SMART GARBAGE MANAGEMENT SYSTEM

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ABSTRACT- *Smart cities are assimilated with multiple ICT and IoT solutions to set up a comfortable human habitation. These include waste management which is efficient and environment friendly. This paper proposes an IoT based garbage management system which is cost-effective and helps the authority to efficiently manage the problem of increasing waste generation in a city. This system includes a network of smart bins which monitor and analyze data collected. An android app is provided through which citizens can track the nearest bin and drivers can get the shortest path while collecting garbage.*

Keywords: IOT; Smart City; Wi-Fi; Sensor

1. INTRODUCTION

Waste management has become one of the key issues all over the world and it increases day by day. Inefficient waste management has become a major environmental and health issue. In any kind of an environment, proper waste management is a basic requirement. Smart cities require innovative solutions for efficient garbage management which incorporate IoT and ICT technologies.

The current situation is that India having an inadequate waste infrastructure, the informal sector and waste dumping. There are major issues associated with public participation in waste management and there is generally a lack of responsibility towards waste in the community [1].

IoT-enabled waste management system can bring significant advantages in the overall implementation of waste management solutions. In the long run, IoT-enabled solutions can also help in segregating waste at the time of waste generation, thereby bringing in significant value to the rest of the lifecycle stages [2].

Solid waste management can be categorized as generation, segregation, collection, transportation and disposal. This paper deals with the segregation, collection and transportation of the waste generated. Segregation of solid waste can be done by the citizens according to the different types of garbage bins provided in a single position whereas drivers and cleaning staff do the collection and transportation. The citizens and the drivers are provided with an android application in which citizens get to know the nearest available bin and drivers are given the shortest path to the filled bin. The admin has a web application through which the bin status can be monitored and bins can be added or removed. Admin generates report according to the type and amount of waste being generated at each location.

2. LITERATURE REVIEW

The paper by Shashika Lokuliyana et al. "Location Based Garbage Management System with IoT for Smart City", proposes an IOT based system for the government to utilize available resources to efficiently manage the overwhelming amounts of garbage collected each day, It also providing a better solution for the inconvenience of garbage disposal for the citizens. Smart bins integrate cloud-based techniques to monitor and analyze data collected to provide predictive routes generated through algorithms for garbage trucks. An android app is developed for the workforce and the citizens, which gives the generated routes for the workforce and finds the nearest available smart bin for citizens. The bins will be fixed with multiple ultrasonic sensors which will be interfaced through a Raspberry Pi Zero W development board the garbage levels will be uploaded to the main server through the onboard Wi-Fi module in the development board. The server will collect the data and store them only in a database. Based on the data collected, garbage trucks can be given routes generated through various algorithms and google maps API to efficiently route through all necessary garbage bins [3].

In the paper by Vikrant Bhor et al. on "Smart Garbage Management System", the level of garbage in the bins is detected with Sensor systems, and communicated to the authorized control room through GSM module. Microcontroller is interfaced the sensor system with the GSM system. A GUI is also developed to monitor the required information related to the garbage for particular locations. This will help to manage the garbage collection efficiently [4].

The research paper by T. Anagnostopoulos et al. on "Top-k Query based Dynamic Scheduling for IoT-enabled Smart City Waste Collection" suggest a top-k query based dynamic scheduling model to face the challenges of near real-time scheduling driven by sensor data streams. An Android application with a user-friendly GUI is created and presented in order to prove feasibility and evaluate a waste collection scenario using experimental data. The proposed system architecture includes a heterogeneous fleet of trucks for serving the waste collection infrastructure. Cloud middleware is responsible to collect data from sensors, aggregate and clean them in order to

provide them to the engine which is implemented in OpenIoT. Dynamic scheduling algorithm finds the first available truck which can load garbage from the filled bins. Then it performs a top-K query which exploits real-time data from the relation. Also, data is stored in a database in which mobile top-k queries specify the number of the full bins in order to start dynamic scheduling. An Android app is implemented for the drivers to have a user-friendly GUI interface with the IOT system [5].

The paper by R. Fujdiak et al. on "Using genetic algorithm for advanced municipal waste collection in Smart City" mainly focuses on IoT vision that introduces promising and economical solutions for massive data collection and its analysis which can be applied in many domains and so make them operate more efficiently. To optimize the logistic procedure of waste collection, the paper uses its own genetic algorithm implementation. The proposed solution provides a calculation of more efficient garbage-truck routes. As an output, the paper provides a set of simulations focused on the mentioned area. All the algorithms are applied within the integrated simulation framework which is developed as an open source solution. The algorithms used are as follows: Floyd-Warshal, TSP formulation, crossover algorithm, Mutation algorithm and Dijkstra, TSP formulation Algorithm [6].

