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SmartGarb: An AI-Powered Application for Predicting Garbage Collection Vehicle Arrival Time in Small Cities with Office Commute Constraints

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Abstract- This research paper introduces SmartGarb, a pioneering mobile application designed to address the persistent issue of unpredictable garbage collection systems that manage vehicle arrival times in small cities, particularly affecting office commuters. Leveraging artificial intelligence (AI), Global Positioning System (GPS), and machine learning (ML), SmartGarb predicts the precise arrival time of garbage collection vehicles, enabling residents to plan their schedules more effectively and reduce inconvenience. The paper presents the development, implementation, and evaluation of SmartGarb, highlighting its potential to enhance urban waste management systems and improve the quality of life for city residents.

Keywords- Garbage collection, GPS, Machine learning, Arrival time prediction, Small cities, Urban waste management

I. INTRODUCTION

Garbage collection delays pose a significant challenge in small cities, especially for residents with office commutes. The lack of predictability in arrival times leads to inconvenience and disruption of daily routines. Garbage collection is crucial in maintaining cleanliness and sanitation in urban areas. However, inefficient management of garbage collection vehicles can lead to delays, missed pickups, and increased operational costs. Timely detection of the location of garbage-collecting vehicles is essential for optimising waste management operations and improving service efficiency.

II. BRIEF REVIEW

With the advancement of technology, various solutions have been developed to track and monitor the whereabouts of these vehicles in real time. GPS (Global Positioning System) tracking systems are commonly used to accurately pinpoint the location of garbage trucks throughout their collection routes. These systems give fleet managers valuable insights into vehicle movement, allowing for better route planning, scheduling, and resource allocation.

Figure 1 represents a truck used in waste management.

Figure 2. shows devices used in waste management.

Figure 3. represents modules used in waste management software.

By leveraging timely location detection technologies, municipalities and waste management companies can streamline operations, reduce costs, and provide communities with more responsive and reliable garbage collection services. This paper introduces SmartGarb, an innovative solution that leverages AI, GPS, and ML to accurately predict the arrival time of garbage collection vehicles, addressing this pressing issue and enhancing urban waste management efficiency.

Figure. 4 shows the data flow in waste management

III. RESEARCH METHODOLOGY

SmartGarb employs a hybrid approach combining AI techniques, GPS data, and ML algorithms to predict vehicle arrival times for garbage collection. The methodology involves data collection from GPS-enabled garbage trucks, preprocessing data to remove outliers and noise, feature extraction to capture relevant factors influencing arrival times, and model training using supervised learning algorithms such as random forest and gradient boosting.

IV. APPLICATION WORKFLOW

The SmartGarb application utilises a combination of artificial intelligence (AI), Global Positioning System (GPS) technology, and machine learning (ML) algorithms to predict the arrival time of garbage collection vehicles in small cities, particularly considering the

constraints posed by office commute schedules. Here's how the application works:

1. Data Collection: The application gathers real-time GPS data from garbage collection vehicles equipped with GPS tracking devices. These devices continuously transmit location information, allowing the application to monitor vehicle movements.
2. Data Preprocessing: Before analysis, the collected GPS data undergoes preprocessing to remove outliers, noise, and inaccuracies. This ensures that the data used for prediction is clean and reliable.
3. Feature Extraction: Relevant features are extracted from the preprocessed GPS data. These features may include current vehicle location, historical travel times along specific routes, traffic conditions, and time of day.
4. Machine Learning Model Training: The application employs supervised machine learning algorithms, such as random forest or gradient boosting, to train predictive models. These models learn from historical GPS data and associated arrival times to predict the arrival time of garbage collection vehicles at specific locations.
5. Real-Time Prediction: As new GPS data becomes available, the trained machine learning models generate real-time predictions of vehicle arrival times for garbage collection. These predictions consider current vehicle location, route characteristics, traffic conditions, and historical patterns.
6. User Interface: The SmartGarb application provides users with an intuitive interface to access the predicted arrival times of garbage collection vehicles. Users can view real-time updates on vehicle locations and estimated arrival times, allowing them to plan their schedules accordingly.
7. Continuous Learning and Improvement: The application continuously collects new GPS data and refines its predictive models over time. As more data becomes available, the models are retrained to improve accuracy and adapt to changing traffic patterns and environmental conditions.

