INTELLIBIN ADVANCED IoT – ENABLED SMART WASTE MANAGEMENT SYSTEM

A DESIGN PROJECT REPORT

submitted by

ABINAYA P

CHARUMATHI P

JANAANI S V

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING

K RAMAKRISHNAN COLLEGE OF TECHNOLOGY

(An Autonomous Institution, affiliated to Anna University Chennai, Approved by AICTE, New Delhi)

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(AUTONOMOUS)

SAMAYAPURAM – 621 112

BONAFIDE CERTIFICATE

Certified that this project report titled **"INTELLBIN ADVANCED IoT – ENABLED SMART WASTE MANAGEMENT SYSTEM"** is Bonafide work of **ABINAYA P (811722104003), CHARUMATHI P (811722104024), JANAANI S V (811722104059)** who carried out the project under my supervision. Certified further, that to the best of my knowledge the work reported here in does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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INTERNAL EXAMINER	**EXTERNAL EXAMINER**

DECLARATION

We jointly declare that the project report on **"INTELLIBIN ADVANCED IoT-ENABLED SMART WASTE MANAGEMENT"** is the result of original work done by us and best of our knowledge, similar work has not been submitted to **"ANNA UNIVERSITY CHENNAI"** for the requirement of Degree of Bachelor of Engineering. This project report is submitted on the partial fulfilment of the requirement of the award of Degree of Bachelor Of Engineering.

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Place: Samayapuram

Date:

ACKNOWLEDGEMENT

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ABSTRACT

The Intellbin uses sensor and IoT technologies to improve waste management. An ultrasonic sensor checks the level of garbage in real time and shows the status on an LCD screen. It displays whether the bin is “Empty” or “Full” and the exact fill percentage. When the bin reaches full capacity (100%), the system stops all sensor operations and locks the lid to prevent overflow. A manual button is given for waste collectors to open the lid for emptying. Pressing the button again resets the system to normal working mode

To collect more useful data, the dustbin includes a load cell that measures the weight of the garbage. A GPS module records the location of the dustbin. When the bin is full, the system sends an automatic alert to the concerned authority. This message includes the full status, the weight of the waste, and the GPS location. This helps the waste management team to quickly identify and clear full bins, making the process more efficient.

For everyday users, a motion sensor is attached to the lid. When someone comes close, the lid opens automatically, allowing people to throw garbage without touching the bin. This reduces physical contact and promotes hygiene. Overall, the Smart Dustbin system helps cities manage waste better by using automation, live tracking, and quick communication. It prevents garbage overflow, saves manual effort, and supports cleaner urban environments.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABBREVIATION	FULL FORM
IoT	Internet of Things
LCD	Liquid Crystal Display
GPS	Global Positioning System
WiFi	Wireless Fidelity
AI	Artificial Intelligence
MCU	Micro Controller Unit
GSM	Global System for Mobile Communications
LoRaWAN	Long Range Wide Area Network
IR	Infrared
MQTT	Message Queuing Telemetry Transport
EEPROM	Electricity Erasable Programmable Read-Only Memory
DC	Direct current
PIR	Passive infrared

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

In today's fast-growing urban areas, effective waste management has become a critical issue. With increasing population and urbanization, public places often face problems related to overflowing dustbins, delayed waste collection, and poor hygiene. Traditional waste collection methods require manual checking of bins, which is time-consuming, inefficient, and often leads to unattended garbage. This results in environmental pollution, spread of diseases, and a negative impact on public health. To solve these issues, smart technologies are being integrated into public infrastructure. The Smart Dustbin System is one such innovative solution that uses Internet of Things (IoT) and sensor-based technologies to improve cleanliness and waste management. It is designed to monitor the level of garbage in real-time and provide automatic alerts when the bin is full. This enables faster and more efficient waste collection by the authorities.

The system uses an ultrasonic sensor to measure the fill level of the dustbin and displays this information on an LCD screen. When the bin reaches full capacity (100%), the lid is automatically locked, and an alert is sent to the concerned authority with the exact fill level, weight (measured by a load cell), and location (via a GPS module). For hygiene and convenience, the system includes a motion sensor that opens the lid automatically when a user approaches, allowing for touchless waste disposal. A manual button allows waste collectors to open the lid for emptying and reset the system afterward. This project aims to develop a Smart Dustbin that solves these problems by using sensors and IoT technology to improve waste management and keep urban areas clean.

1.2 OVERVIEW

The Intelligent Waste Management System is a sophisticated solution aimed at addressing the increasing difficulties of waste disposal in busy and expanding urban environments, where traditional garbage collection methods often prove inadequate in ensuring cleanliness and public health. In many city settings, overflowing bins, inconsistent collection schedules, and manual oversight lead to waste accumulation in public areas, causing environmental contamination and heightened health risks. This project leverages Internet of Things (IoT) technology alongside various sensors to develop a smart waste monitoring system that operates continuously in real-time, offering notable advantages over conventional practices. The system utilizes an ultrasonic sensor to precisely detect the fill level of the bin and displays this information on an LCD interface, providing instant visual updates. When the bin reaches maximum capacity, the lid automatically locks to prevent additional waste from being deposited, and a notification containing key details such as the fill percentage, weight (measured via a load cell), and exact location (tracked through a GPS module) is transmitted directly to waste management authorities.

To further enhance user convenience and uphold hygiene standards, a motion sensor detects approaching individuals and opens the lid automatically for contactless waste disposal. A manual override button is also available, allowing waste collectors to access the bin for emptying and resetting the system for ongoing use. By integrating sensor data, automated alerts, and touchless operation, the Intelligent Waste Management System not only streamlines waste collection but also promotes a cleaner, healthier, and more sustainable urban environment. By combining sensor data, automated alerts, and touchless interaction, the Smart Dustbin System not only streamlines waste management but also promotes a cleaner, healthier urban environment.

1.3 PROBLEM STATEMENT

In many cities, traditional dustbins often overflow because waste collection is not done on time. This leads to unhygienic conditions, bad odors, and littering, which harm public health and the environment. Manual monitoring of dustbins is time-consuming and inefficient. There is a need for a smart system that can automatically detect when a dustbin is full, notify the authorities, and allow touchless operation for better hygiene. This project aims to develop a Smart Dustbin that solves these problems by using sensors and IoT technology to improve waste management and keep urban areas clean.

1.3.1 OBJECTIVE

The main objective of this project is to design and develop a Smart Dustbin that uses sensors and IoT technology to monitor waste levels automatically. It aims to provide real-time information about the dustbin's fill status, send alerts when full, and allow touchless lid operation for better hygiene. Overall, the goal is to improve waste management efficiency and promote cleaner urban environments.

1.3.2 IMPLICATION

The Smart Dustbin project has important implications for improving urban cleanliness and public health. By automating waste level monitoring and sending timely alerts, it helps prevent overflowing bins and reduces littering. This leads to a cleaner environment and fewer health hazards caused by garbage accumulation. The touchless lid operation also promotes hygiene by minimizing contact with the dustbin, which is especially important in public places. Additionally, this system reduces the need for manual checks, saving time and effort for waste management authorities and making the overall process more efficient and reliable.

CHAPTER 2

LITERATURE SURVEY

1. **Smart Dustbins: Real-Time Monitoring and Optimization for Waste Management in Smart Cities through IoT Devices, Sreerama Murty Maturi, Srinivasa Rao Dhanikonda, Somasekhar Giddaluru - 2025**

Advanced smart dustbin system that uses IoT technology to improve urban waste management. The dustbins are fitted with sensors that track the waste level in real-time and send this data to a central system using wireless communication. This helps in monitoring bin status continuously and ensures that garbage is collected before bins overflow. The system also uses data analytics to optimize waste collection routes and schedules, reducing fuel use and manpower. A user-friendly interface allows municipal staff to monitor all dustbins on a dashboard, while alerts are automatically generated for full bins. The study highlights how integrating real-time monitoring with smart planning can lead to cleaner cities and more efficient waste management systems. The importance of combining technology, data-driven decision-making, and responsive infrastructure to achieve efficient, timely, and sustainable waste collection.

2. **A Survey of Smart Dustbin Systems Using IoT and Deep Learning, Sowmya R., Shashi Kumar N. R., and Megha H. R - 2024**

Rapid urbanization has led to a significant increase in waste production, posing challenges for efficient and sustainable waste management. Traditional waste collection methods are often inefficient, resulting in overflowing bins, unsanitary conditions, and increased environmental pollution. This paper provides a comprehensive survey of smart dustbin systems that incorporate Internet of Things (IoT) technologies and deep learning techniques to improve urban waste management. The authors explore various smart bin architectures that use sensors such as ultrasonic and infrared for real-time fill-level detection, microcontrollers like Arduino and Raspberry Pi for data processing, and wireless modules like GSM and Wi-Fi for communication. Additionally, the paper reviews how deep learning models, particularly convolutional neural networks, are applied for automated waste classification to aid in segregation at source.

3. **An IoT Based Smart Waste Management System for the Municipality or City Corporations, Laboni Paul, Rahul Deb Mohalder, Kazi Masudul Alam - 2024**

This research paper presents a comprehensive IoT-based smart waste management system tailored for use by municipalities and city corporations. The core of the system involves the integration of smart dustbins equipped with sensors that detect the fill levels of waste in real time. These dustbins are capable of sending alerts to a centralized waste management server whenever the bin reaches a certain threshold, ensuring timely collection and avoiding overflow situations. This real-time communication helps local authorities manage their waste collection resources more efficiently by focusing only on full bins instead of following fixed routes and schedules. It bridges the gap between municipal waste services and citizens, creating a more efficient, transparent, and environmentally friendly system for managing urban cleanliness and sustainability.

4. **Smart Automated Dustbin using Bin-Level and Distance Monitorin, Kiran Thopate, Pratik Dandawate, Snehal Adsul, Mangesh Gawade and Dnyanesh Anaraseg - 2023**

The system uses ultrasonic sensors to continuously detect the fill level of the bin, allowing it to determine when the bin is nearing capacity. Simultaneously, it includes a distance sensor to detect the presence of individuals nearby, enabling automatic opening of the lid without physical contact. This feature enhances hygiene by reducing the risk of germ transmission, particularly important in public places and hospitals. Once the waste reaches a predefined threshold, the system sends an alert to maintenance personnel, ensuring timely collection and avoiding overflow issues. The authors emphasize that this automation reduces the reliance on manual inspections and streamlines the waste management process. Additionally, the intelligent response mechanism based on user proximity improves the overall usability of the system, making it both efficient and user-friendly.

