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Department of Computer Science and Engineering

PROJECT FINAL REVIEW

Batch no:B30

An IOT Enabled Waste Manage System That Optimizes Garbage Collection Route

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INTRODUCTION

Smart cities require efficient and sustainable waste management systems. Traditional garbage collection methods often lead to overflowing bins, fuel wastage, and poor resource planning.

This project presents an **IoT-enabled Smart Waste Management System** that monitors bin fill levels in real-time, shares GPS location, and calculates the **shortest collection route** using intelligent algorithms.

The goal is to reduce operational costs, save time, minimize environmental impact, and support the development of cleaner, smarter cities.

PROBLEM STATEMENT

Waste management in urban areas faces several challenges, including **inefficient collection, overflowing bins, and increased environmental pollution**. Traditional waste collection systems follow **fixed schedules** rather than real-time monitoring, leading to unnecessary fuel consumption, labor costs, and hygiene issues.

Due to the lack of a **smart tracking mechanism**, authorities struggle to identify **which bins need immediate attention**, causing delays in waste disposal and contributing to unhygienic surroundings.

This project aims to address these challenges by developing an **IoT-based Smart Garbage Monitoring System** that provides **real-time waste level detection and location tracking**, enabling optimized and timely waste collection.

ABSTRACT

This project presents a Smart Trash Bin with Shortest Path Finder designed to improve urban waste collection through IoT and route optimization. The system uses an ESP32 microcontroller paired with ultrasonic sensors to monitor bin fill levels in real-time. A switch differentiates between multiple bins, and when a bin is full, its GPS location is updated to the cloud. A Python-based shortest path algorithm, such as Dijkstra's is then used to calculate the most efficient route for the garbage collection vehicle, starting from its current location. This intelligent routing minimizes fuel consumption, reduces collection time, and enhances operational efficiency. By integrating real-time monitoring, cloud connectivity, and predictive route planning, the system offers a scalable solution for smart cities aiming to automate and optimize their waste management processes.

OBJECTIVES

- Development of Smart Trash Bin System
- Cloud Integration for Real-Time Monitoring
- Shortest Path Algorithm for Route Optimization
- Enhance Reduction in Operational Costs
- Sustainability and Environmental Impact
- Scalability and Flexibility.

Real-Time GPS Navigation for Collection Vehicles

MODULE DESCRIPTION

Task Scheduling Module: Manages and organizes tasks using NLP to extract details like name, date, and priority. Tasks are stored, synced with calendars, and reminders are sent. Enhances productivity with a dashboard and recommendations for optimal scheduling.

Query Resolution Module: Leverages NLP to answer general, technical, and domain-specific queries in real time. Provides accurate, context-aware responses and follow-up suggestions. Simplifies information retrieval and decision-making.

Integration Module: Connects seamlessly with third-party tools like calendars, emails, and IoT devices. Syncs data in real time and automates workflows. Enhances productivity by consolidating tools and creating unified experiences.

User Interaction Module: Facilitates communication through text, voice, and visual inputs with an adaptive interface. Ensures accessibility and delivers user-friendly interactions. Enhances usability across multiple input methods.

Context and Personalization Module: Personalizes experiences by retaining preferences and maintaining context. Adapts to user behavior for tailored interactions. Provides refined recommendations and user-centric responses.

METHODOLOGY

Steps	Detail
System Design & Hardware Integration, Components used	The **ultrasonic sensor** measures the waste level in the bin. The **GPS module** provides the bin's location. The **ESP32 microcontroller** processes the data and sends it to a web-based platform
Data Collection & Processing	The ultrasonic sensor detects the **garbage level** inside the bin. GPS coordinates are collected for bin tracking. The ESP32 transmits data to a **web server** through WiFi.
Real-Time Monitoring & Web-Based Interface	The web platform, accessible via an **IP address**, displays: Waste level percentage Bin location on a map Alerts for bins that need immediate attention
Alert System & Waste Collection Optimization	When the bin reaches a **threshold level (e.g., 80%)**, an **alert is sent** to the municipal authority. The GPS location helps optimize **collection routes**, reducing unnecessary trips and fuel costs.
Testing & Implementation	The system is tested for **accuracy in waste level detection** and **real-time data transmission**. Adjustments are made to improve efficiency before large-scale deployment.

