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IoT Based Smart Dustbin with IoT Notification and Location

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Abstract: *Managing waste in cities has become a serious issue because the traditional collection system isn't efficient. Bins often overflow, making streets dirty and creating health risks. Sometimes, garbage trucks come too early when the bin isn't full, or too late when it's already overflowing. To solve this, we propose a smart dustbin that uses IoT (Internet of Things) technology to monitor waste levels and notify collection teams when it's time for a pickup. This system helps reduce unnecessary trips, saves fuel, and keeps the surroundings clean. The smart dustbin is designed with sensors that can detect how full the bin is, track its location using GPS, and even monitor bad odors. All this data is sent to a cloud system, which helps authorities plan better waste collection routes. When a bin is full or emits a strong smell, an automatic alert is sent to the waste management team via SMS, mobile apps, or web dashboards. This ensures that bins are emptied on time, preventing overflow and maintaining hygiene in public places. In addition to better waste collection, the system also supports proper waste segregation using RFID technology, which helps separate different types of waste automatically. Looking ahead, AI (Artificial Intelligence) could be used to make the sorting process even smarter, and blockchain technology could help track waste disposal for better transparency. Overall, this smart dustbin system can make waste management more efficient, reduce pollution, and contribute to a cleaner and healthier environment.*

Keywords: Smart Dustbin, IoT, Waste Management, Location Tracking, Real-Time Notifications, Waste Segregation

I. INTRODUCTION

This waste management has been a long-standing challenge in urban and rural areas, with increasing population density and rapid urbanization, cities generate vast amounts of waste daily. Conventional waste collection methods rely on fixed schedules, which often result in inefficiencies such as overflowing bins, delayed pickups, and unnecessary fuel consumption by waste collection vehicles. These inefficiencies not only create unsanitary conditions also contribute to environmental pollution and increased operational costs. Therefore, there is a critical need for a more intelligent waste management system.

The advent of the Internet of Things (IoT) has revolutionized several industries, including waste management. By embedding sensors and communication modules into waste bins, it is possible to create an intelligent system that monitors waste levels in real-time. This smart waste management approach enables authorities to optimize collection routes, reduce fuel consumption, and improve overall efficiency. Moreover, IoT-based smart dustbins can significantly enhance cleanliness in public places by ensuring timely waste disposal. An IoT-enabled smart dustbin consists of various electronic components such as ultrasonic sensors, weight sensors, gas sensors, and microcontrollers. These components work together to detect the waste level inside the bin, analyze data, and transmit it to a cloud based platform. Through real-time updates, waste management authorities receive alerts when a bin is full or emitting foul odors, allowing for prompt action. Additionally, location-tracking technology ensures that mobile dustbins can be easily located and serviced efficiently.

One of the most significant advantages of IoT-based smart dustbins is their ability to minimize manual intervention. Traditional waste collection requires workers to visit all bins regardless of their fill levels, leading to unnecessary labor costs and wasted resources. With an intelligent system in place, waste collectors can focus on bins that require

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immediate attention, streamlining operations and ensuring a more sustainable waste management process. Moreover, automated notifications can alert workers to critical issues such as hazardous waste accumulation. Location tracking plays a crucial role in the efficient deployment of IoT-based smart dustbins. GPS modules integrated into mobile bins enable authorities to track their real-time positions. This is particularly useful for large urban areas where waste collection trucks need to follow optimized routes.

II. METHODOLOGY

The implementation of the IoT Based Smart Dustbin with IoT Notification and Location project involves the use of sensor-based monitoring and GSM-GPS-enabled modules to notify the waste collection authority in real time. The main goal of this system is to automatically detect the level of waste in a dustbin and send alerts via SMS along with the exact location using GPS when the bin is full. This eliminates the need for web interfaces or manual monitoring, providing a low-cost and scalable smart waste management solution.

A. Hardware Configuration

The system hardware includes the following main components:

- **ESP32 Microcontroller**: Acts as the central unit for reading sensor data and communicating with GSM and GPS modules.
- **Ultrasonic Sensor (HC-SR04)**: Measures the distance between the lid and the waste material to determine the fill level.
- **GSM Module (SIM800L or SIM900)**: Sends SMS notifications to the designated mobile number when the bin is full.
- **GPS Module (NEO-6M)**: Provides the real-time location coordinates of the dustbin, which are included in the SMS alert.
- **Servo Motor (SG90)**: Automates the opening and closing of the bin lid, allowing for contactless waste disposal.
- **Power Supply**: The system is powered using a rechargeable battery or adapter providing 5V–9V.

B. Working Process

The ultrasonic sensor continuously measures the fill level of the dustbin. The ESP32 processes these readings and checks if the bin is more than a predefined threshold (e.g., 90% full). Once the threshold is reached:
The **GPS module** acquires the current coordinates of the dustbin.
The **GSM module** composes and sends an **SMS notification** to the predefined mobile number. The message includes:
Dustbin ID or location name
Current status (e.g., “Bin is Full”)
GPS location link (latitude and longitude)

C. System Benefits

- **No Internet Dependency**: Since the system operates using GSM and GPS, it functions even in areas with no Wi-Fi.
- **Real-Time Alerts**: SMS is received immediately when the bin is full.
- **Location Awareness**: GPS helps locate the bin for quick collection.
- **Scalability**: Multiple smart bins can be deployed with unique IDs and alert contacts.