5. **IoT-Based Smart Dustbin Monitoring Using GSM, Anil Kumar, Praveen Singh, Suraj Reddy - 2022**

The system employs ultrasonic sensors to continuously monitor the fill level of dustbins and sends real-time notifications to municipal authorities when bins are nearly full. This enables prompt waste collection, reducing issues like overflowing bins, littering, and associated health hazards. By providing accurate, real-time data, the system helps optimize waste collection routes, minimizing unnecessary trips and thus saving fuel, time, and labor costs. The paper also discusses the potential for expanding the system with cloud-based data storage and analytics to further enhance waste management strategies. Moreover, the system can improve public awareness about waste disposal habits through timely feedback. It also offers the flexibility to integrate with other smart city infrastructure, such as GPS tracking for garbage trucks.

6. **Smart IoT-Based Waste Management System for Sustainable Urban Living, Manuel Oliveira, Paulo Silva, Ricardo Costa – 2021**

The system uses ultrasonic sensors to measure bin fill levels and environmental sensors to monitor humidity and temperature. It relies on LoRaWAN for low-power, long-range communication across cities. Machine learning algorithms analyze waste patterns to predict when bins will be full, helping plan dynamic waste collection routes and saving fuel—demonstrated by a 20% fuel reduction in a Lisbon pilot. The system also includes a mobile app for citizens to receive waste disposal reminders and recycling tips, encouraging public involvement. The study addresses challenges like sensor calibration and varied data types, concluding that combining IoT, smart data analysis, and citizen participation is key to achieving sustainable and efficient waste management in modern cities.

7. **An Efficient Smart Dustbin System for Waste Management, Naveen R. Rao and Suresh Venkatraman – 2021**

It proposes an innovative smart dustbin system that combines IoT technology with machine learning to improve urban waste management. Traditional waste collection methods often follow fixed schedules, which can lead to inefficiencies such as overflowing bins or unnecessary pickups, wasting resources and increasing costs. In this system, sensors installed in dustbins continuously monitor the fill level and send real-time data to a centralized cloud platform. Using this data, machine learning algorithms analyze past waste disposal patterns to predict when each dustbin will likely become full. This predictive capability enables dynamic scheduling and routing of waste collection vehicles, allowing for on-demand pickups only when necessary.

8. **IoT Enabled Smart Waste Management System, Rajesh Verma and Tarun Singh – 2020**

IoT-enabled smart waste management system that integrates sensors in dustbins to monitor waste levels in real time. The system incorporates GPS technology to track the exact location of each dustbin and sends the data to a cloud platform for centralized analysis. By analyzing the fill levels and locations of multiple dustbins, the system helps optimize waste collection routes, ensuring that collection trucks only visit bins that need servicing. This approach reduces operational costs, improves efficiency, and minimizes environmental impact by cutting down unnecessary trips and fuel consumption, making waste management smarter and more sustainable. The system can also integrate mobile applications for real-time monitoring, providing municipal authorities with instant updates on waste levels and collection status.

9. Design and Implementation of Smart Dustbin Using IoT, Mohammed Saif Khan, Supriya Roy, and Subhashis Dutta - 2019

The design and implementation of a smart dustbin system using IoT technology to enhance cleanliness and reduce waste overflow in urban environments. The system is equipped with ultrasonic sensors that continuously monitor the fill level of the dustbin and a GSM module that sends real-time SMS alerts to municipal authorities when the bin is about to reach its capacity. This early warning mechanism ensures timely waste collection, preventing spillage, bad odor, and littering in public places. The smart dustbin system is easy to deploy and cost-effective. The potential for scalability and integration with centralized waste monitoring platforms to streamline operations and promote efficient waste disposal practices.

10. Design and Implementation of Smart Dustbin Using IoT, Mohammed Saif Khan, Supriya Roy, and Subhashis Dutta - 2019

The design and implementation of a smart dustbin system using IoT technology to enhance cleanliness and reduce waste overflow in urban environments. The system is equipped with ultrasonic sensors that continuously monitor the fill level of the dustbin and a GSM module that sends real-time SMS alerts to municipal authorities when the bin is about to reach its capacity. The system can be integrated with solar-powered compactors, which automatically compress waste to maximize the bin’s capacity. This optimization reduces the frequency of waste collection trips, thereby saving operational costs and reducing carbon emissions.The smart dustbin system is easy to deploy and cost-effective, making it suitable for smart city initiatives. The authors also highlight the potential for scalability and integration with centralized waste monitoring platforms to streamline operations and promote efficient waste disposal practices.

CHAPTER 3

SYSTEM ANALYSIS AND DESIGN

3.1 EXISTING SYSTEM

The existing waste management system uses sensor-based automation to detect and manage waste collection. It begins with the detection of waste using a proximity sensor, mainly the Ultrasonic Sensor (HC-SR04). When someone approaches with waste, the sensor detects their presence and automatically opens the lid of the dustbin using a proximity detection algorithm. This touchless mechanism reduces physical contact with the bin, improving hygiene and making it more user-friendly in public places like streets, schools, offices, and hospitals. Once the waste is inside, the system continues to monitor the level of waste using either an Ultrasonic or IR Sensor. These sensors help measure how full the dustbin is. When the waste reaches the pre-set full level, the system sends a signal using a Wi-Fi Module (ESP8266). Through an IoT-based notification system (commonly using the MQTT protocol), a message is sent to a central monitoring unit or mobile phone, notifying that the bin is full and needs to be emptied. This ensures that bins are not overflowing and helps maintain cleanliness in the surroundings, while also optimizing the waste collection process by alerting authorities in real-time, reducing unnecessary rounds by collection vehicles, and contributing to a more efficient and sustainable urban waste management system. After the notification is received, the waste management team takes action and collects the waste from the bin. This automated process reduces manual checking of bins and improves efficiency. However, the system still has some limitations, such as its dependency on stable internet connectivity for notifications, the inability to separate biodegradable and non-biodegradable waste, and occasional sensor failures due to dirt or harsh weather conditions.

3.1.1 DEMERITS

- Needs internet to send alerts.
- Uses more power because sensors work all the time.
- Cannot separate different types of waste.
- Sensor may give wrong results if waste is not placed properly.
- Sensors can stop working if they get dirty.
- Only works for one bin, not good for big areas.
- Cannot show real-time bin location or live status.

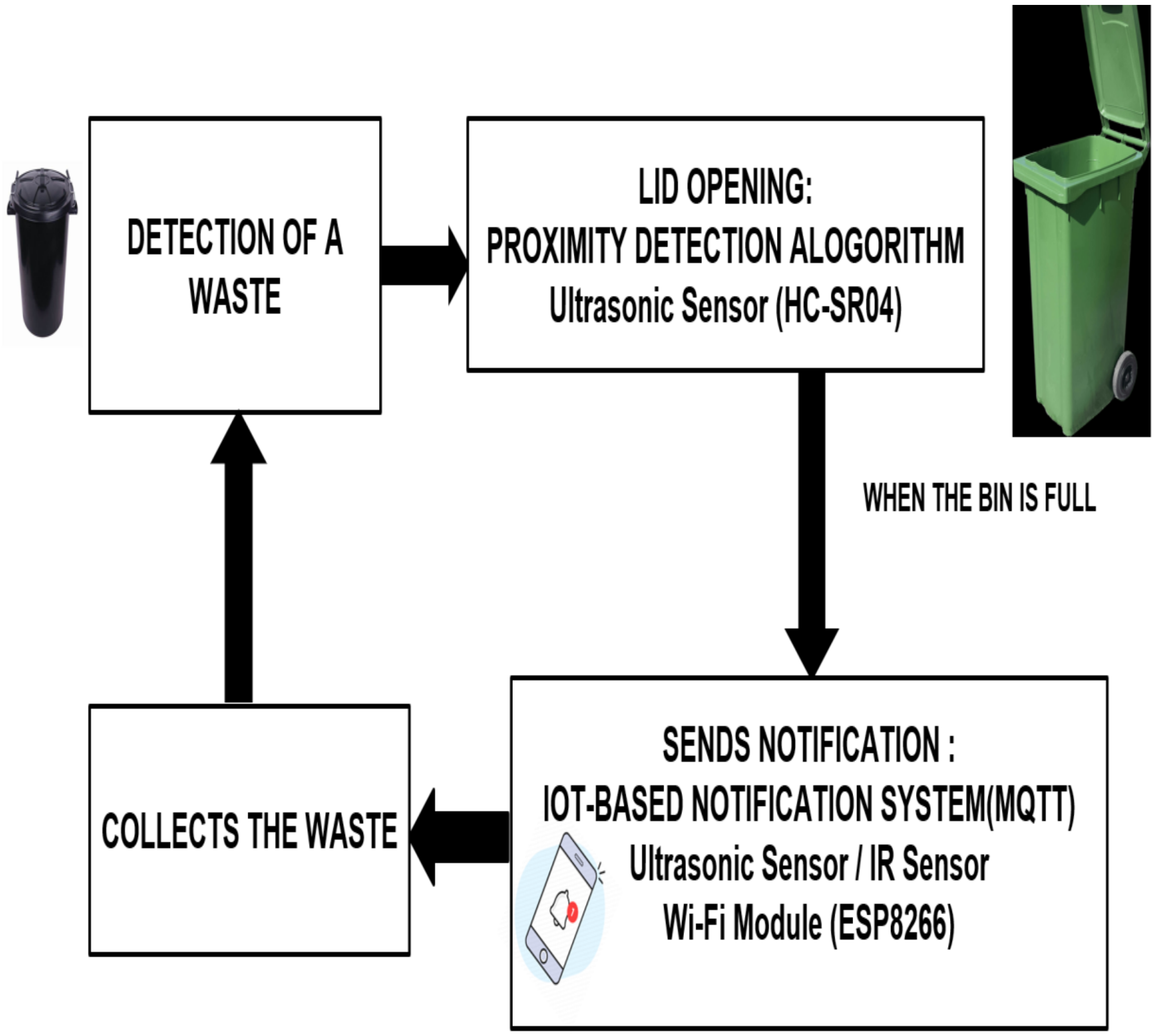

Fig 3.1. Existing System

3.2 PROPOSED SYSTEM

The proposed system is an advanced and improved version of the traditional waste management process. It uses smart technology to solve the problems faced in the existing system. The first step in this system is the detection of waste using an ultrasonic sensor (HC-SR04). When a person comes near the bin with garbage, the sensor detects the movement and automatically opens the lid without needing to touch it. This touch-free feature ensures better hygiene and safety, especially in public areas where many people use the same bin. After the waste is thrown into the bin, the same ultrasonic sensor continues to monitor the waste level inside the bin. The current level is shown clearly on a 16x2 LCD display. For example, when the bin is full, the screen displays something like "FULL: 100%". This helps users and cleaning staff to know the condition of the bin just by looking at the display. Once the bin reaches its full capacity, a signal is sent using the Wi-Fi module (ESP8266). The system sends this alert through a notification, and the data is stored in EEPROM memory so that it is not lost even if there is a power failure. This ensures that no bin is left unnoticed, and timely action can be taken to empty it.