LITERATURE SURVEY

Smart Waste Management Systems

IoT has significanatly improved waste management through automated bin monitoring. Kamble et al. (2018) used ultrasonic sensors and GSM modules to track bin fill levels and notify collection vehicles. Patel et al. (2020) proposed ESP8266 microcontrollers for efficient, wireless monitoring.

Route Optimization Algorithms

Optimizing waste collection routes reduces fuel and improves efficiency. Rui et al. (2017) applied Dijkstra's Algorithm to minimize travel time, while Khan et al. (2019) used the A* algorithm for real-time, dynamic routing based on bin status. **Cloud-Based Monitoring and Analytics**

Cloud platforms enable remote monitoring and data analysis. Nayak et al. (2021) used ThingSpeak to track bin levels and manage schedules. Sharma et al. (2019) leveraged Google Cloud for data storage and dynamic route optimization.

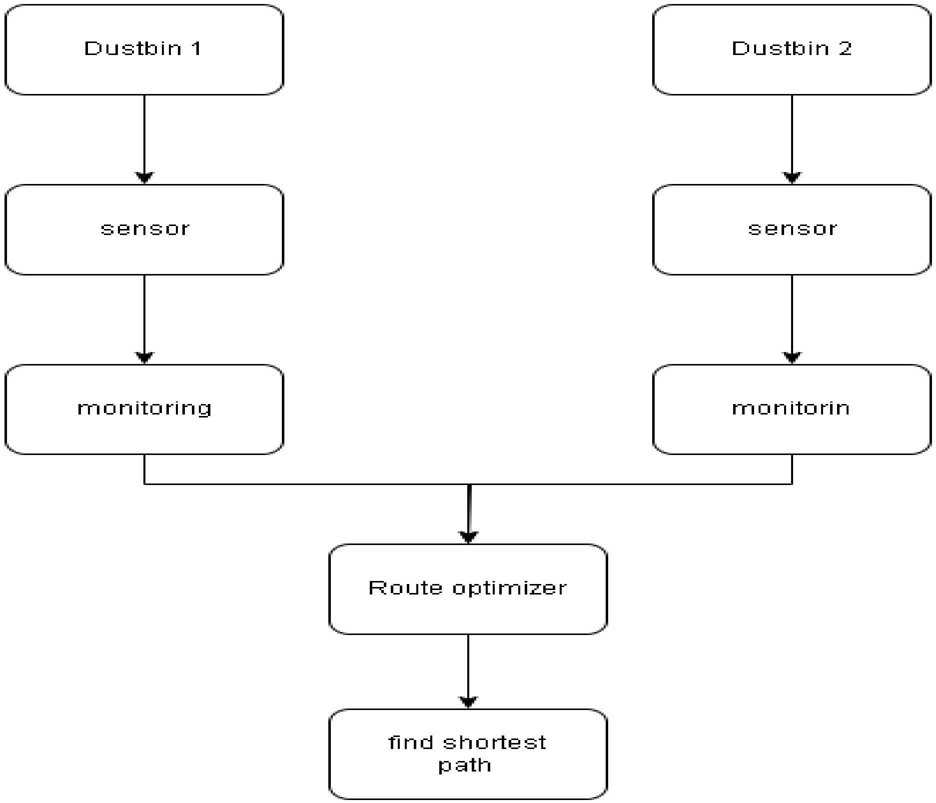
Predictive Maintenance in Waste Management

IoT supports predictive maintenance of vehicles and sensors. Mujtaba et al. (2020) used real-time monitoring to reduce breakdowns. Mehta et al. (2021) combined IoT with machine learning to forecast maintenance needs, enhancing fleet reliability.

