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Real-Time Monitoring and Route Optimization in Smart Waste Collection Systems

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Abstract: An essential component of urban infrastructure is the collection and handling of waste. Public health suffers when there are insufficiently effective and optimized systems. In this study, an eco-friendly, effective, and efficient "smart dustbin system" utilizing cloud computing, mobile applications, and the Internet of Things is proposed. This system uses sensors to give real-time garbage level monitoring and uses a mobile app to send alert messages to truck drivers to ensure timely collection. Cloud computing also makes it possible for real-time analytics, scalable sensor data storage, and easy access to bin and route data from any location, all of which improve system efficiency. The Traveling Salesman Problem (TSP) is used to determine the best course of action, which lowers operating expenses and enhances waste management in general.
Keyword: IoT sensors, Cloud computing, Mobile application, Real-time monitoring, Traveling Salesman Problem (TSP)

1.INTRODUCTION

In metropolitan or city areas, the clearance of waste management is one of the challenging tasks for the majority of the country all over the world. There is need of a well-organized waste clearance system is mandatory by keeping green environment[6]. Garbage has been is a big problem in most of cities and always city has been clean its ongoing task which needs laborious efforts. The garbage dust bins when every they are full a foul smell in surrounding of bin. This
attracts animals like cats, dogs, and flies. And these animals spill them even more. Another negative effect is the diseases that spread. It's not just the garbage that spread them, but the animals also can be a source.
In general, the garbage wastes are collected manually after visiting the entire area by the corporation vans, which is a tedious and sometimes faced huge challenge to manage the entire city. Moreover, in big cities, where extensive numbers of dustbins are deployed, and cleaning in routine basis is challenging.[3]
Therefore, we introduce “smart dust bin system” to resolve the all problems and smart dust bin facility to the address the problem. This system is working on based on IOT and mobile application.
Internet of Things (IoT) is one of the fastest-growing technologies of the present world. IoT is a network of inter-connected objects where these objects or things can transfer information among them without any direct interaction. IoT has led us to intelligent systems and devices which make our life a lot easier by making things efficient[1]. The cities are becoming ’smart cities’ But waste collection systems are still a matter of concern. The waste collection system has not still improved rather remained inefficient. This waste collection system can be improved with the idea of IoT based smart bins system.

This smart app developed for Municipal Corporation to manage and analyze the garbage transportation system. In this app consisting of the two modules namely admin and truck driver. admin (Municipal Corporation member) he is the super user of this application. Admin is mainly responsible to add the truck driver information to the database and the admin can add or remove bins and identify sensor faults in bins. admin can track garbage transportation trucks working. Admin can view the report of trucks garbage disposal work. status of all active bins. The admin has the capability to register new admins and add/ delete numbers from the SMS notification list. And Smart bin garbage collector to monitor the waste level of the bin it shows that garbage is full.

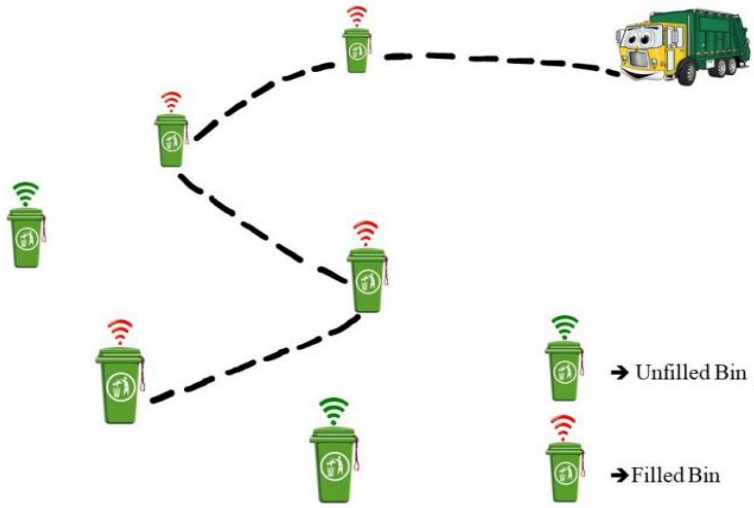

Fig 1: A typical IoT garbage collector system

The garbage status stored in database and it display message when it is full and also sends a notification to the particular truck driver. Using mobile application truck drivers view the filled dust bins location in Google map It shows a map with all the available bins. The truck driver get notification from the dustbins and he list all filled number of garbage dustbins and he can search for the nearest bin path here using the shortest path route algorithm technique it helps to find out the nearest route map. With the help google map disposes garbage collector and also Truck drivers can update their status regarding to the clearance of the dustbins in an mobile application. This app helps admin to keep eye on work of truck drivers. Truck drivers can report their work easily without using paper logs. Fig 1 Shows an IoT based waste collection system with smart bins.