A unique feature of the proposed system is the addition of GPS tracking using a Neo-6M GPS module. This allows real-time tracking of the bin's location. This is very useful for municipalities or waste collection agencies as it helps them know the exact location of each bin and plan the collection routes more efficiently. With GPS and live notification support, this system can reduce unnecessary travel, save fuel, and reduce the time taken to collect waste. Moreover, it enables dynamic route optimization, especially in densely populated or high-traffic areas, by allowing authorities to prioritize bins that are full or located in sensitive zones such as hospitals or schools.

3.2.1 MERITS

- Touch-free waste disposal using ultrasonic sensors.
- Real-time bin level shown on LCD screen.
- Sends automatic notifications when bin is full.
- GPS tracking helps locate full bins easily.
- Saves time and fuel for waste collection vehicles.
- Data is stored using EEPROM for reliability.
- Better hygiene and cleanliness in public areas.
- Helps build smarter and cleaner cities.

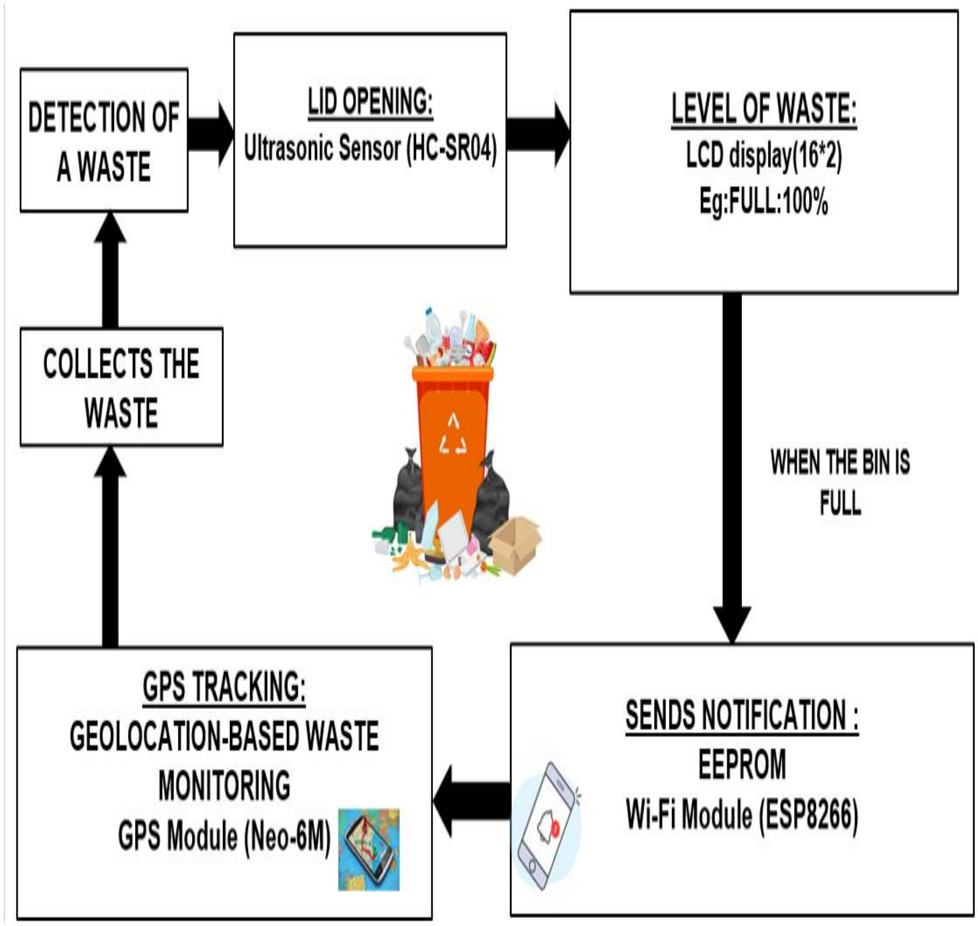

Fig 3.2. Proposed System

3.2.2 BLOCK DIAGRAM

A Smart Dustbin integrated with IoT technology and multiple sensors offers an advanced and efficient approach to urban waste management. The system uses an ESP32 microcontroller as the central control unit, which processes input from different sensors and communicates with remote monitoring platforms. An ultrasonic sensor (HC-SR04) is used to measure the fill level of the bin, and a 16x2 LCD screen displays the real-time status as "Empty," "Partially Full," or "Full" along with the percentage. Once the bin reaches full capacity, the servo motor automatically closes the lid and all sensor operations are paused to prevent overflow. This ensures cleanliness and minimizes the chances of littering.

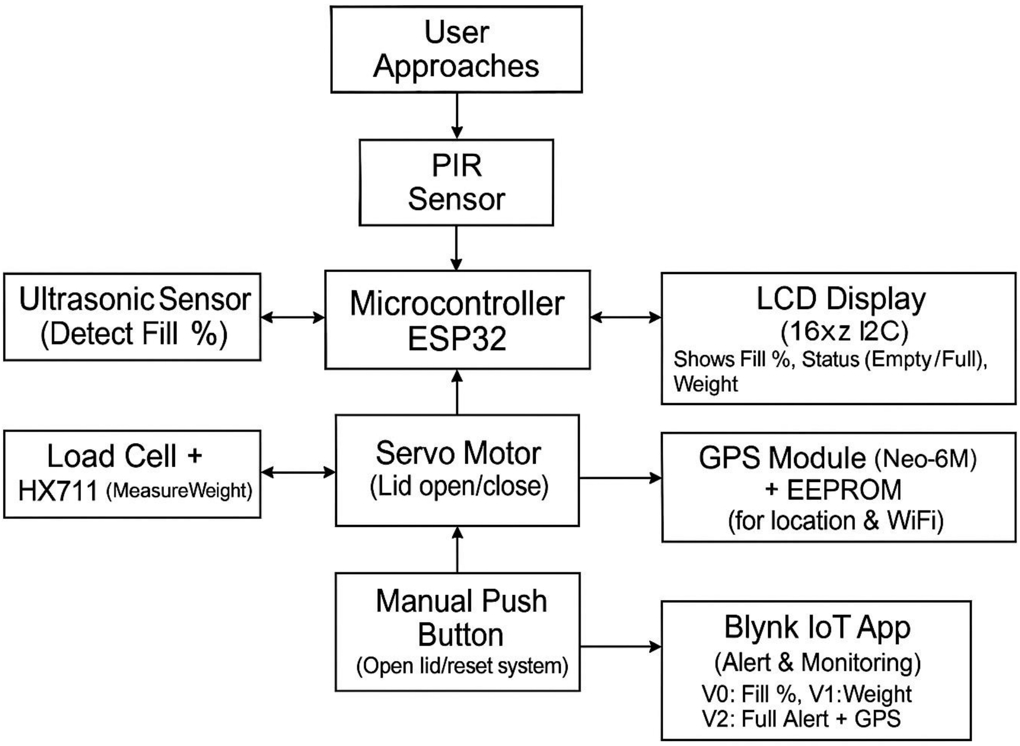

Fig 3.3. Block Diagram

To support waste collectors, the system includes a manual reset mechanism using a button. Pressing and holding this button opens the lid, allowing for waste removal. Holding the button again resets the system to resume its normal working state. The weight of the collected waste is measured using a load cell connected through an HX711 module. Furthermore, a GPS module (Neo-6M with EEPROM) provides the precise location of the dustbin. When the dustbin becomes full, an alert containing the fill status, weight, and GPS location is sent to the concerned authority using the Blynk IoT platform. This helps in tracking and organizing efficient waste collection schedules. For added hygiene and convenience, the Smart Dustbin includes a motion detection feature using a PIR sensor. When someone approaches, the lid opens automatically using the servo motor, enabling touchless waste disposal. This feature is especially helpful in reducing the spread of germs and promoting safe usage in public places. Overall, the system uses real-time monitoring, automation, and wireless communication to ensure faster response, reduce manual effort, and support cleaner urban environments.

3.2.3 CIRCUIT DIAGRAM

It represents an intelligent IoT-based dustbin designed for efficient urban waste management using various sensors and modules. At the heart of the system is the ESP32 microcontroller, which serves as the central processing unit. It coordinates data from all the connected components and enables wireless communication through built-in Wi-Fi or Bluetooth. Two ultrasonic sensors (HC-SR04) are positioned to serve different roles—one likely detects the presence of a user near the dustbin, while the other measures the trash level inside the bin by calculating the distance from the sensor to the top of the garbage pile. When a person is detected close to the bin, a servo motor (SG90) is triggered to automatically open the lid, ensuring a touchless experience for hygiene and convenience.

To measure the weight of the garbage inside the dustbin, a load cell is installed at the base. This load cell is connected to an HX711 amplifier module, which amplifies the weak signals from the load cell and sends them to the

ESP32 for processing. Additionally, the system features a GPS module (Neo-6M), which provides real-time location data of the dustbin. This is particularly useful for municipal authorities to track the position of mobile or public bins for route optimization during garbage collection. An IR sensor is also included, likely to detect hand gestures or object movement near the lid for triggering actions such as opening the bin. To provide a visual display of real-time information, a 16x2 LCD screen is used. This display can show useful data such as the bin's fill level, weight, or even GPS coordinates. For more advanced functionality like mobility, the system includes a DC motor controlled by an L298N motor driver module. This setup may allow the dustbin to move autonomously or adjust its position when needed. the system can be equipped with infrared sensors to detect nearby obstacles, ensuring smooth navigation in crowded areas. To enhance user interaction, a voice alert module can be integrated, providing spoken reminders or notifications when the bin is full or in motion.

