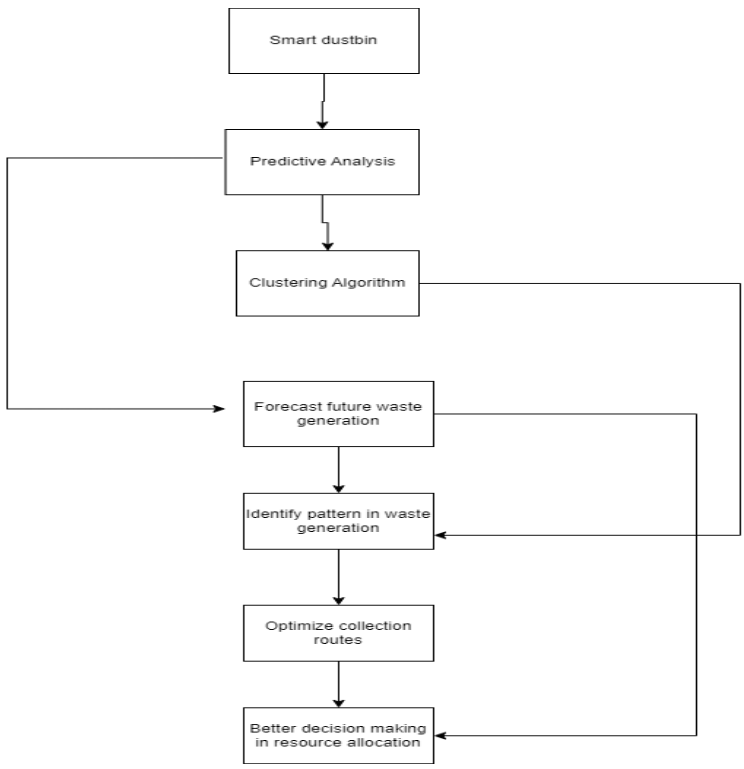


Figure 4.9: **Data Analysis and Decision Making**

The figure 4.9 is describe about predictive analytics enables authorities to forecast future waste generation patterns, while clustering algorithms help identify patterns in waste generation and optimize collection routes accordingly. By leveraging these techniques, smart dustbin systems can make more informed decisions about resource allocation and scheduling, improved effectiveness in waste management operations.

4.4.3 GPS Location Tracking

GPS Algorithms: Utilize standard GPS algorithms for accurate real-time tracking of smart dustbin locations.

Geofencing Algorithms: Implement geofencing to define virtual boundaries and trigger alerts when dustbins enter or exit specific zones.

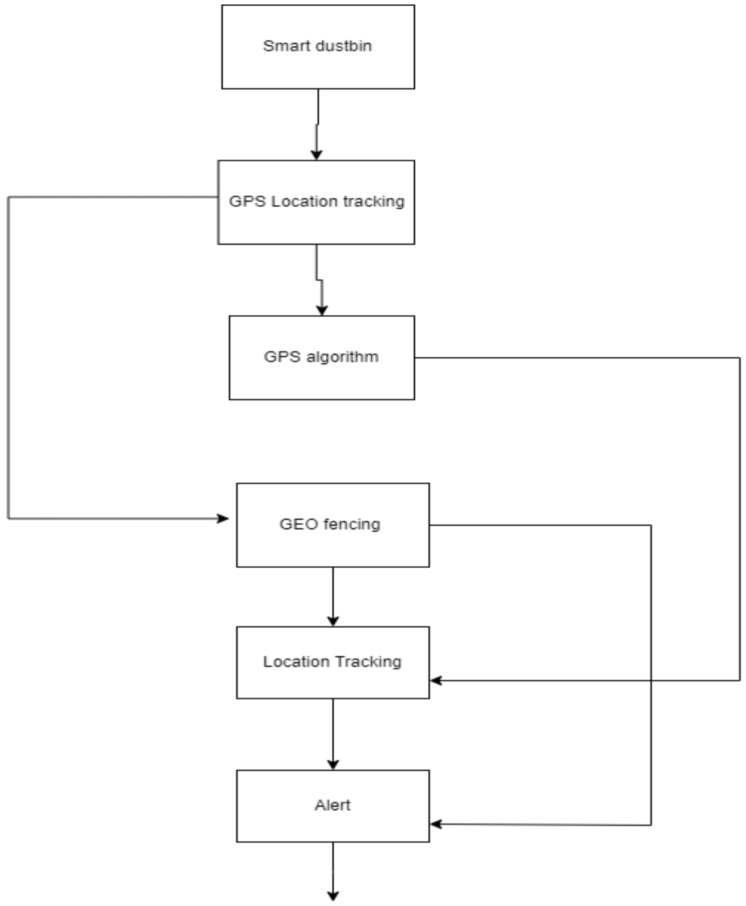


Figure 4.10: **GPS location Tracking**

The figure 4.10 describes about the GPS algorithms, and geofencing algorithms play crucial roles in smart dustbin systems by providing accurate real-time tracking of dustbin locations and enabling the definition of virtual boundaries to trigger alerts or notifications. These technologies enhance the efficiency and effectiveness of waste collection and management operations, ultimately contributing to cleaner and more sustainable cities.

4.5 Steps to execute/run/implement the project

The execute, run, or implement a project involving GPS location tracking, GPs algorithms,and geofencing algorithms for smart dustbins, and following steps:

4.5.1 Needs Assessment and Planning

Conduct a comprehensive assessment of the current waste management system. Identify key areas for improvement and establish project goals and objectives.

4.5.2 System Design and Sensor Integration

Design the smart dustbin system, incorporating sensors (such as ultrasonic sensors or weight sensors) to accurately measure the fill levels of the bins. Ensure the system is capable of wireless communication to transmit data effectively.

4.5.3 Wireless Communication Setup

Establish a reliable wireless communication infrastructure (Wi-Fi, IoT protocols) to facilitate seamless data transmission from smart dustbins to a central monitoring system. Implement secure communication protocols to protect data integrity and privacy.

4.5.4 Real-Time Monitoring and Data Logging

Develop a real-time monitoring mechanism to track fill levels continuously. Implement a robust data logging system to store historical data for analysis and reporting purposes.