2.LITERARURE SURVEY

The literature reviewed a number of publications to get details on the previous research that has been done. Gianluca, Davide Marzioni, Emanuele Alidor, and Sauro Longhi Di Bu~ o, Massimo Grisostomi, Mario Prist, and Matteo Pierro[14] made a suggestion, and a garbage collector using information-gathering sensor motes providing the obtained data and providing the bin's status via Data Transfer Nodes, or DTN. This container has a personalized prototype rather than just installing sensor nodes on a basic basis. The entire system is built to support heterogeneous sensor in order to communicate. One use for a wireless sensor network is regulating bin by collecting information from moles. The constraint the information regarding the bin is not directly sent either to the client or the server; it must be via the Nodes for Data Transfer [7]. In this work [8], Shubham Thakker and R. Sarayanamoorthi demonstrate how to determine the type of plastic by employing Near Infrared Reflectance (NIR) spectroscopy. The disgruntled fade Municipal solid waste (MSW) equipment is able to be placed in a place of need. By employing opposing materials that can blend into a consistent substance.The

many approaches for managing the internet of things are covered in paper [12], along with a description of its specific capabilities. of IoT, and gives an overall notion of preparing application of information management over online. An outline of the idea of merging user application using IOT [9] and addresses in-depth a synopsis of mobile sensor and analysis data administration. They described recent improvements made by leading global inventors in creating IoT standards, managing huge data, and mobile analytics, open source, and standards platforms for creating Internet of Things apps. Several IoT difficulties that we have listed in this paper need to be addressed if the IoT goal is to be realized. Taking these up major obstacles necessitate both international cooperation and extremely powerful applications. notable achievements in IoT research. A novel method was presented in this study and put into practice for smart cities waste management in relation to IOT [10], The idea of dynamic scheduling is necessary for the cleanup of dustbin on a regular basis and the Top-k query resulted in dustbin cleaning prioritized. City Garbage Collection Indicator with GSM and RF (Zigbee) technology [11].

3.METHODOLOGY

This smart bin system is very useful in preventing overflow of dustbins and accumulation of
wastes around the dustbin. This prototype model monitors the bins and provides details about the level of garbage collected in the garbage bins via sensors & Internet [4].

Using this smart bin system admin can be kept smart dustbin in cities along with the areas and admin update the dustbin location with the help GPS system. admin add truck driver to particular areas and can track garbage transportation trucks working. (figure2) shows the Smart bin garbage collector to monitor the waste level it shows that garbage is full when it is full sends a notification to the particular truck driver. Truck Driver login mobile application using his Username and password once his login he would be able to access the list of filled dustbin information like status and location of the bin. Using google map truck driver search the dust bin is filled along with the position i.e., latitude and longitude of the bin to the garbage collectors number. driver access those location information it shows the most shortest driving route from source to destination with the way-points of filled bins. Using shortest path it helpful to find shortest route to collect wastes only from the filled bins instead of all the bins in the area[1]. This smart bin system is helpful to reduces the fuel cost and human labor making because all bins of a location can be cleared in single attempt.