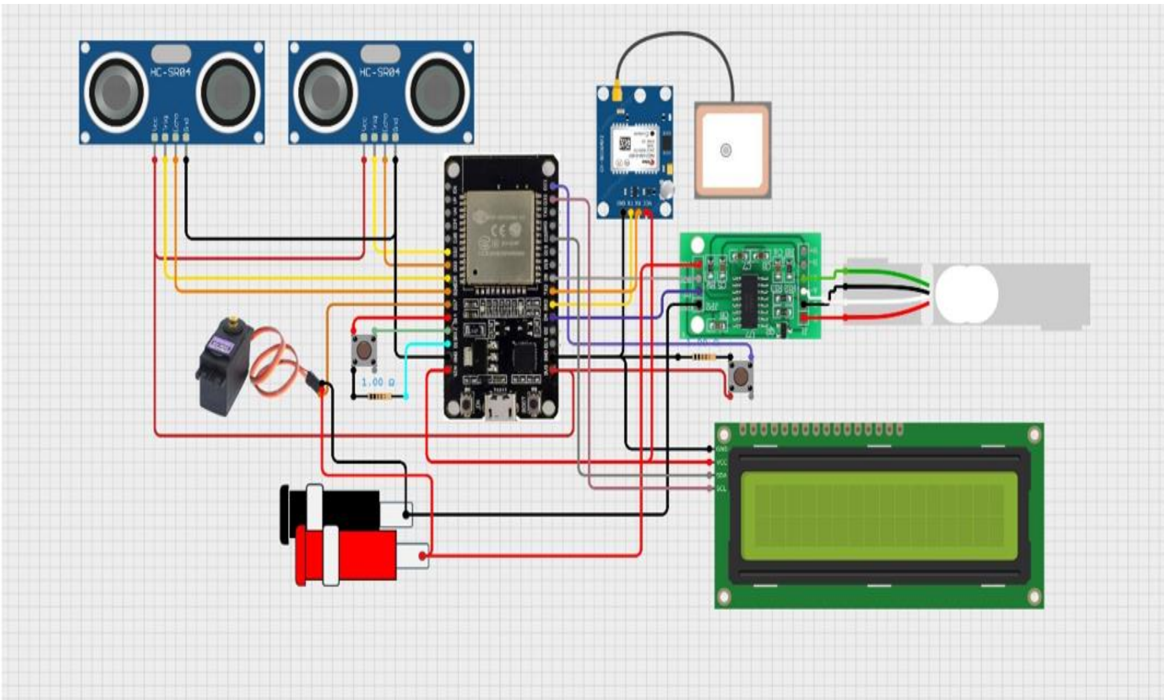

Fig 3.4. Circuit Diagram

CHAPTER 4
SYSTEM CONFIGURATION

4.1 HARDWARE REQUIREMENTS

4.1.1 ULTRASONIC SENSOR (HC-SR04)

The Ultrasonic Sensor (HC-SR04) is used to measure the fill level of the dustbin by emitting ultrasonic waves. These waves reflect back when they encounter an object, such as the waste inside the bin. The time taken for the waves to return is used to calculate the distance from the sensor to the waste surface, which then helps determine the percentage of the bin's fill level.

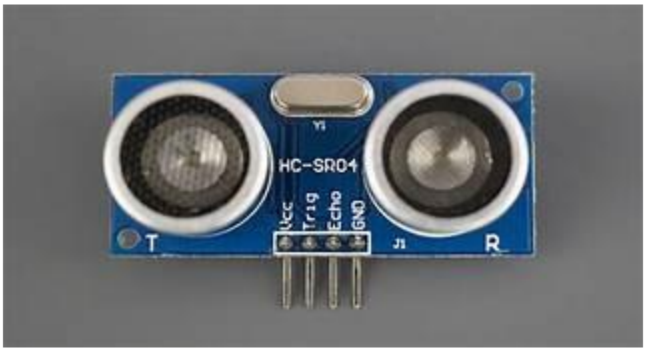

Fig 4.1. Ultrasonic Sensor

4.1.2 SERVO MOTOR

The Servo Motor is used to control the bin lid's opening and closing mechanism. It is activated by the PIR Motion Sensor when a user approaches the bin. The servo motor automatically opens the lid, allowing the user to dispose of waste without touching the bin. After the waste is disposed of, the servo motor closes the lid, preventing any unpleasant odors from escaping and ensuring the bin remains hygienic. This touchless operation not only improves convenience for users but also helps maintain public cleanliness. To further enhance sanitation, an automatic disinfectant spray can be integrated into the system, ensuring the bin remains germ-free after each use.

Fig 4.2. Servo Motor

4.1.3 GPS MODULE

The GPS Module (Neo-6M) is responsible for tracking the real-time location of the smart dustbin. When the bin reaches its full capacity, the GPS module continuously updates the exact coordinates of the bin. This location data is essential for optimizing waste collection routes, as the system can send the location of the full bin directly to the waste management team. This reduces the time and fuel spent by the collection team in searching for bins and ensures that bins are emptied promptly when they are full. The GPS data is included in the WhatsApp alert sent through Whatabot.io, enabling maintenance teams to identify the location of the bin immediately and take action accordingly.

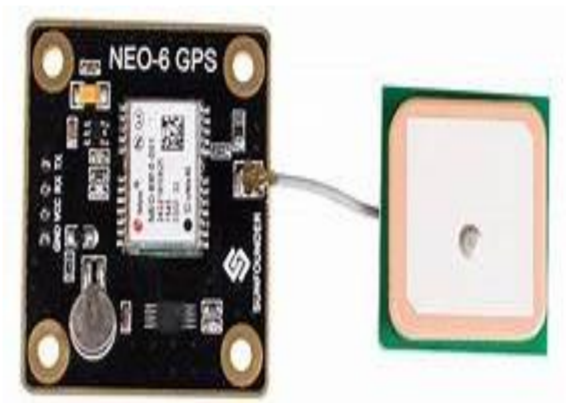

Fig 4.3. Neo-6M

4.1.4 WIFI MODULE

The Microcontroller (NodeMCU), paired with the Wi-Fi Module (ESP32), serves as the brain of the Smart IoT-Based Dustbin. The NodeMCU processes all incoming data from the various sensors, including the ultrasonic sensor, load cell, and PIR sensor. It also manages the servo motor's operation for lid control. The ESP32, a powerful Wi-Fi-enabled chip, enables the dustbin to communicate with remote systems. The ESP32 connects to the internet and allows the system to send data to the Blynk app, where users or authorities can monitor the bin's status in real-time, including fill percentage, weight, and whether the bin is full or empty.

Fig 4.4. Microcontroller

4.1.5 HX711

The HX711 is a small device used in a smart dustbin to measure how much trash is inside by weighing it. It works with a load cell, which senses the weight. The load cell sends a very weak signal, and the HX711 makes this signal stronger and changes it into numbers that a microcontroller like Arduino can understand. This helps the smart dustbin know when it is getting full. When the dustbin reaches a certain weight, it can send a message or alert to clean it.

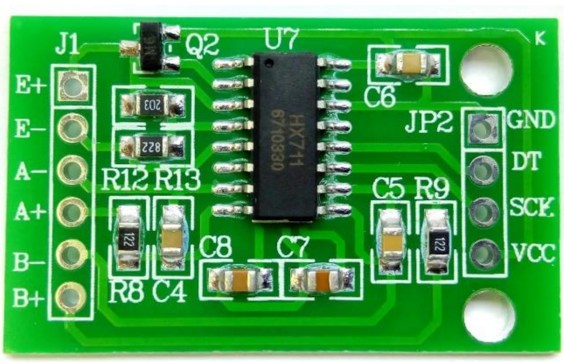

Fig 4.5. HX711

4.2 SOFTWARE REQURIMENTS

4.2.1 ARDUINO IDE

In the Smart IoT-Based Dustbin project, the Arduino IDE is used to program the microcontroller, such as NodeMCU or ESP32. It provides a platform to write, compile, and upload code that controls the hardware components. The ultrasonic sensor measures the waste level inside the bin by detecting the distance from the top to the trash. The servo motor automatically opens or closes the lid. The LCD display shows useful information like the fill level or operational status. The GPS module sends the location data of the bin. The code also enables Wi-Fi connectivity so that sensor data can be transmitted to an IoT platform.

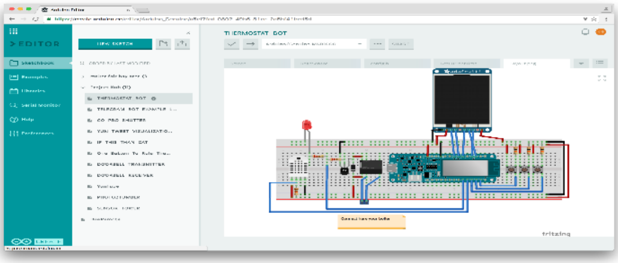

Fig 4.6. Arduino IDE

4.2.2 BYLNK APP

The Blynk IoT platform is used to remotely monitor the smart dustbin through a mobile application. The microcontroller sends real-time data such as waste level and location to the Blynk cloud via Wi-Fi. This data is displayed on the app using widgets like gauges, graphs, and labels, giving a clear view of the bin’s status. If a GPS module is connected, the app can show the bin's location. Blynk also allows notifications to be sent when the bin is full or needs attention. This helps waste management authorities take timely action. It reduces unnecessary trips to empty bins and improves collection efficiency. With Blynk, smart monitoring becomes easy, user-friendly, and efficient.

4.3 SYSTEM ARCHITECTURE

The Smart Dustbin employs an integrated system of sensors and IoT components to streamline urban waste management. An ultrasonic sensor continuously monitors the fill level of the waste inside the bin, providing real-time data displayed on an LCD screen that indicates whether the bin is "Empty" or "Full" along with the precise percentage. Additionally, a load cell measures the total weight of the waste, enabling accurate tracking of waste volume. A motion sensor detects approaching individuals, triggering the lid to open automatically for a contactless and hygienic disposal experience. A manual button allows waste collectors to open or reset the system, ensuring easy maintenance and waste removal. When the bin reaches full capacity, the system automatically disables the ultrasonic sensor to prevent overfilling, and the lid remains closed until emptied. Upon reaching 100% fill, the system sends an automatic alert to the concerned authority via IoT communication channels.

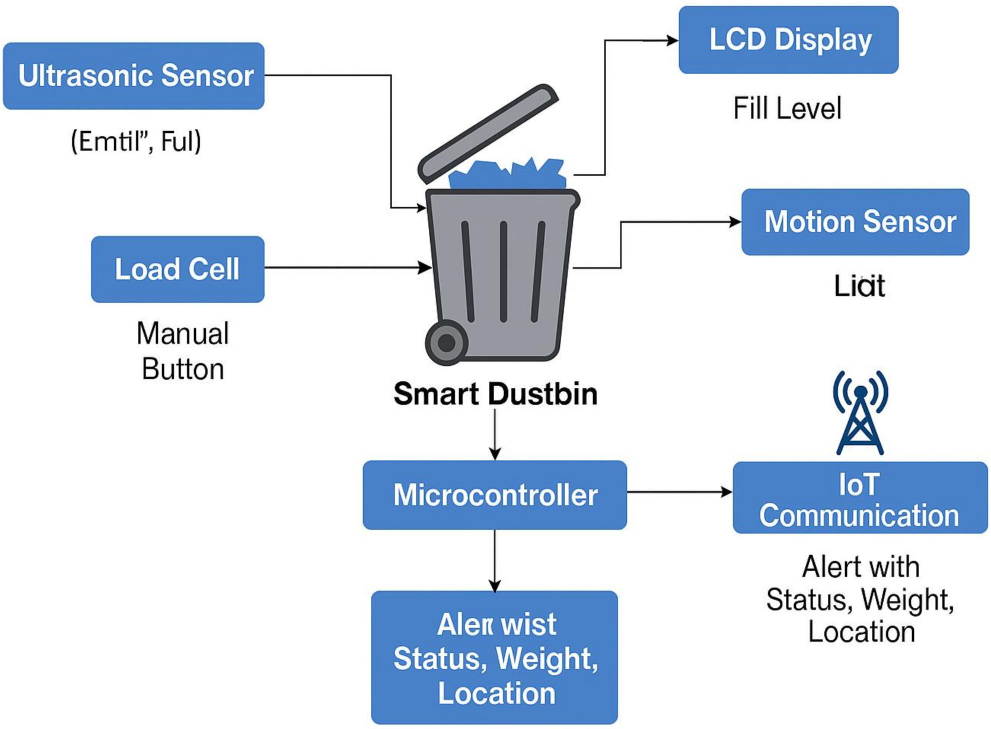

Fig 4.7. System Architecture

The alert includes detailed information such as the full capacity status, the current waste weight, and the GPS location of the dustbin for efficient tracking and timely collection. When the system detects full capacity, it should stop all sensor functionalities and send alerts. This integrated approach combines automation, real-time monitoring, and remote notifications to reduce manual intervention, improve hygiene, and ensure regular waste collection.