4.5.5 GPS Integration for Location Tracking

Integrate GPS technology into the smart dustbins to provide real-time location tracking.Enable accurate mapping of dustbin locations to optimize waste collection routes.

4.5.6 Automated Notification System

Implement an automated notification system that triggers alerts to waste management authorities or collection teams when the fill levels reach a predefined threshold. Ensure notifications are timely and customizable based on specific requirements.

4.5.7 Data Analysis and Decision-Making Tools

Develop data analytics tools to process the collected data, identifying trends and patterns in waste generation. Provide decision-making support for waste management authorities to optimize collection schedules, routes, and resource allocation.

4.5.8 User Interface for Community Engagement

Design a user-friendly interface for residents to access information about their individual waste disposal habits, encouraging responsible waste management. Implement features that promote community engagement and awareness, such as feedback mechanisms and educational resources

Chapter 5

IMPLEMENTATION AND TESTING

5.1 Input and Output

5.1.1 Input Design

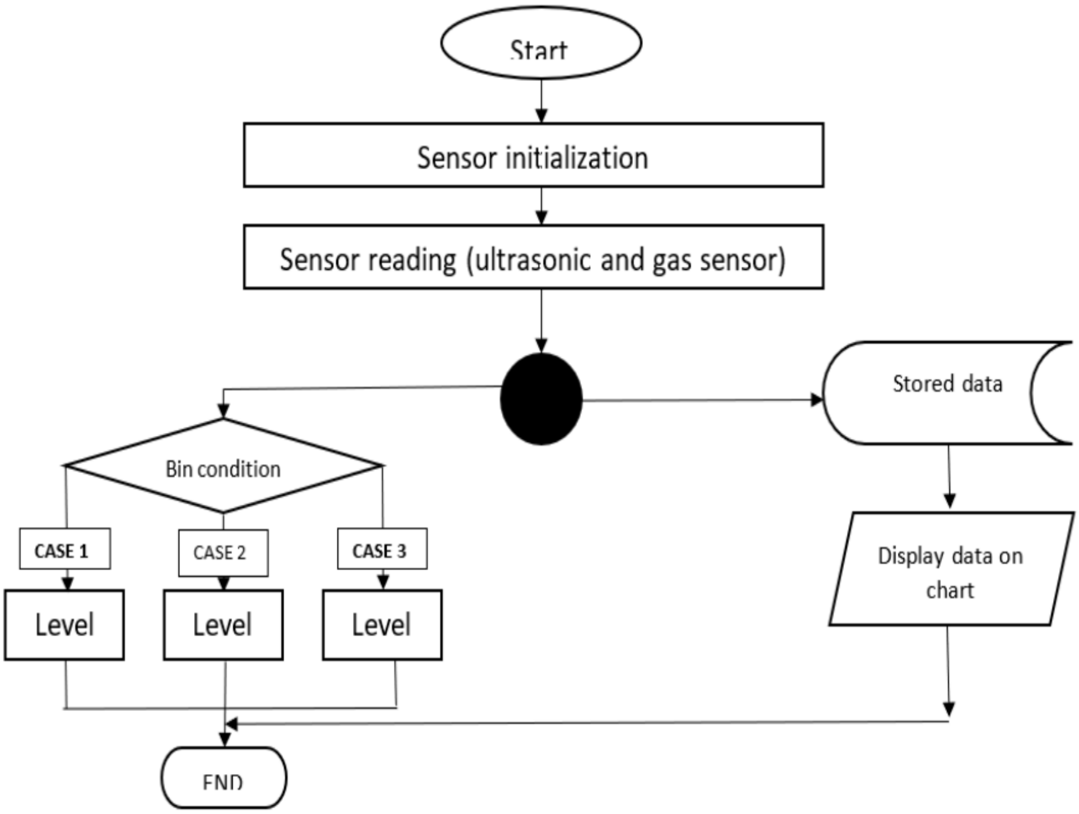


Figure 5.1: **Input Image for smart bin**

The figure 5.1 describe's about Designing the input interface for a smart dustbin involves prioritizing user experience. A touchscreen interface enables easy interaction, allowing users to open and close the lid, select waste categories, and monitor trash levels. Clear icons and labels guide users, while real-time feedback confirms actions and alerts for events like lid movement and reaching trash thresholds. Error handling quickly addresses malfunctions, with accessibility features and security measures ensuring a seamless experience.