By leveraging AI, GPS technology, and machine learning algorithms, the SmartGarb application provides residents with timely and accurate information about vehicle arrival times for garbage collection, helping them plan their schedules more effectively and minimise inconvenience caused by delays.

IV. IMPLEMENTATION

The SmartGarb application is developed for Android and iOS platforms, providing users with an intuitive interface to access real-time vehicle information arrival times for garbage collection. The application integrates with existing GPS tracking systems deployed in garbage trucks, continuously updating predictions based on live data feeds. Machine learning models are deployed on cloud servers to ensure scalability and performance.

V.INCORPORATING NOTIFICATION ALERT FEATURE EVEN WHEN GPS IS TURNED OFF, AND MOBILE IS SILENT

Incorporating such a feature into the SmartGarb application can greatly enhance its usability and ensure that all household members are informed about the arrival of the garbage-collecting vehicle, even if their GPS is turned off or their phone is on silent mode. Here's how this feature could work:

1. Alert System Integration: SmartGarb can include an alert system that sends notifications to the mobile devices of all

registered household members when the garbage-collecting vehicle is predicted to arrive.

2. Multiple Notification Channels: The application can utilise multiple notification channels, including push notifications, SMS messages, and email alerts, to reach household members regardless of their preferred communication method.
3. Emergency Contact Option: In cases where a household member's GPS is turned off, or their phone is on silent mode, SmartGarb can provide an option for designated emergency contacts to receive alerts and make phone calls to inform them about the arrival of the garbage collecting vehicle.
4. Customisable Alert Settings: Users can customise their alert settings within the SmartGarb application, specifying the type of notifications they prefer to receive (e.g., push notifications, SMS, email) and setting up emergency contacts for phone call notifications.
5. Reminder Feature: Additionally, SmartGarb can include a reminder feature that prompts household members to inform each other about the arrival of the garbage collecting vehicle, ensuring that everyone is aware of the scheduled pickup.
6. Accessibility Options: To accommodate users with accessibility needs, SmartGarb can offer options for text-to-speech alerts or vibrating notifications for individuals who may have difficulty receiving standard alerts.
7. Privacy Considerations: SmartGarb should prioritise user privacy and allow individuals to opt out of receiving notifications if they prefer not to be alerted about garbage collection schedules. By implementing these features, SmartGarb can ensure that all household members are promptly informed about the arrival of the garbage collecting vehicle, facilitating communication and coordination within the household.

VI. EVALUATION:

A pilot study was conducted in a small city named Narmadapuram (Hoshangabad), and its streets had a high concentration of office commuters. Real-time GPS data from garbage trucks are collected over several weeks; SmartGarb can generate arrival time predictions and be compared against actual arrival times. The evaluation metrics include accuracy, precision, and recall, demonstrating the reliability and usability of the application.

VII. RESULTS

We can evaluate the performance of our proposed system using real-world GPS data collected from garbage collection vehicles in urban areas. Experimental results demonstrate the effectiveness of the AI-based approach in accurately predicting the location of these vehicles with high precision and recall rates. By providing timely information on the whereabouts of garbage collection vehicles, our system enables better coordination and scheduling of waste management activities, leading to improved efficiency and cost savings. The proposed system offers significant benefits for waste management operations by providing real-time tracking and monitoring capabilities. Future work will further optimise the predictive models and integrate additional data sources to enhance the system's performance and scalability.

VIII. CONCLUSION

SmartGarb represents a significant advancement in addressing the challenge of vehicle arrival times for unpredictable garbage collection in

small cities with office commute constraints. By harnessing AI, GPS, and ML technologies, SmartGarb provides residents with timely and accurate information, enabling them to plan their schedules better and mitigate inconvenience. Future research will enhance the accuracy and robustness of arrival time predictions and expand the application to other urban contexts.

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