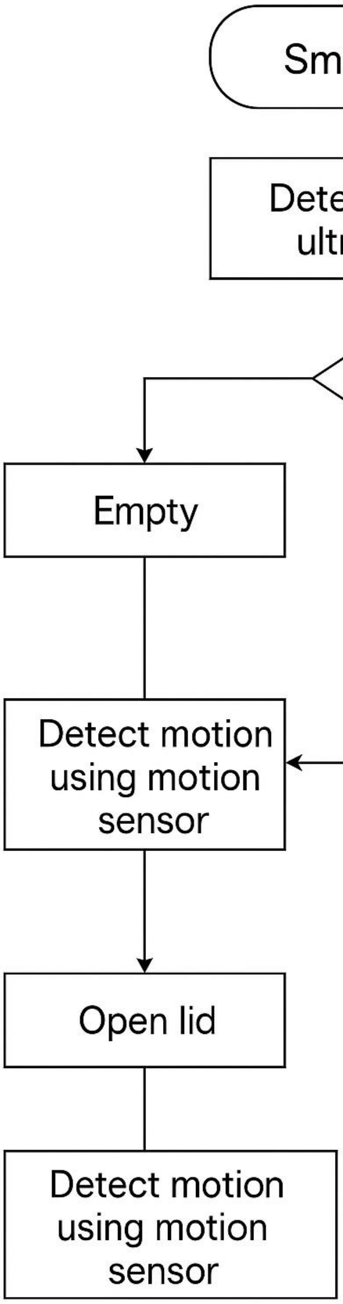

Fig 4.7. Flow graph

CHAPTER 5

MODULES

5.1 MODULE DESCRIPTION

- Waste Level Detection Module
- Automatic Lid Control Module
- Alert and Communication Module
- Manual Override and Reset Module
- Display and User Interface Module

5.1.1 WASTE LEVEL DETECTION MODULE

This is the core sensing module of the smart dustbin. It uses an ultrasonic sensor (HC-SR04) to continuously monitor the amount of waste inside the bin. The ultrasonic sensor works by emitting sound waves at a high frequency and measuring the time it takes for the echo to return after hitting the waste surface. Using this time, the system calculates the distance between the sensor and the top of the waste pile, which helps determine how full the bin is. The data from the ultrasonic sensor is processed by the microcontroller (NodeMCU/ESP32), which calculates the percentage of the bin that is filled.

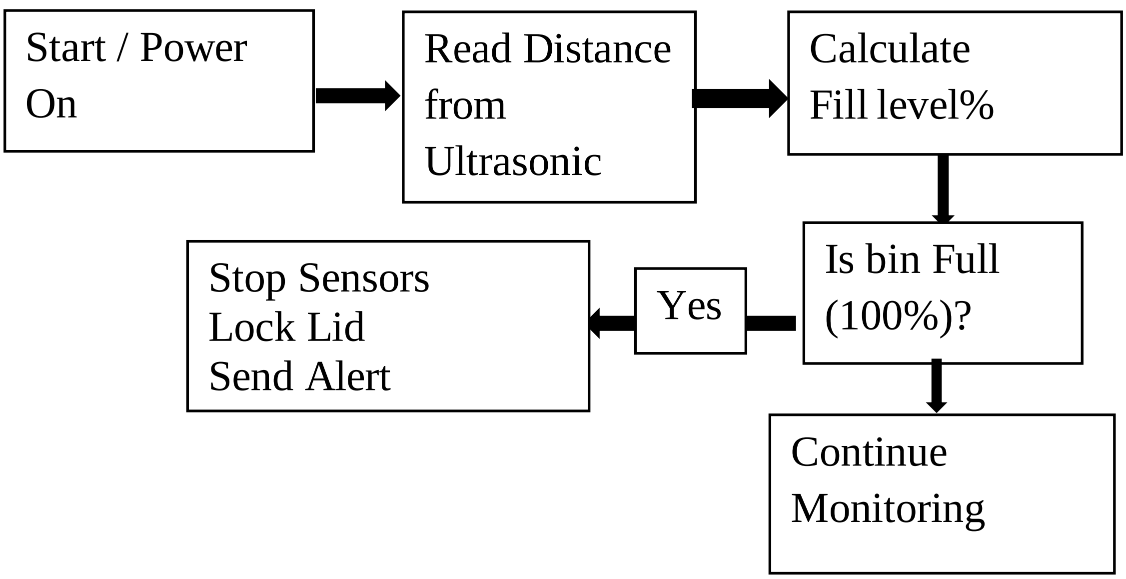

Fig 5.1. Flow of Waste Level Detection Module

5.1.2 AUTOMATIC LID CONTROL MODULE

The automatic lid control system enables a contactless user experience, making the smart dustbin hygienic and easy to use. This module consists of a PIR (Passive Infrared) motion sensor and a servo motor. When someone approaches the dustbin, the PIR sensor detects the presence of motion. In response, the microcontroller activates the servo motor to open the lid automatically, allowing the user to throw in waste without touching the bin.

After a short duration (typically 5–10 seconds), the system automatically closes the lid to keep the waste inside securely. This not only ensures cleanliness but also prevents bad odor from escaping the bin. The motion sensor is disabled once the bin reaches its maximum fill level, which prevents the lid from opening. This feature ensures that no more waste is added when the bin is already full, thus preventing unsanitary overflow conditions.

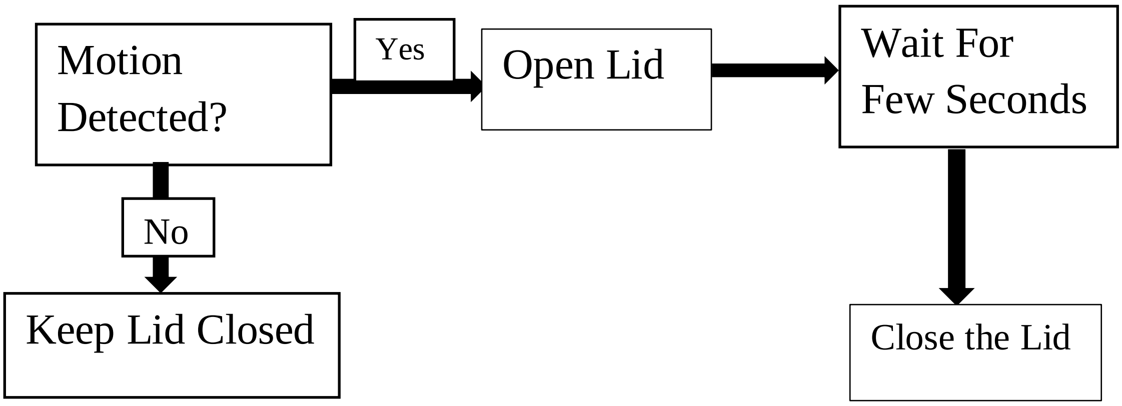

Fig 5.2. Flow of Automatic Lid Control Module

5.1.3 ALERT AND COMMUNICATION MODULE

Beyond just alerting municipal authorities when the bin reaches full capacity, the Alert and Communication Module could integrate AI-powered analytics to predict waste accumulation trends based on usage patterns, helping optimize waste collection routes and reduce unnecessary trips. To enhance energy efficiency, a solar panel attachment could ensure self-sustaining energy, while advanced load sensors would provide more accurate weight estimates by differentiating between light and heavy waste items. Multi-sensor monitoring, including temperature and humidity sensors, could track decomposition rates and detect harmful gases, ensuring safer waste management. AI-driven waste sorting could automatically classify waste into recyclables, organic matter, and non-recyclables, streamlining the process for municipal waste management centers and reducing contamination in recycling streams. On the public engagement front, a mobile app could provide real-time feedback to citizens, encouraging proper waste segregation practices, while gamification elements, such as a points-based system, could incentivize responsible waste disposal and foster community participation. These enhancements could push smart waste management to the next level, making cities cleaner, more efficient, and environmentally friendly. When the bin reaches 100% capacity, the system gathers critical information such as:

- The GPS location of the dustbin (using the Neo-6M GPS module)
- The weight of the waste (can be estimated using a load sensor or calculated based on volume)
- The timestamp of when the bin was filled

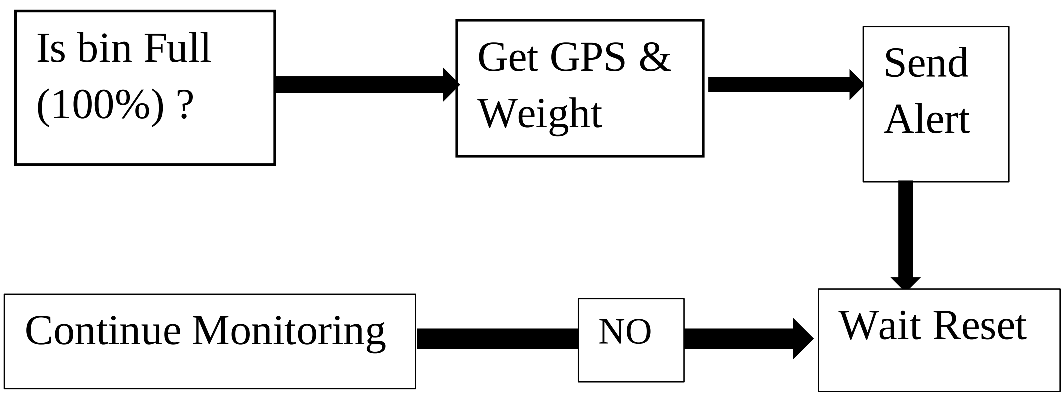

Fig 5.3. Flow of Alert and Communication Module

5.1.4 MANUAL OVERRIDE AND RESET MODULE

This module provides a manual control feature that is useful for maintenance workers. After the waste in the bin is collected and the bin is emptied, the system needs to be reset to function properly again. A manual push-button is installed on the smart dustbin to serve this purpose. When the waste collector presses the reset button:

- The ultrasonic sensor is reactivated to start measuring the new waste level.
- The motion sensor is enabled again to allow automatic lid opening.
- The system display is updated to show the current (reset) waste level.
- The communication module is reset and prepared for the next cycle.