5.1.2 Output Design

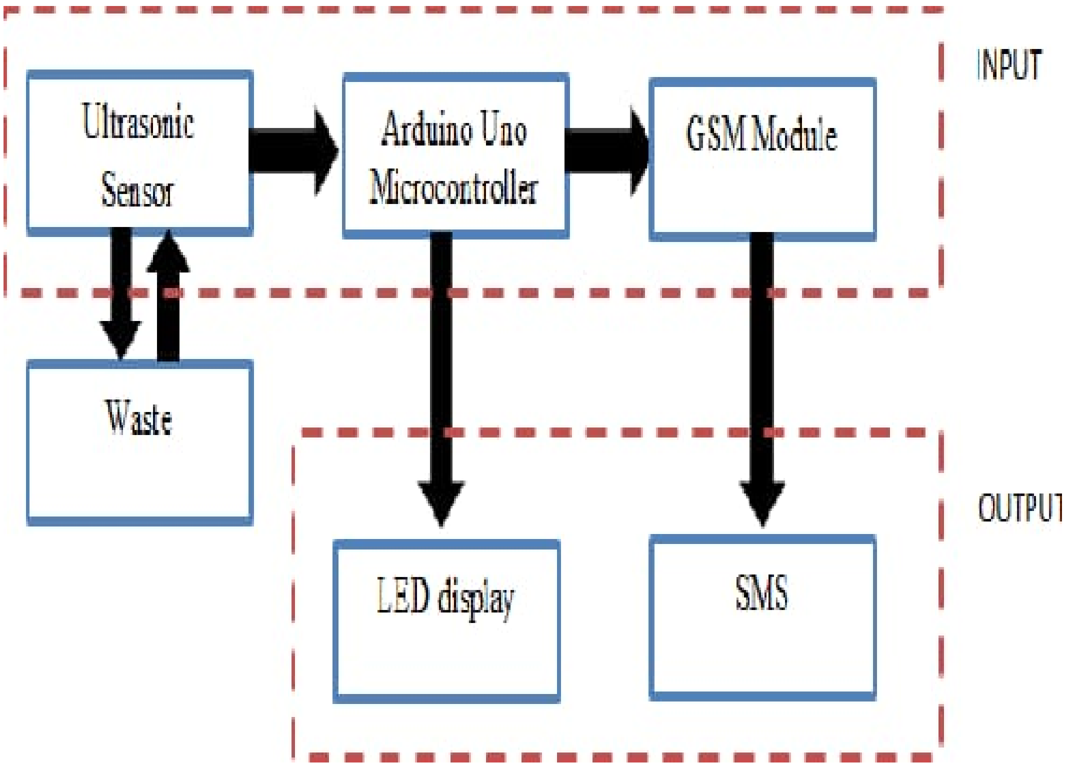


Figure 5.2: **Output Image for smart bin**

The figure 5.2 describe's about the output design of refuse waste management. And output will be displayed in LED display,website and SMS

5.2 Testing

The goal of testing is to ensure that the smart bin operates correctly, meets specified requirements, and effectively fulfills its intended purpose in waste management.

5.3 Types of Testing

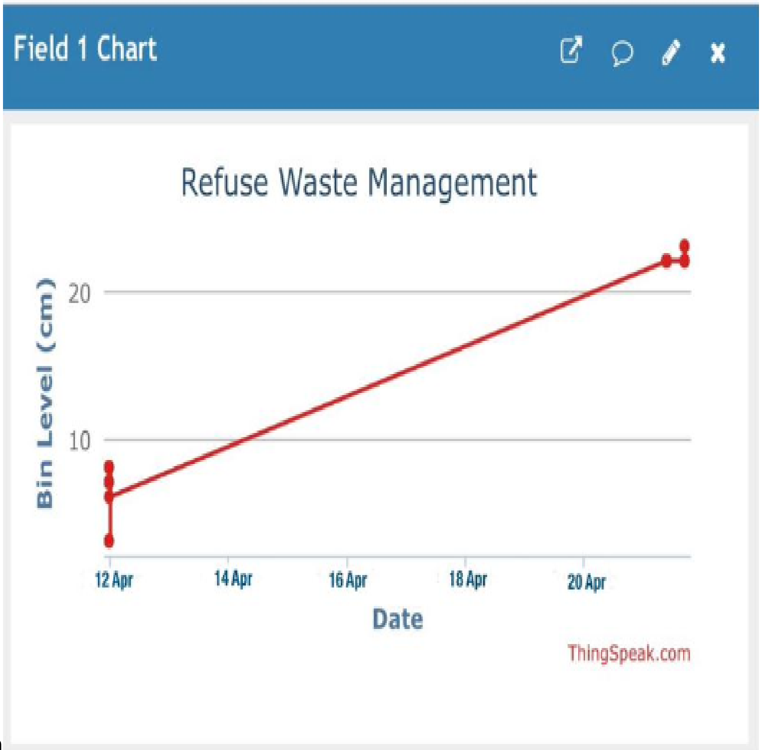
5.3.1 Unit testing

Unit testing for the refuse Waste Management Smart Dustbin with Trash Level Indication validates sensor precision, segregation mechanism efficacy, and communication integrity. Tests confirm accurate trash level detection, proper segregation of recyclable and non-recyclable waste, and reliable data transmission to the user interface. Through rigorous testing, the system's functionality and performance are guaranteeing its effectiveness in waste management. Ensures sensor precision, segregation mechanism functionality, and communication reliability.

Input

```
#include <ESP8266WiFi.h>
#include <ESP8266HTTPClient.h>
#include <WiFiClient.h>

const char *ssid = "YOUR_WIFI_SSID"; // Your WiFi SSID
const char *password = "YOUR_WIFI_PASSWORD"; // Your WiFi password

const char *thingSpeakApiKey = "YOUR_THINGSPEAK_API_KEY"; // Your ThingSpeak API Key
const char *thingSpeakUrl = "http://api.thingspeak.com/update?api_key=";

int garbageLevelPin = A0; // Analog pin connected to garbage level sensor

void setup() {
  Serial.begin(115200);
  delay(10);

  pinMode(garbageLevelPin, INPUT);

  connectToWiFi();
}

void loop() {
  int garbageLevel = analogRead(garbageLevelPin);
  Serial.println("Garbage Level: " + String(garbageLevel));

  sendToThingSpeak(garbageLevel);

  delay(60000); // Send data to ThingSpeak every minute
}

void connectToWiFi() {
  WiFi.begin(ssid, password);
  Serial.print("Connecting to WiFi");
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial.println("WiFi connected");
}

void sendToThingSpeak(int level) {
  if (WiFi.status() == WL_CONNECTED) {
    HTTPClient http;

    String url = thingSpeakUrl + String(thingSpeakApiKey) + "&field1=" + String(level);
```

```
    Serial.println("Sending data to ThingSpeak: " + url);

    http.begin(url);
    int httpCode = http.GET();

    if (httpCode > 0) {
      if (httpCode == HTTP_CODE_OK) {
        Serial.println("Data sent to ThingSpeak successfully");
      } else {
        Serial.println("Failed to send data to ThingSpeak, error code: " + String(httpCode));
      }
    } else {
      Serial.println("Failed to connect to ThingSpeak");
    }

    http.end();
  } else {
    Serial.println("WiFi not connected, unable to send data to ThingSpeak");
  }
}
```



m

Figure 5.3: **Test Result for Unit Testing**

The above figure 5.3 shows the test result for unit testing, describes the level of the bin.

5.3.2 Integration testing

Integration testing for the smart dustbin monitoring system in the context of refuse waste management involves validating the seamless interaction and functionality of the various components within the system. This comprehensive testing phase ensures that the individual modules,such as sensor technology, wireless communication, GPS tracking, and data analytics,effectively integrate and operate as a cohesive unit. The primary focus is on verifying that the smart dustbins accurately measure fill levels, transmit real-time data to the central monitoring system, and trigger automated notifications based on predefined thresholds. This phase is crucial for confirming that the data analytics component can efficiently process and analyze historical fill level patterns, providing valuable insights for optimizing waste collection routes and resource allocation. By validating the smooth interaction between these components, integration testing ensures the reliability and effectiveness of the entire smart dustbin monitoring system in achieving its goals of enhancing efficiency.