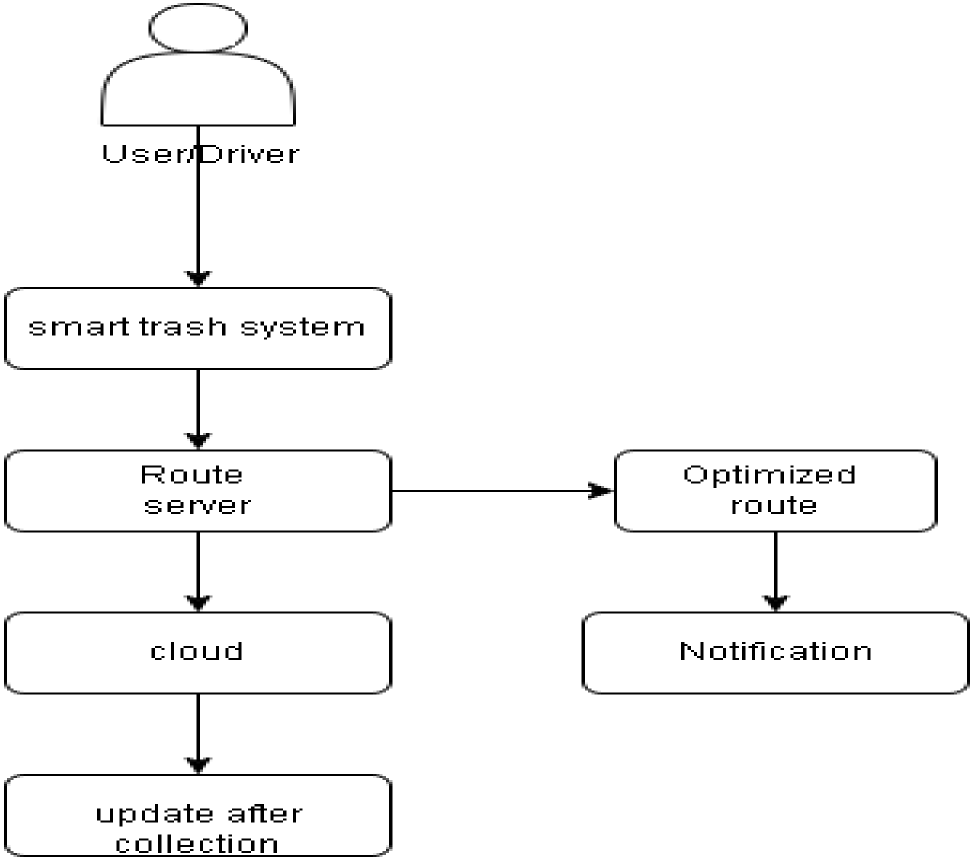
Sustainability and Environmental Impact

IoT systems contribute to sustainability by reducing fuel use and emissions. Zhao et al. (2019) noted improved route efficiency leads to lower environmental impact. Sharma et al. (2020) stressed the importance of real-time data in promoting sustainable urban waste practices.

SYSTEM ARCHITECTURE



FLOW CHART


User/Driver
smart trash system
Route
server
Optimized
route
cloud
Notification
update after
collection

ALGORITHM

1. Data Collection
   Read bin fill levels (Ultrasonic sensor)
   Get GPS coordinates
   Send data to cloud (Firebase/MySQL)
2. Bin Status Check
   Identify bins >80% full
3. Route Calculation
   Fetch full bin locations
   Use Google Maps API or Dijkstra’s/A* Algorithm
4. Optimization Output
   Generate shortest path
   Estimate time & distance
5. Notification & Display
   Show route in app/dashboard
   Notify driver via SMS
6. Dynamic Update
   Recalculate route as bin status changes

REFERENCES

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CONCLUSION

The **IoT-enabled Waste Management System** effectively optimizes garbage collection by integrating smart sensors, GPS tracking, and real-time monitoring. By utilizing an **ESP32 microcontroller**, **ultrasonic sensors**, and **GPS modules**, the system detects the fill levels of waste bins and determines their precise location. The collected data is transmitted to the **Blynk application**, allowing authorities to monitor bin status remotely.

The system enhances efficiency by dynamically **optimizing garbage collection routes**, reducing unnecessary fuel consumption and labor costs. Additionally, it sends location-based alerts and SMS notifications to waste collection drivers, ensuring timely waste disposal and preventing overflows.

This solution significantly contributes to **cleaner urban environments**, reducing pollution and promoting sustainable waste management practices. Future enhancements could include **machine learning algorithms for predictive analysis** and the integration of **solar-powered sensors** for enhanced energy efficiency.

THANK YOU