This manual override feature ensures that the system does not require complex reprogramming or hardware handling during maintenance. It makes the dustbin easy to use for both users and cleaning staff. Moreover, the reset process helps maintain accurate system data and ensures smooth operation without interruptions. It also provides a quick and efficient way to restore the system to its operational state after emptying, saving time and effort for maintenance personnel.

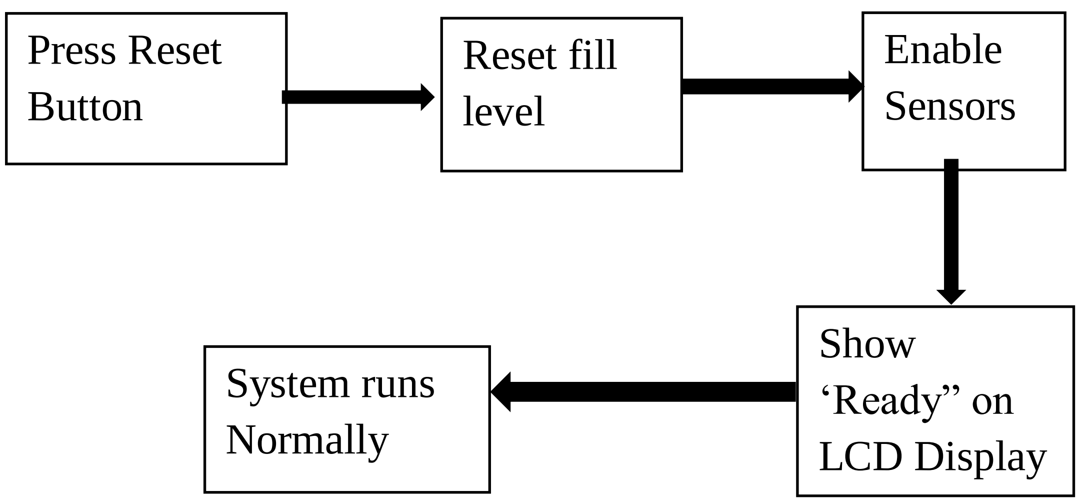

Fig 5.4. Flow of Manual Override and Reset Module

5.1.5 DISPLAY AND USER INTERFACE MODULE

The smart dustbin uses a 16x2 LCD display to communicate vital information to users and maintenance personnel. This module provides a real-time user interface that shows:

- The percentage of the bin that is currently filled
- Alerts such as “Bin Full,” “Lid Locked,” or “Sensor Active”
- Status updates like “Lid Opening” or “Reset Successful”

This module is important for ensuring that people using the dustbin are aware of its current state. For example, if the display shows “Bin Full,” users will understand that the bin is no longer accepting waste. For waste collectors, the display acts as an indicator of system status and confirms when the bin is ready to be reused after resetting. Additionally, having clear and immediate information displayed helps in reducing improper waste disposal and encourages responsible usage. It also aids maintenance personnel in quickly diagnosing issues, thereby minimizing downtime. Overall, the LCD display enhances the efficiency and user-friendliness of the smart dustbin system by providing transparent and accessible status updates at a glance.

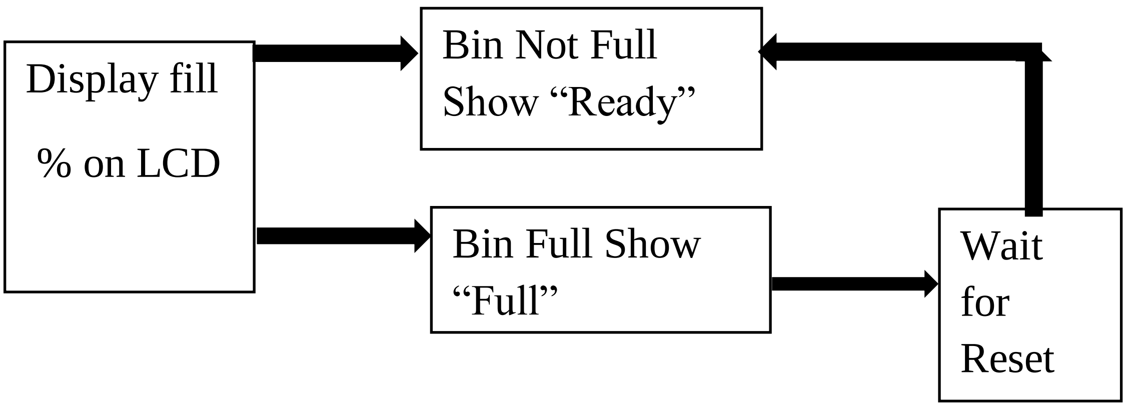

Fig 5.5. Flow of Display and User Interface Module

CHAPTER 6
TEST RESULT AND ANALYSIS

6.1 TESTING

Testing played a vital role in the development of the Smart Dustbin system, ensuring that every component functioned correctly and the entire system operated smoothly. The testing process was carefully planned and executed to verify both hardware and software performance. Hardware components such as the ultrasonic sensor, servo motor, LCD display, and communication modules were individually tested to confirm their proper functioning. This was followed by integration testing, where all the components were connected to work as a single system, ensuring smooth interaction and data flow between them. Unit testing helped identify issues in individual components, while integration testing ensured that these components worked well together.

Additionally, both white box testing and black box testing were performed. White box testing involved checking the internal logic, control structures, and software code for accuracy and reliability, while black box testing focused on the system's behavior and output from a user's perspective. Real-world scenario testing was also conducted to evaluate the system's performance under practical conditions such as outdoor environments and repeated usage. These tests confirmed that the Smart Dustbin could detect waste levels accurately, open and close the lid at the right times, display appropriate messages on the LCD, and send alert notifications when the bin was full. The overall testing process significantly contributed to refining the system, ensuring it performs reliably in daily use and is ready for deployment in real-world environments. The overall testing process significantly contributed to refining the system, ensuring it performs reliably in daily use and is ready for deployment in real-world environments. Rigorous evaluation under various conditions has strengthened its functionality, making it a dependable solution for smart waste management.

6.2 TEST OBJECTIVES

The main goal of testing the Smart Dustbin was to make sure all parts, both hardware and software, work correctly and reliably. First, each part was tested separately, like the ultrasonic sensor that detects waste levels, the servo motor that opens and closes the lid, and the LCD display that shows messages. Then, testing made sure these parts work well together — for example, the sensor telling the motor when to move and the display showing the right message. The software was also tested to check that it works properly in all situations, even unusual ones. Testing also checked if the whole system is strong, durable, and easy to use. It was tested under different conditions and many times to make sure it works well over time. The testing helped find and fix problems early so the system wouldn't fail when used.

6.3 PROGRAM TESTING

Program testing is an important step where the software that controls the Smart Dustbin is checked to make sure it works correctly. This means testing if the program reads the sensor data right, sends the right commands to open or close the lid, and updates the display messages properly. It also checks if the program sends alerts when the bin is full. Different methods were used in testing the program. Unit testing checked small parts of the code separately, while integration testing checked if these parts worked together well. White box testing looked inside the code to make sure all conditions and loops work correctly, and black box testing checked if the system behaves correctly from the user's point of view without looking at the code. Program testing helped find and fix mistakes like wrong sensor readings or slow motor response, making sure the Smart Dustbin works smoothly and reliably.

6.4 TESTING AND CORRECTNESS

6.4.1 UNIT TESTING

Unit testing involves testing the smallest parts of the system separately to ensure that each module or component works correctly on its own. For the Smart Dustbin, this meant individually testing components like the ultrasonic sensor, which detects waste levels, the servo motor responsible for opening and closing the lid, and the LCD display that shows the system status messages. In software terms, unit testing also involved verifying individual functions or blocks of code to ensure they perform their tasks accurately. This phase helps catch errors early in the development process before integrating parts together, making it easier to isolate and fix specific issues.

6.4.2 INTEGRATION TESTING

Once each individual part is tested and confirmed to work correctly, integration testing is performed to check how well the components function when combined. For example, the system was tested to ensure that sensor readings successfully trigger the motor to operate the lid, and the LCD display updates the messages accordingly. This phase verifies the communication and interaction between hardware and software components, making sure data flows correctly between modules. Integration testing helps uncover problems that might not be visible during unit testing, such as timing issues, data mismatches, or hardware-software coordination failures.

6.4.3 FUNCTIONAL TESTING

Functional testing focuses on validating the complete behavior of the Smart Dustbin system against the defined requirements. This testing checks whether all the intended features work correctly when the system is used as a whole. It covers tasks like detecting the waste level accurately, opening and closing the lid automatically at appropriate times, displaying accurate status messages on the LCD screen, and sending alert notifications when the dustbin reaches full capacity. Functional testing ensures that the system behaves correctly under normal and boundary conditions, providing confidence that the product meets user expectations.

6.4.4 WHITE BOX TESTING

White box testing is a detailed method that examines the internal structure and logic of the software. In this approach, testers look into the code itself to verify the execution of different paths, loops, conditions, and error handling mechanisms. For the Smart Dustbin, white box testing involved checking whether the control flow within the microcontroller program operates without faults, such as ensuring the code properly reads sensor data, processes it, and issues commands to other components. This method helps detect hidden bugs, unreachable code, or logical errors that could affect system performance or cause unexpected behavior.

6.4.5 BLACK BOX TESTING

Black box testing evaluates the system's external behavior without considering the internal code or logic. Testers focus on providing various inputs and observing the outputs to verify that the system responds as expected. In the Smart Dustbin project, black box testing involved simulating different waste levels and user interactions to confirm that the bin lid opens and closes at the right times, status messages are displayed correctly, and alert messages are sent when necessary. Additionally, edge cases such as unexpected user actions, network failures, and sensor malfunctions were tested to assess the system's fault tolerance and reliability. This ensured that the smart dustbin remained efficient, responsive, and capable of handling real-world scenarios while maintaining smooth functionality. To further validate the efficiency of the alert mechanism, integration testing was performed to ensure seamless communication between the GSM module and the municipal authorities' database. This confirmed that alerts were promptly received and acted upon to prevent overflow and maintain cleanliness.