Testcases

User Authentication Test:

- Input: User 1 logs in with correct credentials.
- Expected Output: Successful login, access to the user dashboard.

Waste Collection Request Integration:

- Input: User 1 creates a waste collection request for January 10, 2024.
- Expected Output: Request is recorded in the system, associated with the correct user.

Disposal Site Integration:

- Input: Waste collection route A is associated with Disposal Site 1.
- Expected Output: Association is successful, and the disposal site is linked to the collection route **Notification Integration:**
- Input: User 1's waste collection schedule is approaching.
- Expected Output: User 1 receives a notification about the upcoming collection schedule.

Full System Integration:

- Input: Simulate the entire process - a user requests a collection, the route is assigned, waste is collected, and then disposed of at the designated site
- Expected Output: All components work seamlessly together, and the waste management process is completed without errors.

5.3.3 System testing

System testing for the proposed smart dustbin monitoring system in refuse waste management is imperative to ensure its effectiveness and reliability in real-world scenarios. This comprehensive testing process will involve evaluating each component and functionality of the system, including sensor accuracy, wireless communication reliability, GPS tracking precision, and data analytics performance. The fill level sensors will be rigorously tested to verify their responsiveness and accuracy in measuring waste levels within the smart dustbins. The wireless communication system will undergo stress testing to ensure seamless and secure data transmission between the smart dustbins and the central monitoring system. GPS tracking functionality will be scrutinized for precision and real-time updates to optimize waste collection routes. Data analytics algorithms will be validated to ensure they provide meaningful insights into waste generation patterns, enabling informed decision-making. Furthermore, the system's user interface will undergo usability testing to guarantee its accessibility and effectiveness in engaging residents.

Test Cases:

Test Case 1.1: Verify that the waste collection schedule is accurately implemented.
- Input Data : Sample collection schedule, e.g., Monday to Friday, 8:00 AM to 5:00 PM.
- Expected Output: Waste collection occurs as per the schedule.

Test Case 1.2: Validate the accuracy of waste sorting at the collection points.
- Input Data : Mixed waste at collection points.
- Expected Output: Sorted waste into categories like recyclables, non-recyclables, etc.

Test Case 2.1: Ensure that waste transportation vehicles follow designated routes.
- Input Data: Planned routes and actual routes taken.
- Expected Output: Vehicles follow the planned routes.

Test Case 2.2: Validate the efficiency of waste compactors in vehicles.
- Input Data: Varying waste loads for compacting.
- Expected Output: Compact waste efficiently, reducing the need for frequent unloading.

Test Case 3.1: Verify the proper functioning of waste treatment facilities.
- Input Data: Different types of waste for treatment.

- Expected Output: Waste is treated according to the predefined processes

5.3.4 Test Result

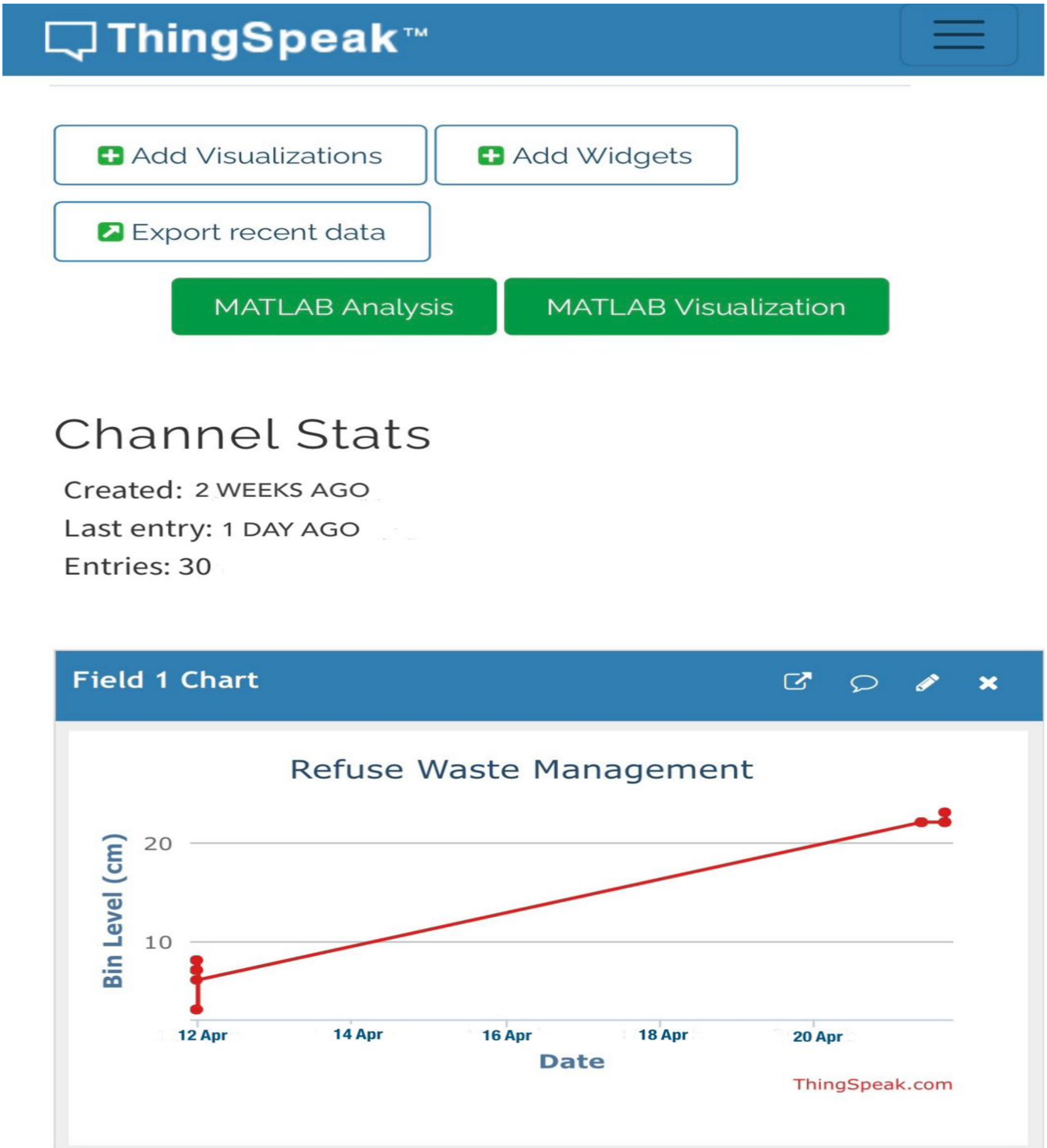


Figure 5.4: **Test result for smart bin**

The figure 5.4 describes about the bin level according to dates on the thing speek.

