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TRASHTRACK: PIONEERING SUSTAINABLE WASTE MANAGEMENT SOLUTIONS

Sathya harikara Sankar. S[1], Ritika Singh[2], Rohith Koushik D C[3] , Saurav Kumar[4], Sandeep M.M[5], Sankeet Rajesh ollala[6] Dr.Anantha Subramanya Iyer K N[7]

[1]Master of Business Administration, Core Marketing, CMS Business School, Bengaluru, India

[2]Master of Business Administration, Core Marketing, CMS Business School, Bengaluru, India

[3]Master of Business Administration, Core Finance, CMS Business School, Bengaluru, India

[4]Master of Business Administration, Core Marketing, CMS Business School, Bengaluru, India

[5]Master of Business Administration, Core Marketing, CMS Business School, Bengaluru, India

[6]Master of Business Administration, Core Marketing, CMS Business School, Bengaluru, India

[7]Professor, Department of Marketing, CMS Business School, Bengaluru, India

[1] sathyaharikarasankar@gmail.com, [2] ritikaasingh07@gmail.com, [3]rohitkaushik01@gmail.com
[4]sauravkhandelwal38@gmail.com, [5]sandeepmagaji7@gmail.com, [6]sanketollala2@gmail.com
[7]asi@cms.ac.in

ABSTRACT- The IoT-based Trash Track system is designed to revolutionize waste management by monitoring and optimizing garbage collection in real-time. Using an integrated network of smart sensors, GPS tracking, and cloud connectivity, the system provides real-time data on waste bin status and garbage collection routes. It allows authorities to locate the nearest waste collection points and track the fill levels of bins, enabling efficient waste disposal and collection planning. Each bin is equipped with ultrasonic sensors to detect waste levels and notify collection teams when bins are full. By providing real-time data and predictive analytics, Trash Track minimizes unnecessary waste collection trips, reduces fuel consumption, and helps lower carbon emissions. The system enhances the efficiency of urban waste management, contributing to a cleaner and more sustainable environment.

INTRODUCTION: The increasing urban population has led to significant challenges in waste management. Traditional waste collection methods are inefficient, leading to overflowing bins, excessive fuel consumption, and increased pollution. The Trash Track system leverages Internet of Things (IoT) technology to automate and optimize the waste collection process IoT enables real-time communication between smart sensors, cloud servers, and monitoring systems. This allows waste management authorities to track bin statuses, optimize collection routes, and prevent waste overflow. The system includes embedded sensors that detect fill levels and send data via Wi-Fi or GSM modules to a central monitoring dashboard. Predictive analytics help in forecasting waste accumulation trends, ensuring timely collection and efficient resource utilization.By integrating cloud computing, remote monitoring, and AI-based route optimization, Trash Track significantly reduces operational costs, improves sanitation, and enhances urban cleanliness. The cloud infrastructure ensures

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scalability, allowing cities to expand the system as required. The IoT-driven approach provides a smart, sustainable, and data-driven waste management solution.

HARDWARE DESCRIPTION

1) Vehicle Sensors (IR, Ultrasonic)

IR sensors are used to detect the presence of waste and measure the fill level of garbage bins, ensuring efficient waste management. Ultrasonic sensors, on the other hand, measure the height of waste inside the bin to determine whether it is full or empty. These sensors play a crucial role in automating the waste collection process by providing accurate data on bin status.

2) GPS Module

A GPS tracking device is installed in waste collection vehicles to monitor their real-time location. This helps in optimizing collection routes and tracking vehicle movement, ensuring that waste is collected in a timely and efficient manner. By integrating GPS technology, waste management authorities can enhance operational efficiency and reduce unnecessary fuel consumption.

3) Embedded Controller (Arduino / ESP32 / Raspberry Pi)

An embedded controller, such as Arduino, ESP32, or Raspberry Pi, acts as the central processing unit of the system. It collects data from various sensors and transmits it to the cloud via Wi-Fi. Additionally, it controls system functions such as sending alerts and triggering relays, enabling seamless automation in waste management.

4) Remote Monitoring & Control Unit (Cloud-Based System)

The system uses IoT connectivity via Wi-Fi to monitor the waste collection process in real time. Municipal authorities can track bin status, vehicle movement, and collection schedules through a cloud-based dashboard. This remote monitoring capability improves decision-making and ensures a more effective waste collection process.

5) Waste Collection Status Monitor (LCD Display / Cloud Dashboard)

A real-time waste collection status monitor displays key information such as waste levels, collection status, and bin identification numbers. This can be accessed via an LCD display or a cloud dashboard, making it easier for waste management personnel to track and manage waste collection operations efficiently.

6) User Notification Mobile App (Android / iOS)

A mobile application for Android and iOS sends alerts to waste management authorities and users regarding the status of waste bins. It notifies them when bins are full and require collection while also displaying optimized collection routes. This enhances coordination and ensures timely waste disposal.

7) Data Dashboard (Web-Based / Cloud Platform)

The data dashboard serves as a central repository for storing and analysing waste collection data. It generates reports on waste management efficiency, bin utilization, and predictive maintenance. By leveraging data analytics, waste management authorities can identify trends and optimize waste collection strategies.

8) Waste Collection Optimization AI (AI-Based Route Planning System)

An AI-based route planning system uses advanced algorithms to optimize collection routes based on bin fill levels and vehicle locations. This technology reduces fuel consumption, minimizes operational costs, and improves overall waste collection efficiency. By implementing AI-driven optimization, waste management systems can become more sustainable and cost-effective.

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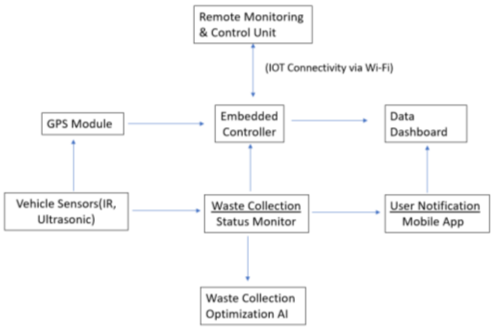
I. BLOCK DIAGRAM



II. WORKING

The Trash Track Smart Waste Management System operates through a well-integrated setup that includes power supply regulation, sensor integration, data collection, and wireless communication. The system is powered by a 230V AC to 12V DC converter, ensuring a stable voltage supply for the circuit. A 1N4007 diode rectifies AC to DC, while an LM 7805 voltage regulator stabilizes the 5V output. IR and Ultrasonic sensors detect waste bin levels, and a GPS module tracks garbage truck locations. RFID scanners tag bins with unique IDs for easy tracking. The Arduino microcontroller processes data from the sensors and transmits it to a central system. Wireless transmission is handled via Wi-Fi, sending real-time updates to a cloud-based dashboard. An AI system analyses bin data to optimize garbage truck routes, prioritizing bins that are full. Users can access bin status and collection schedules through a web dashboard or mobile app. The system automatically updates once a bin is emptied, ensuring an efficient waste collection process.

III. CONCLUSION

The Trash Track Smart Waste Management System offers an automated, cost-efficient, and eco-friendly solution for urban waste monitoring and collection optimization. By integrating IoT technology, AI-powered route prediction, and real-time monitoring via cloud-based platforms, the system enhances waste collection efficiency, reduces fuel consumption, and prevents overflowing bins. The benefits of the system include smart waste tracking with IoT sensors, AI-driven route optimization, real-time bin status updates, cost reduction, and eco-friendly waste disposal practices. Overall, Trash Track transforms waste management into a smarter, data-driven process that contributes to cleaner, more sustainable urban living

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