6.5 ANALYSIS

The analysis phase plays a very important role in understanding how well the Smart Dustbin project works and how it can be improved. After completing the testing process, all the results were carefully studied to check how the system behaved in different situations. This included checking the response time of the sensor, the accuracy of the distance detection, the performance of the servo motor in opening and closing the lid, and how clearly the LCD display showed messages. The analysis also looked at how often the alert system was triggered and whether the system handled full-bin situations properly.

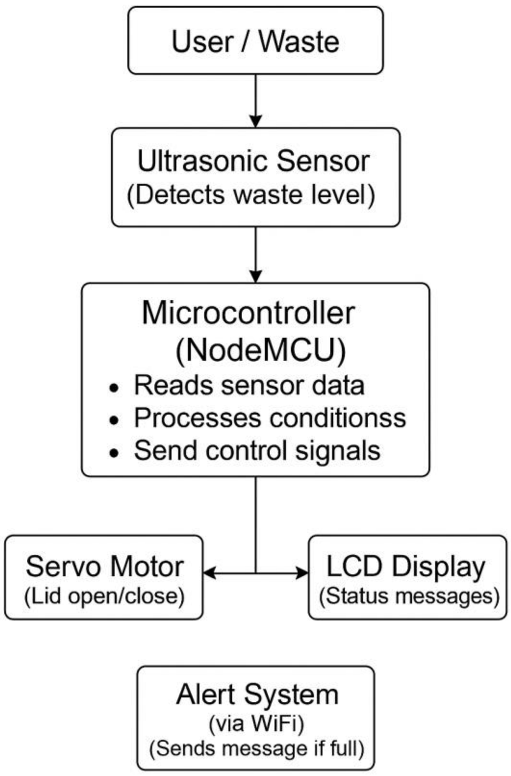

Fig 6.1. Process

Another key part of the analysis was evaluating how smoothly the hardware and software parts worked together. If there was any delay, mismatch, or failure, it was noted and solutions were proposed to fix it. The goal of this phase was not only to check whether the system was working but also to understand how efficient and user-friendly it was in real-world usage. The analysis helped highlight strong points of the system, such as its ability to automate waste handling, as well as areas that might need further improvement, like power usage or long-term durability. Overall, the analysis confirmed that the Smart Dustbin was reliable, functional, and ready for practical application.

6.6 FEASIBILITY STUDY

A feasibility study was done to understand whether the Smart Dustbin system is practical, useful, and worth building on a larger scale. This study looked at different types of feasibility: technical, economic, operational, and social. In terms of technical feasibility, the system proved successful. All the components used—such as the ultrasonic sensor, servo motor, NodeMCU, and LCD—are easily available, and the technology used is simple and reliable. The software code was lightweight and compatible with common microcontrollers, making the system easy to set up and maintain. In terms of economic feasibility, the project is cost-effective. The total cost of components is low, making the Smart Dustbin affordable for homes, schools, offices, and public spaces. The system also reduces the need for manual waste checking, which can save money and effort in the long run. Operational feasibility was also confirmed, as the system ran smoothly during real-time use and was easy to operate. From a social feasibility perspective, the Smart Dustbin supports cleanliness and hygiene, which are important for public health. People can use it without touching the lid, making it more sanitary. Overall, the feasibility study showed that the Smart Dustbin is not only technically sound but also useful, affordable, and socially beneficial.

CHAPTER 7
RESULT AND DISCUSSION

7.1 RESULT

The Smart Dustbin project has successfully achieved its intended goals by integrating sensor technology and IoT to create a more efficient and automated waste management solution. The system accurately detects the waste level using an ultrasonic sensor and continuously displays the fill status and percentage on an LCD screen, providing clear visual feedback to users and waste management staff. When the bin reaches 100% capacity, the system intelligently halts all sensor functions and locks the lid to prevent overflow and maintain hygiene. At this point, it also triggers an automatic alert mechanism that sends a notification to the concerned authorities. This alert contains essential information, including the current status of the bin, the weight of the waste collected (measured through a load cell), and the exact GPS location of the bin. The ability to notify collection teams promptly ensures timely disposal, reducing logistical inefficiencies and minimizing environmental impact. This feature allows for quick identification and dispatch of waste collection teams, thereby reducing delays in service and improving responsiveness.

In addition to its alert and monitoring features, the smart dustbin also incorporates a motion sensor to facilitate touchless operation. When someone approaches the bin, the lid automatically opens, allowing users to dispose of waste without physical contact. This promotes hygiene and is particularly useful in public spaces where minimizing contact is important. The system also includes a manual override function that enables authorized personnel (waste collectors) to press and hold a button to open the lid for waste removal. Holding the button again resets the system and restores it to its normal operational mode.

7.2 CONCLUSION

The Smart Dustbin project introduces a technologically advanced approach to urban waste management by integrating automation and IoT capabilities. Using ultrasonic sensors, the system monitors the fill level in real time, displaying waste status on an LCD screen to prevent overflow and maintain cleanliness. When the dustbin reaches full capacity, the lid automatically closes, halting all sensor operations until it is manually reset by waste collectors. The inclusion of a motion sensor enables touchless waste disposal, enhancing hygiene and convenience in high-traffic areas. Furthermore, the system's alert mechanism sends real-time notifications to authorities, providing crucial details such as waste weight measured via a load cell and precise GPS location, allowing optimized collection routes for efficiency.

By combining automated functionalities with smart tracking and communication technologies, this project significantly improves urban cleanliness and waste management processes. The ability to notify collection teams promptly ensures timely disposal, reducing logistical inefficiencies and minimizing environmental impact. The touchless lid operation not only promotes hygiene but also encourages a more user-friendly waste disposal experience. Overall, the Smart Dustbin contributes to the advancement of smart city infrastructure, fostering sustainability and enhancing public health standards while reducing manual intervention in waste collection. Overall, this project has shown that low-cost, sensor-based smart systems can have a substantial impact on improving urban infrastructure. It serves as a strong example of how modern technologies like IoT, automation, and embedded systems can be harnessed to solve everyday problems and contribute to building smart cities. With further scaling and implementation, such solutions have the potential to transform waste management practices across the globe.

7.3 FUTURE ENHANCEMENT

The Smart Dustbin system presents several opportunities for future enhancements that can significantly improve its performance, scalability, and impact on urban waste management. One of the most promising enhancements is the integration of solar panels, which would enable the dustbin to operate independently of external power sources, making it ideal for deployment in public and remote areas. Additionally, developing a mobile application would allow real-time monitoring, status updates, and control features for both users and municipal authorities, enhancing the convenience and responsiveness of the system. Further advancements could include the implementation of AI and machine learning algorithms to detect and categorize different types of waste, such as biodegradable, non-biodegradable, and recyclable items. This would support better waste segregation and recycling efforts, contributing to environmental sustainability. Incorporating voice assistance and audio feedback features would make the system more accessible to visually impaired individuals, increasing inclusivity and user-friendliness.

The system can also be upgraded to support inter-bin communication, where multiple smart bins communicate with each other and with the central waste management system. This would allow dynamic route planning for waste collection trucks, reducing fuel usage and improving overall efficiency. Moreover, integrating advanced data analytics could help track waste generation trends, predict peak usage times, and assist city planners in making informed decisions about waste bin placement and collection schedules. In the long term, features such as automatic disinfection systems, weatherproof designs, and multilingual user interfaces could be added to further improve the durability, hygiene, and accessibility of the dustbin. These enhancements would transform the Smart Dustbin from a basic automated device into a fully intelligent, interactive, and sustainable solution aligned with the vision of future smart cities.

APPENDIX – A

SOURCE CODE

main.ino

```
#define BLYNK_TEMPLATE_ID "TMPL3Fg05gPZA"
#define BLYNK_TEMPLATE_NAME "Smart Dust Bin"
#define BLYNK_AUTH_TOKEN "c6gHjtqxbcTN7CrplHKI3NTahJo8r23k"
#include <BlynkSimpleEsp32.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <ESP32Servo.h>
#include "HX711.h"
#include <TinyGPS++.h>
#include <WiFiManager.h>
#include <EEPROM.h>
#include <WiFi.h>
#include <ArduinoJson.h>
#include <HTTPClient.h>
#define TRIG_PIN_A 25
#define ECHO_PIN_A 26
#define TRIG_PIN_B 32
#define ECHO_PIN_B 33
#define HX711_DT 4
#define HX711_SCK 5
#define SERVO_PIN 27
#define SDA 21
#define SCL 22
#define RXD2 16
#define TXD2 17
#define BUTTON_PIN 12
```

```
#define PWM_3v 14
#define GND 13
#define OPERATOR_BUTTON_PIN 23
#define BLYNK_PRINT Serial
const int doorOpenAngle = 0;
const int doorCloseAngle = 90;
const int servoDelay = 10;
const float emptyDistance = 12.22;
const float fullDistance = 1.0;
const String phoneNumber = "918015813768";
const String apikey = "2c1b6945-2472-4b86-998d";
const unsigned long HOLD_TIME = 5000;
LiquidCrystal_I2C lcd(0x27, 16, 2);
Servo doorServo;
HX711 scale;
TinyGPSPlus gps;
HardwareSerial gpsSerial(2);
WiFiManager wm;
char ssid[32];
char pass[32];
bool shouldSaveConfig = false;
bool portalRunning = false;
unsigned long buttonPressStart = 0;
bool binSetFull = false;
bool bitSetPrint = true;
bool enableCheck = true;
bool checkOperatorBtn = false;
unsigned long operatorButtonStart = 0;
float prevFill = -1;
```

```
float prevWeight = -1;
unsigned long manualOverrideTime = 0;
void openDoor();
void closeDoor();
float readDistance(int trigPin, int echoPin);
float readWeight();
float calculateFillPercentage(float dist);
void checkInsideSensors();
void sendDustbinFullAlert(float fill, double lat, double lng);
void checkResetButton();
void checkOperatorButton();
void saveCredentials(const char* newSSID, const char* newPass);
void readCredentials();
void saveConfigCallback();
void setup() {
  Serial.begin(115200);
  EEPROM.begin(512);
  pinMode(PWM_3v, OUTPUT);
  pinMode(GND, OUTPUT);
  digitalWrite(PWM_3v, HIGH);
  digitalWrite(GND, LOW);
  pinMode(BUTTON_PIN, INPUT_PULLDOWN);
  pinMode(OPERATOR_BUTTON_PIN, INPUT_PULLDOWN);
  Wire.begin(SDA, SCL);
  lcd.begin();
  lcd.backlight();
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("SMART DUST BIN");
```

```
  lcd.setCursor(0, 1);
  lcd.print("Initializing...");
  delay(2000);
  doorServo.attach(SERVO_PIN);
  doorServo.write(doorCloseAngle);
  pinMode(TRIG_PIN_A, OUTPUT);
  pinMode(ECHO_PIN_A, INPUT);
  pinMode(TRIG_PIN_B, OUTPUT);
  pinMode(ECHO_PIN_B, INPUT);
  scale.begin(HX711_DT, HX711_SCK);
  scale.tare();
  gpsSerial.begin(9600, SERIAL_8N1, RXD2, TXD2);
  wm.setSaveConfigCallback(saveConfigCallback);
  readCredentials();
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Connecting WiFi");
  lcd.setCursor(0, 1);
  lcd.print("Please wait...");
  bool connected = false;
  while (!connected) {
    WiFi.begin(ssid, pass);
    unsigned long wifiStart = millis();
    while (WiFi.status() != WL_CONNECTED && millis() - wifiStart <
10000) {
      delay(500);
      Serial.print(".");
    }
    if (WiFi.status() == WL_CONNECTED) {
```

```
    connected = true;
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("WIFI Connected");
    lcd.setCursor(0, 1);
    lcd.print(WiFi.SSID());
  } else {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("WiFi Not Connected");
    for (int i = 5; i >= 0; i--) {
      lcd.setCursor(0, 1);
      lcd.printf("Retrying in: %d", i);
      delay(1000);
    }
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Connecting WiFi");
    lcd.setCursor(0, 1);
    lcd.print("Please wait...");
  }
}
delay(1000);
Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);
Blynk.syncVirtual(V2);
unsigned long syncStart = millis();
while (millis() - syncStart < 3000) {
  Blynk.run();
  delay(100);
```

```
  }
  checkResetButton();
  if (binSetFull) {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Bin Status: FULL");
    lcd.setCursor(0, 1);
    lcd.print("Manually Set");
    return;
  }
void loop() {
  Blynk.run();
  checkResetButton();
  checkOperatorButton();
  while (gpsSerial.available()) {
    gps.encode(gpsSerial.read());
  }
  if (WiFi.status() != WL_CONNECTED) {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("WiFi Reconnect");
    lcd.setCursor(0, 1);
    lcd.print("Please wait...");
    Serial.println("WiFi disconnected, attempting reconnect...");
    bool connected = false;
    while (!connected) {
      WiFi.begin(ssid, pass);
      unsigned long wifiStart = millis();
```

```
    while (WiFi.status() != WL_CONNECTED && millis() - wifiStart <
10000) {
      delay(500);
      Serial.print(".");
    }
    if (WiFi.status() == WL_CONNECTED) {
      connected = true;
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("WiFi Connected");
      lcd.setCursor(0, 1);
      lcd.print(WiFi.SSID());
      delay(1000);
      lcd.setCursor(0, 1);
      lcd.printf("Full: %.1f%%       ", prevFill);
    }
}
```