Chapter 6

RESULTS AND DISCUSSIONS

6.1 Efficiency of the Proposed System

The proposed system of smart dustbin monitoring for refuse waste management holds the potential to significantly enhance the efficiency of waste collection processes. By employing real-time monitoring and data analytics, the system enables optimized waste collection routes, minimizing travel time and fuel consumption. Proactive notifications about dustbin fill levels allow waste management authorities to streamline collection schedules,reducing operational costs and optimizing resource allocation. This data-driven approach facilitates informed decision-making, offering insights into waste generation patterns and guiding future waste management strategies. The integration of GPS technology ensures precise route planning, contributing to a reduction in environmental impact through decreased carbon emissions from waste collection vehicles.Moreover, the system's user-friendly interface promotes public awareness and participation,encouraging responsible waste disposal practices. Overall, the smart dustbin monitoring system is poised to revolutionize traditional waste management,providing a more sustainable, cost-effective, and responsive solution to the challenges of urban waste collection.

6.2 Comparison of Existing and Proposed System

Existing System:

The existing system of refuse waste management is undergoing a transformative shift with the implementation of smart dustbin monitoring. Traditionally, waste management relied on fixed collection schedules and manual monitoring, leading to inefficiencies, overflows, and increased operational costs. However, the integration of sensor technology and real-time monitoring has introduced a paradigm shift in this sector.Smart dustbin monitoring leverages sensors to measure fill levels, allowing for dynamic tracking of waste accumulation.

This real-time data is transmitted through wireless communication, enabling waste management authorities to receive instant updates on bin statuses. Proactive notifications are triggered as the bins approach full capacity, empowering authorities to optimize collection routes and schedules. This results in reduced fuel consumption, operational costs, and environmental impact. The system's integration with GPS technology enhances efficiency by enabling precise location tracking of dustbins.This facilitates optimized route planning for collection vehicles, minimizing travel time and enhancing overall operational effectiveness.Moreover, the data collected from the smart dustbins offers valuable insights into waste generation patterns, enabling informed decision-making for future waste management strategies.Overall, the existing solid waste management system is transitioning from a reactive and resource-intensive model to a proactive, data-driven, and environmentally sustainable approach through the incorporation of smart dustbin monitoring.

Proposed system:

The proposed system for refuse waste management aims to introduce a cuttingedge solution through smart dustbin monitoring, leveraging advanced technologies to optimize waste collection processes. This innovative approach integrates sensor technology, wireless communication,a nd data analytics to enhance the efficiency of traditional waste management practices. The smart dustbin monitoring system involves the implementation of sensors to continuously measure the fill levels of dustbins. Real-time data on the fill status is communicated wirelessly, enabling proactive notifications to waste management authorities when bins approach capacity. This timely information facilitates dynamic route planning for collection vehicles, minimizing unnecessary trips and reducing operational costs.

Moreover, the system incorporates GPS technology for precise location tracking of smart dustbins. This allows for the optimization of collection routes,reducing travel time and minimizing the environmental impact of waste collection vehicles. The integration of environmental sensors further promotes sustainability by monitoring air quality and encouraging eco-friendly waste management practices. Data analytics play a crucial role in the proposed system, providing insights into waste generation patterns. Historical data aids in optimizing resource allocation, ensuring that collection teams are strategically deployed based on demand trends.

6.3 Sample Code

```
#include <Arduino.h>
// Include Wifi libraries based on the type of board being used
#if defined (ESP32)
#include <WiFi.h>
#elif defined (ESP8266)
#include <ESP8266WiFi.h>
#endif
#include <WiFiClient.h> // Client wifi connection library #include <ThingSpeak.h> // ThingSpeak
    Cloud library
#define WIFISSID "TP-Link_8E98"
I/ WiFi SSID
#define WIFIPASSWORD "86427920"
// Wifi password
WiFiClient client; // Wifi client configuration
unsigned long myChannelNumber = 2394057;
// ThingSpeak channel number
const char * myWriteAPIKey = "Y769PAN3DWTKA14C" ;
// ThingSpeak Write API key
String readstring = "";
/I Variable to store incoming data from serial port
String waterlevel;
// Variable to store water level data
int indl;
// Index variable
void setup 1
Serial. begin (9600); // Initialize serial communication
Serial. println (;
Serial print ("Connecting to AP");
WiFi. begin (WIFISSID, WIFIPASSWORD) ;
// Connect to WiFi network
// Wait for WiFi connection
while (WiFi. status ) != WL.CONNECTED) 1
Serial. print(".");
delay (200) ;
Serial. println ("");
Serial. printin ("WiFi connected.");
Serial println ("IP address: ");
Serial. println (WiFi.localP); // Print local IP address
Serial. println () ;
ThingSpeak. begin (client); // Initialize ThingSpeak client
}
void loop) {
readstring =""; // Reset the variable to store incoming data
// Read data from serial port
while (Serial. available @) {
delay (10); // Delay added to ensure stability
char c = Serial.read (); // Read a character from serial port
```

```
// Exit the loop when '#' is detected after the word
if (c =='#'){
break ;

  readstring += c; // Build the string
}
// Check if data is received
if (readstring length > 0) 1{
Serial. println (readstring); // Print received data


waterlevel = readstring; // Store received data
in waterlevel variable
Serial. print ("Water Level: ");
Serial println (waterlevel); // Print water level data
ThingSpeak.setField (1, waterlevel); // Set the value of Field 1 in ThingSpeak channel
ThingSpeak. writeFields (myChannelNumber, myWriteAPIKey); // Write data to ThingSpeak channel
delay (1000); // Delay before sending next data
}
}
```

Output

Figure 6.1: **Web result of prototype**

The figure 6.1 is all about over project web result image while execution, it shows the level of dustbin according to the dates.