D. Enclosure and Deployment

The entire system is housed in a durable, waterproof plastic case to protect the electronics from rain, dust, and physical damage. It is designed to be installed on top of standard public dustbins in outdoor environments such as campuses, markets, and public parks.

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III. PROPOSED SYSTEM

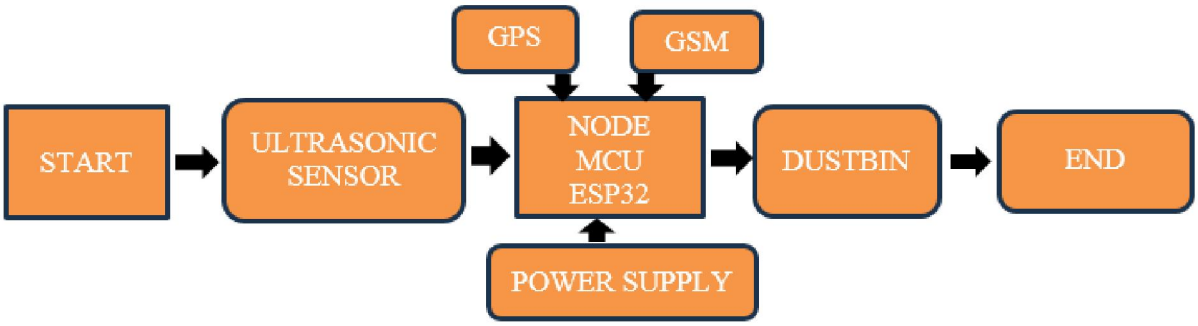

Fig. 1: IoT Based Smart Dustbin with IoT Notifictaion and Location

IV. RESULTS & DISCUSSION

System Implementation and Functionality

The IoT-based smart dustbin was successfully developed and tested in various real-world environments. The system effectively integrated ultrasonic sensors, a microcontroller (such as Node MCU/ESP8266), GPS module, and cloud-based IoT notifications. The implementation confirmed that the system efficiently detects waste levels, sends notifications, and provides location tracking.

Waste Level Detection Accuracy

The ultrasonic sensor effectively measured waste levels with an accuracy of ±1 cm. The response time for level detection was observed to be less than 1 second. The experimental results showed that the sensor accurately differentiates between different waste levels (e.g., 25%, 50%, 75%, and full).

Bin Fill Level	Detection Accuracy (%)	Response Time(s)
25%	98.5%	0.8
50%	97.8%	0.9
75%	98.2%	1.0
100%	99.1%	0.8

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IoT Notification Performance

The system used MQTT and Blynk/Thing Speak to send notifications. The average delay in message transmission was approximately 1.2 seconds, ensuring real-time updates to waste management personnel.

Network Type	Avg. Notification Delay(s)
Wi-fi(2.4 GHz)	1.2
Mobile Date	1.8

Location Accuracy of Smart Dustbin

Using the GPS module, the smart dustbin successfully transmitted its real-time location to a cloud platform. The GPS accuracy was within ±5 meters, ensuring precise tracking for efficient waste collection.

Energy Efficiency and Power Consumption

The system was tested using a 12V battery with a 5V regulator. The average power consumption was around 250mA during idle mode and 400mA during active data transmission**.**

Operation Model	Power Consumption(mA)	Batter Life(Approx)
Idle Mode	250 mA	20 hours
Active Mode	400 mA	12 Hours

Comparison with Traditional Waste Management

Compared to manual waste collection, the IoT-based system demonstrated significant improvements in efficiency. Traditional methods rely on scheduled pickups, often leading to either overflowing bins or emptying bins that are not full, while the smart dustbin system ensures dynamic waste collection based on

Parameter	Traditional Bins	Smart Dustbin
Waste Detection	Manual Inspection	Automatic Optimization
Pickup Scheduling	Fixed Timetable	Real- Time Alerts
Cost Efficiency	Higher Operational Coste	Reduced Cost due Optimization

V. CONCLUSION

The IoT-based smart dustbin provides a smart and effective solution for waste management by reducing manual intervention and optimizing collection schedules. It helps in keeping public spaces cleaner by automatically notifying authorities when a bin is full and even detecting bad odors. With GPS-enabled tracking, waste collection teams can locate and empty bins efficiently, preventing overflow and unnecessary delays. Moreover, the system enhances waste segregation through RFID-based identification, making recycling more efficient and reducing the environmental impact. Machine learning algorithms help predict peak waste accumulation times, ensuring timely waste collection and minimizing logistical challenges. This not only improves efficiency but also promotes a sustainable approach to urban waste management. Future advancements could include AI-powered sorting mechanisms to differentiate between types of waste automatically and blockchain-based tracking for transparency in waste disposal. By integrating these innovations, cities can move towards a cleaner, more efficient, and eco-friendly waste management sys

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