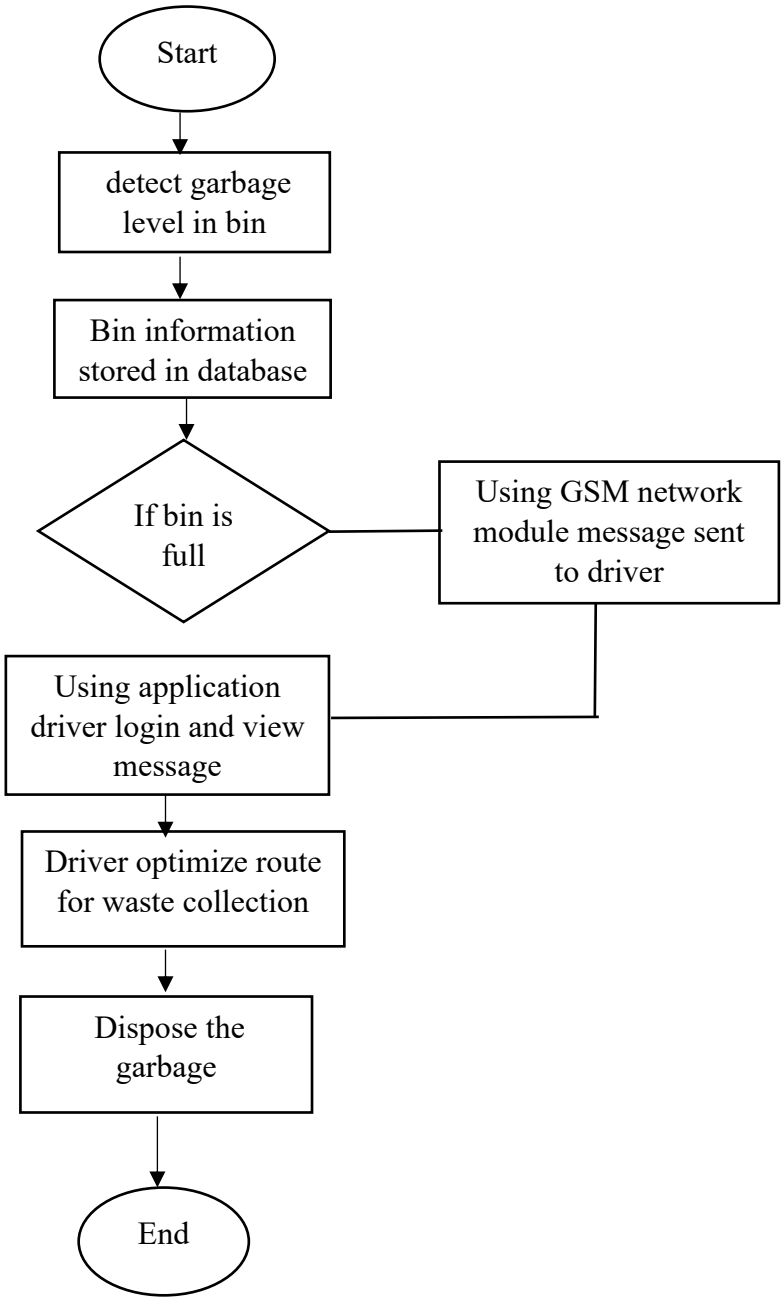

Figure 2: Flowchart Represents the Working of Smart Dustbin system

3.1 Smart Dustbin System

Admin can be kept smart dustbin in cities and update the dustbin location with the help GPS system. And we used database to store related to bin which gives garbage level information to database with the help of GPS map for the further process we used ultrasonic sensor is placed inside the bins to detect the level of dustbin being filled up. Once the Dustbin gets filled up a message is sent to the particular truck driver via GSM module. Arduino Uno is a main controller unit this device used to power supply to which all other sensors are connected.

3.2 Mobile Application

Android app will designed to interact with truckdriver and all the connected dustbins. Municipal member he is the Administrator in app, municipal member add bins, add truckdriver, update the dustbin location, set garbage collector on duty and can view work of truck drivers[2]. Once the municipal admin add truckdriver the driver opens the application. Truck Driver login mobile application. If he is already a registered member he can login using his Username and password. If he is new user he should be registered in mobile app. the user logs in successfully, when content of the bin is filled, then the status of the bin will be updated in the application which will be visible to the driver. If the driver wants to see the location of the bin, he can click on the Map button.

Using map truck driver search the dust bin is filled along with the position i.e., latitude and longitude of the bin to the garbage collector's number. An android application is used by the truck driver to access the information like latitude, longitude. This information is also stored in the database. The location shows the shortest driving route from source to destination with the way-points of filled bins. The waste collecting truck starts from its base and dumps all the collected wastes in another designated location and in its same way it collects wastes from the filled bins. So, an shortest path routing is needed to collect wastes only from the filled bins instead of all the bins in the area[1].