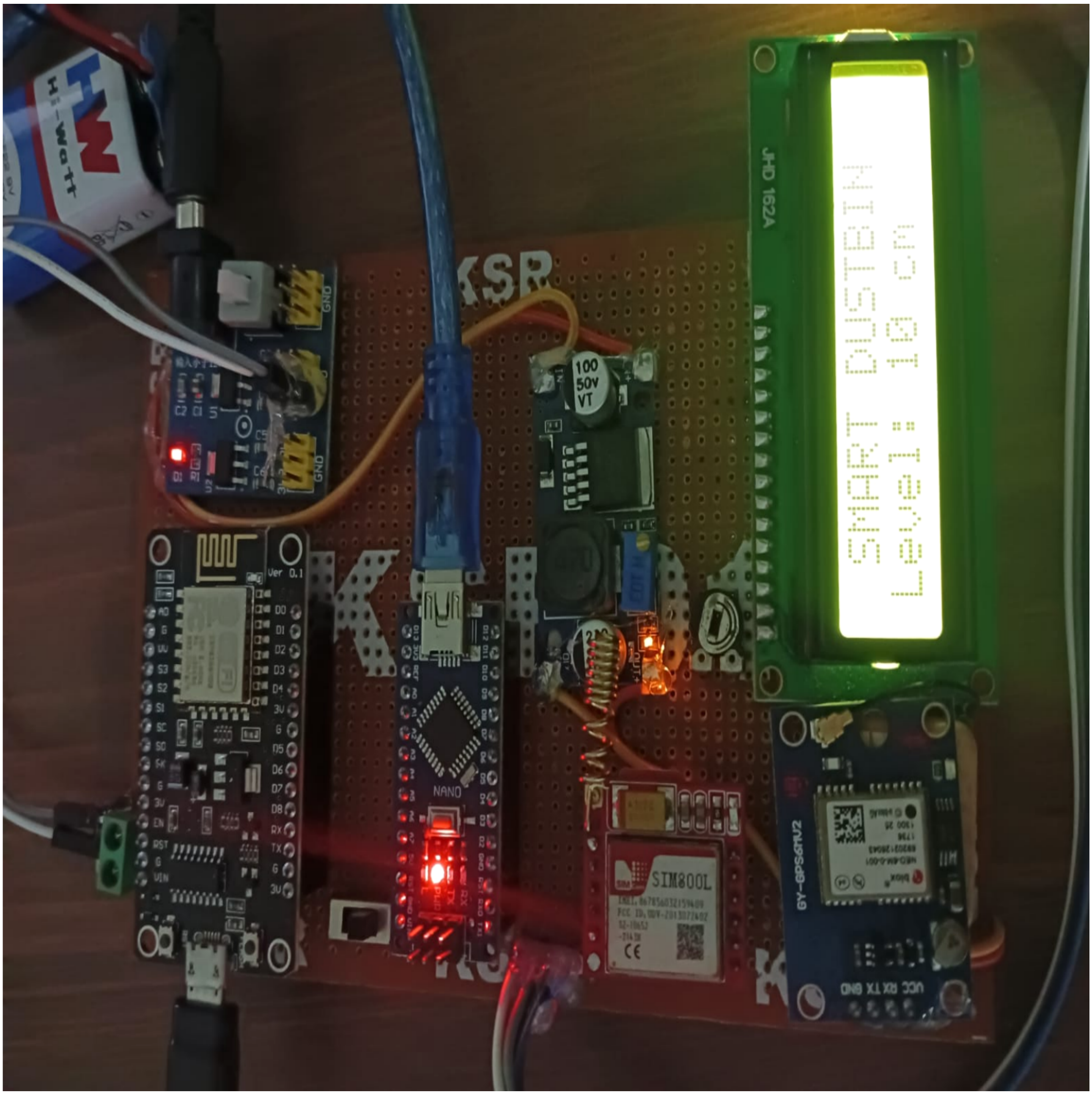


Figure 6.2: **Output image for smart bin**

The figure 6.2 is all about over project output for smart bin, it shows the level of dustbin according to the dates and give an alert message to register number.

Chapter 7

CONCLUSION AND FUTURE ENHANCEMENTS

7.1 Conclusion

In this ”Refuse waste management smart Dustbin with Trash Level Indication” project introduces an innovative waste management solution powered by IoT technology. Through the integration of sensors and microcontrollers, this system can accurately detect trash levels and distinguish between recyclable and non-recyclable materials. By automating waste segregation and providing real-time monitoring capabilities, the smart dustbin encourages eco-friendly practices and reduces the strain on traditional waste disposal methods. Moreover, its user-friendly interface enables individuals to conveniently monitor trash levels, receive timely alerts, and customize segregation preferences via a mobile app or web dashboard. This technology not only streamlines waste collection and management processes but also fosters environmental awareness and promotes sustainable behaviors within communities. Looking ahead, ongoing refinement and potential enhancements, such as AI-driven algorithms and integration with smart city infrastructure, hold promise for further improving efficiency and scalability.Ultimately, the ”Smart Dustbin” project represents a significant step towards creating cleaner, greener environments and contributing to a more sustainable future for generations to come.

7.2 Future Enhancements

The ”Refuse Waste Management Smart Dustbin with Trash Level Indication” project presents several avenues for future enhancements aimed at refining its functionality and maximizing its impact. One promising direction involves integrating Artificial Intelligence (AI) algorithms to improve waste sorting capabilities, enabling the system to automatically categorize, Waste into finer categories for more effective,recycling. Predictive analytics can also be leveraged to forecast waste generation patterns and optimize collection schedules,reducing operational costs and environmental impact. Augmented Reality (AR)interfaces could enhance user engagement by providing interactive visual overlays of waste disposal instructions and real-time trash level indicators. Additionally, the implementation of self-cleaning mechanisms would ensure the maintenance of hygiene and odor prevention within the dustbin. Blockchain technology could enhance transparency and traceability in waste management processes, while gamification features in the mobile app could incentivize responsible waste disposal behaviors. Community engagement tools and integration with smart city infrastructure further enhance the project's scalability and effectiveness in promoting sustainable waste management practices. By exploring these future enhancements,the smart dustbin project can continue to evolve as a comprehensive solution for addressing the challenges of urban waste management while promoting environmental stewardship and community involvement.

