
**AUTOMATIC INTELLIGENT WASTE BIN WITH AUTONOMOUS
AREA-BASED GARBAGE COLLECTION USING IOT**

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ABSTRACT

Waste management has become a critical challenge due to speedy urbanization & advancing waste generation. Traditional waste bins rely on manual handling, which often leads to polluted conditions like overflowing garbage, foul odor, & inappropriate waste segregation. The Automatic Intelligent Waste Bin with Autonomous Area-Based Garbage Collection Using IoT is developed to give a smart & efficient solution to these problems.

The system uses an ESP32 microcontroller to process inputs from many sensors like ultrasonic & infrared sensors. These sensors detect the presence of a user & automatically open the lid using a motor-driven mechanism, allowing touch-free waste disposal. A robotic arm mechanism is incorporated to sort waste into wet & dry categories, enhancing waste segregation.

An OLED display illustrates real-time system status, & motor drivers control the movement of the robotic components. The system is powered by a rechargeable lithium-ion battery & uses Wi-Fi connectivity to send alerts to a mobile application when the bin is full. This project gives a hygienic, efficient, & affordable waste management solution suitable for smart cities, hospitals, campuses, & residential areas.

INTRODUCTION

Waste management is an crucial aspect of maintaining cleanliness & environmental sustainability. With the rapid advancement of population & urbanization, the amount of waste generated daily has boosted significantly. Traditional waste collection systems are ineffective & often lead to unhygienic conditions due to manual handling & lack of proper monitoring.

To overcome these tasks, smart waste management systems using Internet of Things (IoT) technology have been presented. These systems automate waste collection, enhance hygiene, & give real-time monitoring.

The presented system uses an ESP32 microcontroller with sensors & automated mechanisms to make an intelligent waste bin.

It automatically opens when a user approaches, segregates waste using a robotic arm, & sends notifications when the bin is full. This system decreases human effort, increases cleanliness, & supports modern smart city infrastructure.

LITERATURE SURVEY

Several studies have highlighted on increasing waste management using automation & IoT technologies. Early waste management systems relied on manual collection & basic monitoring, which resulted in inefficiency & health harms. Recent advancements focus on the usage of microcontrollers like ESP32 for real-time monitoring & communication. These systems give data to cloud platforms, allowing stronger decision-making & waste collection planning.

Research published by IEEE highlights IoT-based smart waste management systems that usage sensors to monitor garbage levels & optimize collection processes.

Studies from Elsevier illustrate that automated waste segregation using sensors & robotic systems enhances recycling efficiency & decreases environmental effect.

PROPOSED SYSTEM

The presented system is a smart waste bin integrated with IoT technology that executes automatic lid operation, waste segregation, & real-time monitoring.

A. System Overview

1. Ultrasonic and IR sensors detect the presence of a user/consumer.
2. The lid opens automatically using a motor-driven mechanism.
3. Waste is placed inside the bin.
4. A robotic arm divides wet & dry waste.

5. Ultrasonic sensor monitors the garbage level.
6. OLED display shows system status.
7. ESP32 transfer data via Wi-Fi to a mobile app.
8. Alerts are produced when the bin is full.

B. Key Components

- ESP32 Microcontroller
- Robotic Arm
- Gear Motors
- Motor Driver
- OLED Display
- Ultrasonic Sensor
- IR Sensors
- 12V Lithium-ion Battery
- Wi-Fi Module (inbuilt in ESP32)

C. Working Principle

The system is energized by a rechargeable battery attached to the ESP32.

1. Ultrasonic & IR sensors detect the presence of a user closer the bin.
2. When a consumer is detected, the ESP32 activates the motor to open the lid automatically.
3. The consumer disposes of the waste without contact the bin.
4. After waste is stored, the lid closes automatically.
5. The robotic arm mechanism identifies & differentiates waste into wet & dry compartments.
6. Another ultrasonic sensor constantly measures the level of garbage inside the bin.
7. The OLED display shows real-time information like bin status (empty/full).
8. When the bin reaches a certain level, the ESP32 sends a notification to the mobile application via Wi-Fi.
9. This allows timely waste collection & avoids overflow.