3.3 Navigation system

The efficacy of a waste collection system highly depends on the navigation system to find the shortest route map (figure 3) among the bins which need to be emptied.

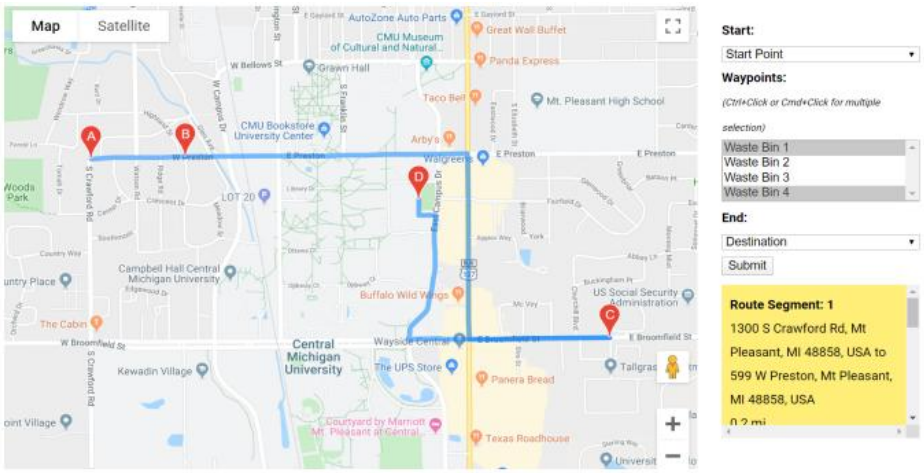

Fig 3: shortest route to collect waste from bin 1 and 4

The proposed navigation system is based on Google map with the position i.e., latitude and longitude and shows the most optimized driving route from source to destination with the way-points of selected bins. The waste collecting truck starts from its base and dumps all the collected wastes in another designated location and in its way it collects wastes from the selected filled bins. So, use dijkstra's algorithm is to collect wastes only from the selected bins instead of all the bins in the area[1].

3.4 Algorithm: Smart Dustbin Route Mapping

Step1: Detect full Dustbins

- IoT sensors identify full dustbins.
- All of the full trashcan locations are gathered by the system.

Step 2: Create a List of Completed Dustbins

- List all of the bins that are full.
- Include the waste disposal center as the route's beginning and ending points.

Step3: Calculate Distances

- Determine the distance (or time) between every pair of bins, as well as the distance between each bin and the garbage disposal center.
- Store these distance in a table.

Step4: Use the TSP Algorithm

- Discover the shortest path by using a TSP technique (such as Nearest Neighbor):
- beginning at the location for disposing of garbage.
- Making one visit to each full trashcan.
- going back to the trash disposal facility.

Step5: Select the Best Path

- The most effective or shortest path will be generated by the algorithm.

Step 6: Send the route to the driver

- Using the mobile app, give the garbage truck driver the best path.

Step 7: Monitor in Real-Time

- Continually monitor the contents of the container.
- The driver's path should be updated if more bins fill up.

3.5 IOT Components

1. GSM: A GSM module is a device that allows electronic devices to communicate with each other over the GSM network. GSM is a standard for digital cellular communications, which means that it provides a platform for mobile devices to communicate with each other wirelessly. The GSM module sends a message to the particular garbage collectors in this way the waste management can be achieved in an efficient way.

2. Ultrasonic Sensors: An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. The ultrasonic Sensors placed over the bins lid to detect the garbage outside bin[4].

4.CONCLUSION

In order to enhance the efficacy of waste disposal in public spaces, this paper concludes with the demonstration of an intelligent waste management system that leverages mobile and IoT technologies. Through a smartphone app, the system alerts garbage truck drivers when waste containers are full. It operates like this instantly. By using the Traveling Salesman Problem (TSP) to guide their route mapping, drivers can reduce fuel and labor costs by using the shortest path possible to collect waste. This method helps to handle rubbish more efficiently and creates cleaner, more sustainable public spaces.

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