Chapter 8

PLAGIARISM REPORT

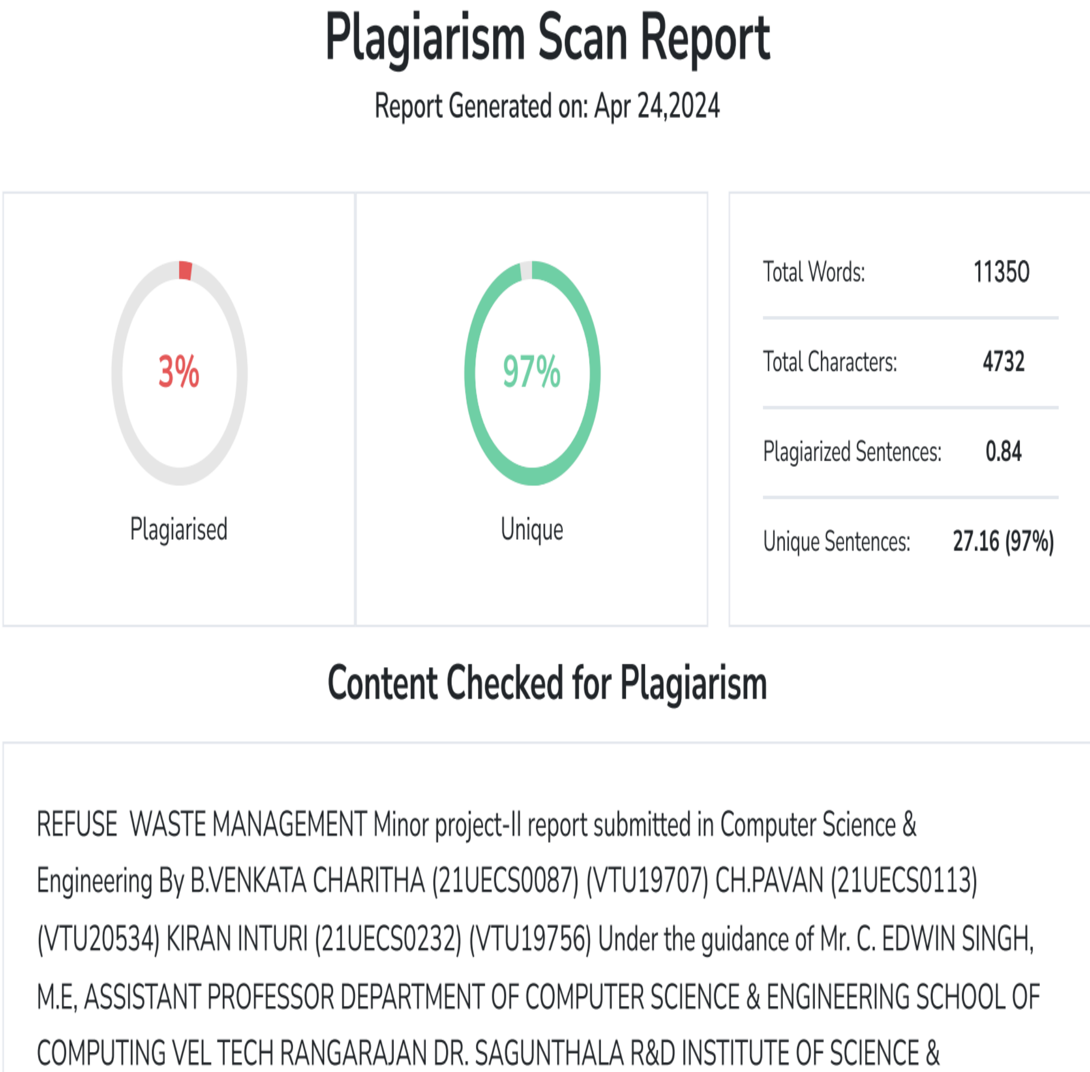


Figure 8.1: **Plagiarism Report**

Chapter 9

SOURCE CODE & POSTER PRESENTATION

9.1 Source Code

```
#include <LiquidCrystal.h>
// Pin definitions for LCD
const int rs = 7, en = 8, d4 = 9, d5 = 10, d6 = 11, d7 = 12;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
#include<SoftwareSerial.h>
#include <TinyGPS.h>


// Initial latitude and longitude values
float lat = 13.0827, lon = 80.2707;


// SoftwareSerial objects for GSM and GPS modules
SoftwareSerial gsmSerial (2 , 3) ; // rx , tx
SoftwareSerial gpsSerial(4, 5); // rx,tx


TinyGPS gps; // TinyGPS object to parse GPS data
String latitude ; // String to store latitude
String longitude ; // String to store longitude

// Function prototype for sending SMS
void message1 ( void ) ;

// Pin definitions for ultrasonic sensor
const int TrigPin = A1;
const int EchoPin = A0;

long period , interval ; // Variables for ultrasonic sensor readings
String readstringdata =       ; // String to store sensor data


//#define serial