D. Advantages

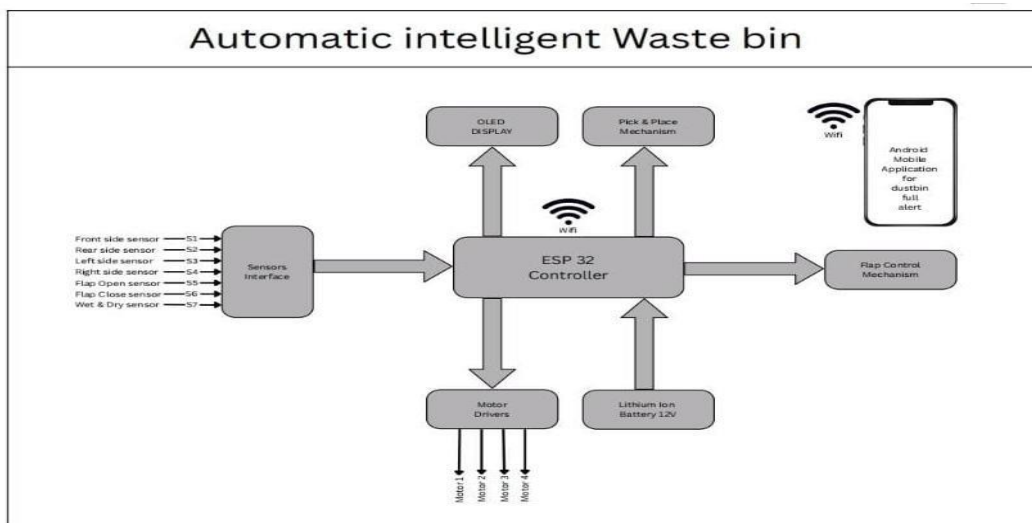
- Automatic waste segregation
- Real-time monitoring using IoT
- Increases cleanliness & sanitation

- Affordable & energy-efficient system
- Suitable for smart city applications
- Decreases human effort
- Avoids overflow of garbage
- Contact-free & hygienic waste disposal

E. Application

- Smart cities
- Shopping malls & offices
- Industrial waste management
- Residential areas
- Railway stations & public places
- Hospitals & healthcare facilities
- Colleges & campuses

Block Diagram:



Model:



RESULTS AND DISCUSSION

The automatic intelligent waste bin was examined in a controlled environment to evaluate its operation. The ultrasonic & infrared sensors successfully detected consumer presence & triggered automatic lid operation. The robotic arm mechanism efficiently segregated waste into various compartments, increasing waste management efficiency. The OLED display provided precise real-time status updates. The IoT system successfully transferred data to the mobile application, & notifications were produced when the bin reached its capacity. The system illustrated reliable operation, decreased manual intervention, & increased hygiene. However, performance depends on appropriate sensor calibration & steady Wi-Fi connectivity. Overall, the system proved to be efficient & suitable for real-world applications.

CONCLUSION

The Automatic Intelligent Waste Bin with Autonomous Area-Based Garbage Collection Using IoT gives a smart & effective solution to modern waste management tasks. By integrating sensors, automation, & IoT technology, the system ensures hygienic waste disposal, automatic segregation, & real-time monitoring. The use of ESP32 allows efficient processing & wireless communication, created the system suitable for smart environments. This project coordinates to enhanced cleanliness, decreased human effort, & good waste management practices.

FUTURE WORK

- Coordination of AI for advanced waste classification
- GPS tracking for garbage collection vehicles
- Coordination with municipal waste management systems
- Solar-powered system for energy/power efficiency
- Mobile app with real-time analytics dashboard

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