APPENDIX – B
SCREENSHOTS

Sample Output

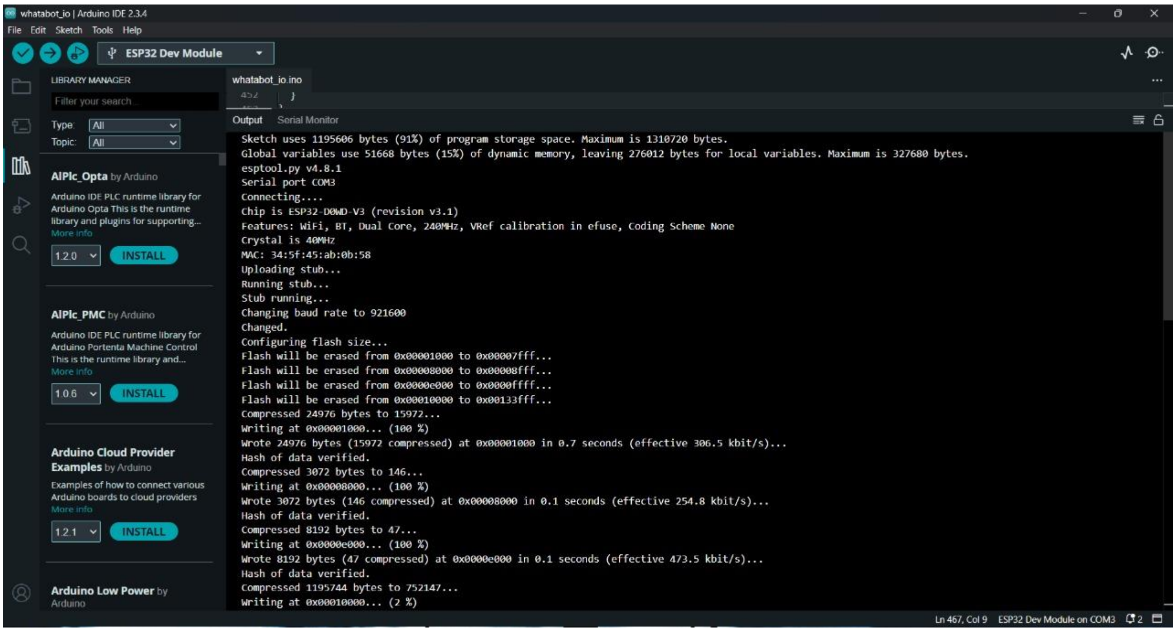

Fig B2.1 Compiling Sketch

Fig B2.2 Waiting for Wifi connection

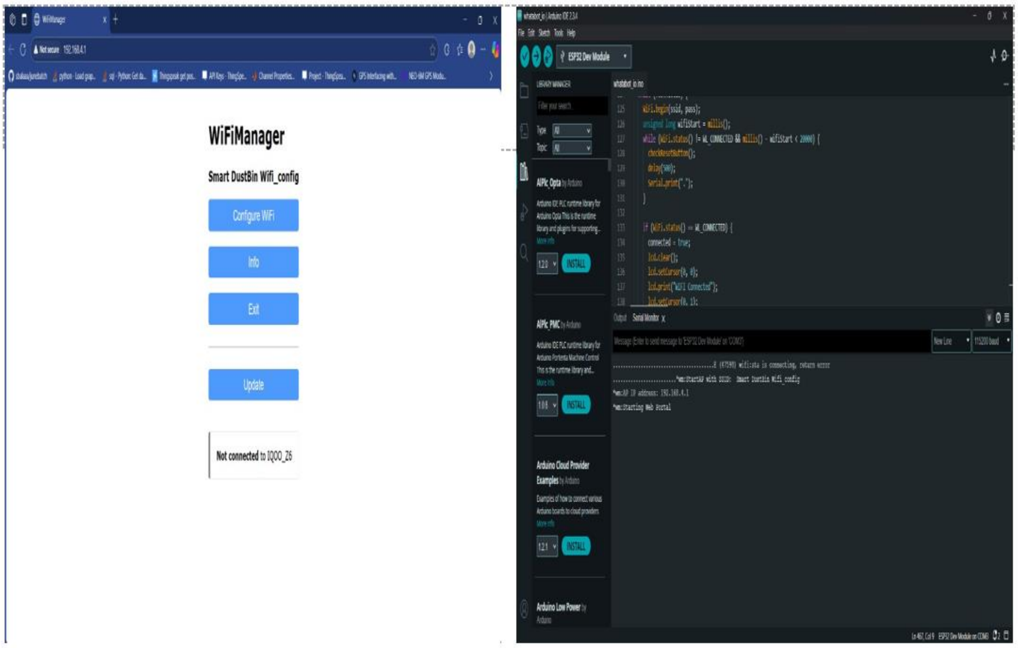

Fig B2.3 Wifi Manager

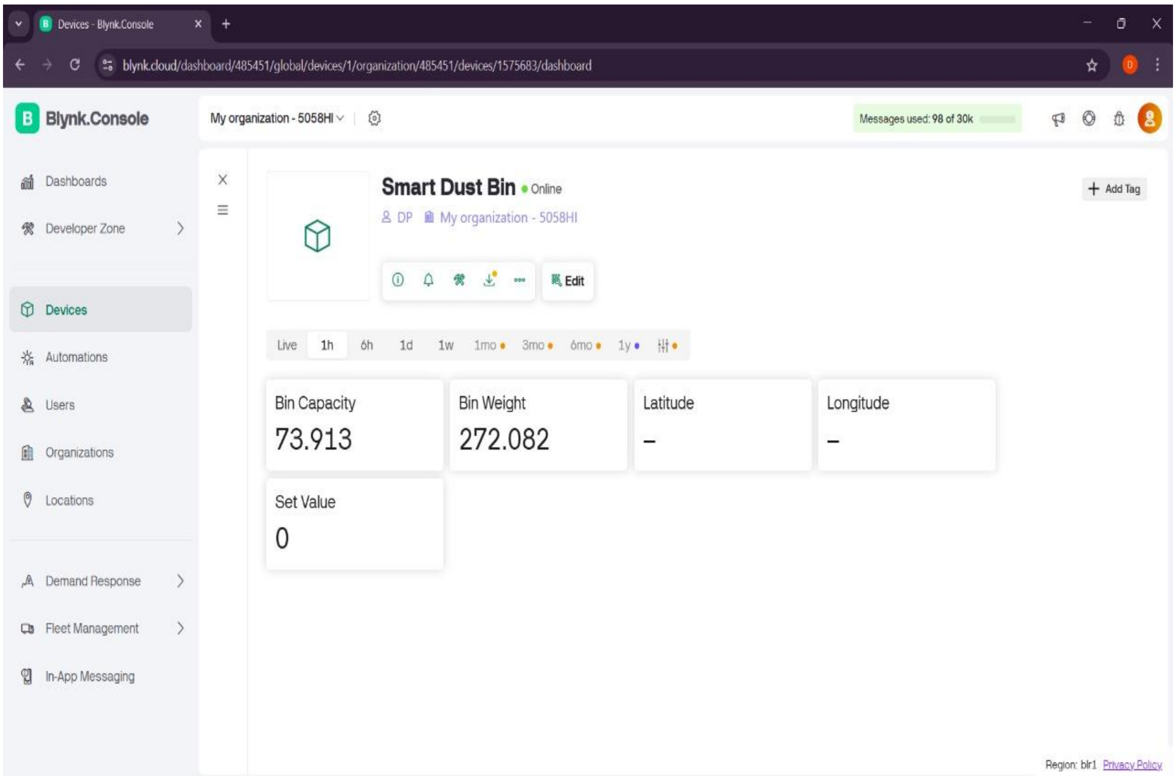

Fig B2.4 Blynk Dashboard

Fig B2.5 Status Display Indicating Full Capacity

Fig B2.6 Real time Tracking

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