```

```
void setup () {
Serial.begin(9600); // Initialize serial communication
pinMode ( TrigPin , OUTPUT) ; / / Set TrigPin as output
pinMode(EchoPin , INPUT) ; // Set EchoPin as input
gpsSerial. begin (9600); // Initialize serial communication with GPS module
gsmSerial. begin (9600); // Initialize serial communication with GSM module


Icd. begin (16, 2); // Initialize LCD display
Icd. setCursor(0, 0); // Set cursor to (0, 0)
lcd print (" SMART DUSTBIN "); // Print message on LCD
delay (1000); // Wait for 1 second
}
void loop ( {
latitude = "13.0827"; // Set latitude
longitude = "80.2707"; // Set longitude
readstringdata =""; // Clear sensor data string
delay (500); // Wait for 500 milliseconds


/***** Ultrasonic Sensor *****/
digitalWrite (TrigPin, LOW) ;
delay Microseconds (2) ;
digitalWrite (TrigPin, HIGH) ;
delayMicroseconds (10) ;
digitalWrite (TrigPin, LOW) ;
period = pulseln (EchoPin, HIGH) :
interval = period / 58.2;
// Display level on LCD
Icd. setCursor (0, 1) ;
Icd. print ("Level: ");
Icd. print (interval);
Icd. print (" cm ");
// Check if bin is full
if (interval < 5) 1
//Display "Bin Level: Full" on LCD
Icd. setCursor (0, 1);
Icd. print("") ;
delay (200) ;
Icd. setCursor (0, 1) ;
Icd. print ("Bin Level: Full ");
delay (2000) ;
Icd. setCursor (0, 1);
Icd. print ("

delay (200) ;
Icd. setCursor (0, 1);
lcd. print("Sending Message ");
delay (1000) ;
delay (100) ; messagel ();
```

```
/I Send message
delay (100) ;
Icd. setCursor (0, 1);
Icd. print (" AlertMessageSent") ;
delay (2000) ;
Icd. setCursor (0, 1) ;
Icd. print ("   ") ;
delay (200) ;
}
// Store sensor data in readstringdata
readstringdata += String (interval);
readstringdata += String ('#');
Serial. println (readstringdata); // Print sensor data
delay (500) ;


// Read GPS data
while (gpsSerial. available) 1
if (gps. encode (gpsSerial.read))) {
gps. f-get-position (&lat, &lon) ;
String latitude = String (lat, 6) ;
String longitude = String (lon, 6) ;
delay (500) ;


readstringdata =""; // Clear sensor data string
delay (2000); // Wait for 2 seconds
}
// Function to send SMS
void messagel (void) {
gsmSerial. print ("AT\r\n") ;
delay (800) ;
gsmSerial print ("AT+CMGF=1\r\n") ;
delay (800) ;
gsmSerial print ("'AT+CMGS=") ;
delay (500) ;
gsmSerial. print ("7095921465"); // Change the recipient's phone number
delay (500) ;
gsmSerial. write ('"');
gsmSerial. print("\r\n");
delay (500) ;
gsmSerial print("'Dustbin Full Alert'\r\n http://maps.google.com/maps?q=loc:" + latitude + "," +
    longitude ) ;
delay (500) ;
delay (500) ;
gsmSerial. write ((char) 26) ;
}
```

9.2 Poster Presentation

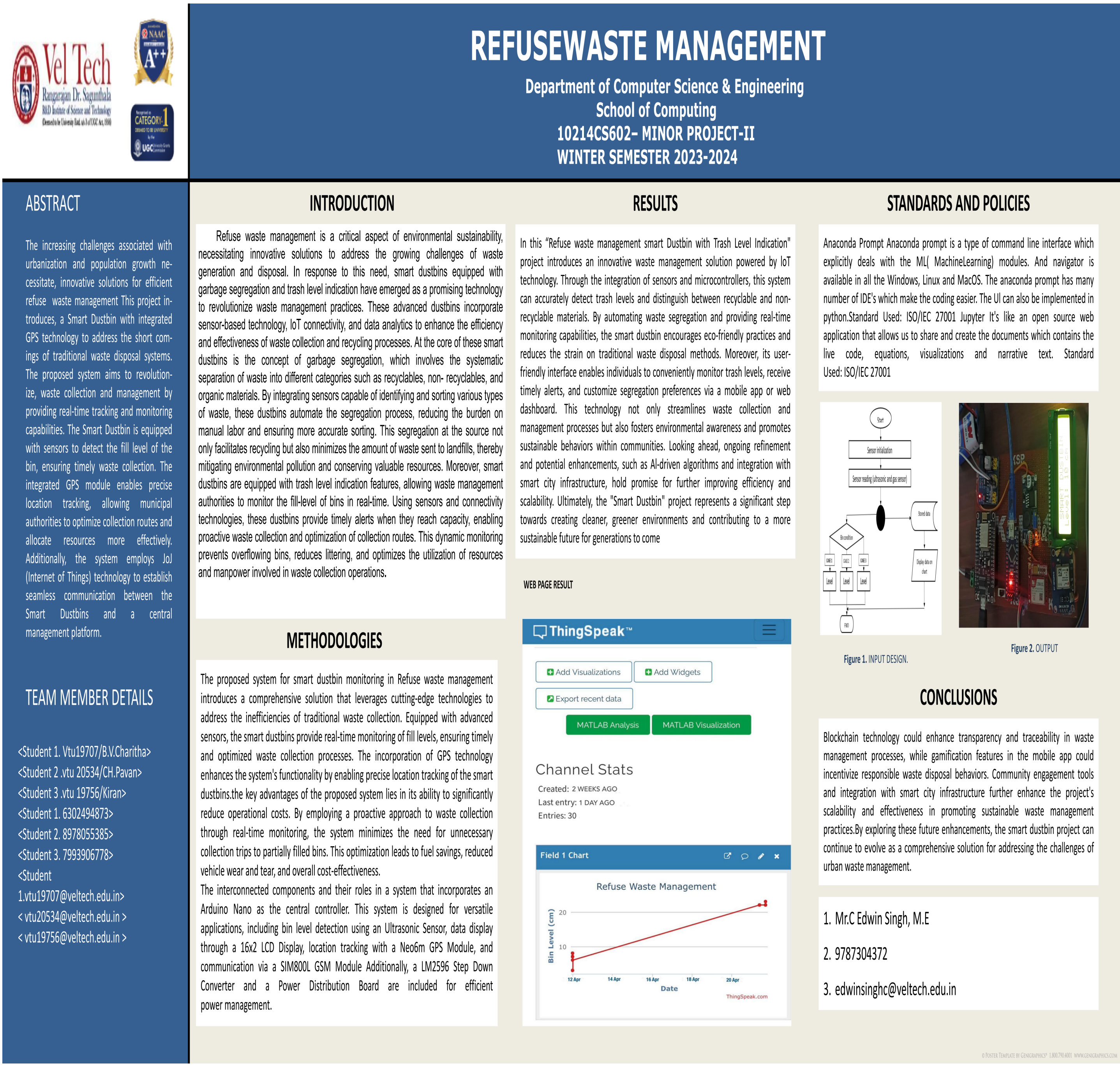


Figure 9.1: **Poster Presentation**

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