Referring to the paper of S. Lokuliyana et al. on "IGOE IoT framework for waste collection optimization" uses a sensor network based on disposal sites set up around the city. The sensor nodes notify relevant authorities about the availability of waste to be collected. A mobile application is built for citizens to alert authorities about an overflow of an authorized disposal site or unauthorized dumping site of waste. The same application is used by the authorities to convey messages to the citizens. An optimization algorithm is used to create the route in which the trucks use to collect the garbage from the disposal sites. Finally, an analysis is done to find out the delay of the waste collection process, effective waste collection rate and the waste collection process efficiency. The whole system is built as a framework and is named the IGOE waste collection framework [7].

3. PROPOSED SYSTEM

The Garbage bins will be fixed with ultrasonic sensor that will serve 2 purposes, collect garbage level data and detect hand movements to open bin door automatically through a servo motor. All the sensors will be interfaced through a NodeMCU development board. The garbage levels will be uploaded to the main server through the onboard Wi-Fi module in the development board. The server will gather the data and store them only a database. This data will be analyzed and displayed on two different dashboards that can be accessed by the workforce and clients. Using analytics, reports will be generated which can be monitored by the admins through the admin dashboard. Based on the data collected, garbage trucks can be given routes in Google maps API to efficiently route through all necessary garbage bins and finally reach the dumping site. The routes will be provided through the android workforce application. A client application will be developed which will allow clients to receive routes to the nearest available bin. This application also can be used to provide feedback, complaints, etc. The application is expected to provide for all the citizens a convenient medium to participate in garbage management in a city. This project incorporates IOT solutions to implement a system that provides the municipal council with a system that better equips them to handle the garbage problem in a smart city. Every party is interacting with this system that is the citizens, the workforce, and the admins.

The Figure 1 shows the block diagram of the system, it consist of two bins having sensors and Wi-Fi. Through the Wi-Fi module each bins communicate with the web application (for admin) and the mobile application (for workforce and user).

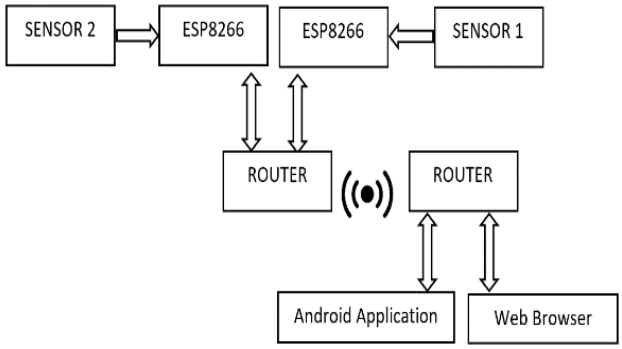

Figure 1: Block Diagram

The proposed system mainly consists of four components; Garbage bins, Server, Web service, Android application. The working of the system is depicted as follows.

3.1 Smart Bin

The bins will be fixed with ultrasonic sensors that will serve 2 purposes, collect garbage level data and detect hand movements to open bin door automatically through a servo motor. All the sensors will be interfaced through a NodeMCU development board the garbage levels will be uploaded to the main server through the onboard Wi-Fi module in the development board.

3.2 Server

The server will gather the data and store them only a database. This data will be analyzed and displayed on two different dashboards that can be accessed by the admin and clients.

3.3 Web Service

Using analytics, reports will be generated which can be monitored by the admins through the admin dashboard. Based on the data collected, garbage trucks can be given routes generated through various algorithms and Google maps API to efficiently route through all necessary garbage bins and finally reach the dumping site.

3.4 Android Application

There are two components; Workforce application and End-user application, the routes will be provided through the android workforce application. A client application will be developed which will allow clients to receive routes to the nearest available bin. This application also can be used to provide feedback, complaints, etc.

The Figure 2 shows the flowchart of the system. Configuring Wi-Fi and MQTT protocol is the first step. Using ultra sonic sensor then finding the distance using the formula given below

Distance= duration*0.034/2

Duration can be finding out by the ultrasonic sensor pins. When increase in the garbage level will decrease the distance.so now checking the conditions each time so according to the conditions there are some action to be done. If the distance>20 it will stop the iterations. If not check distance>15 assume garbage is empty and stop the iterations. If not distance>5 condition and the garbage is medium otherwise garbage is full then stop the iterations. Same time the distance values are uploading to the server. MQTT protocol works as publish/ subscribe fashion.

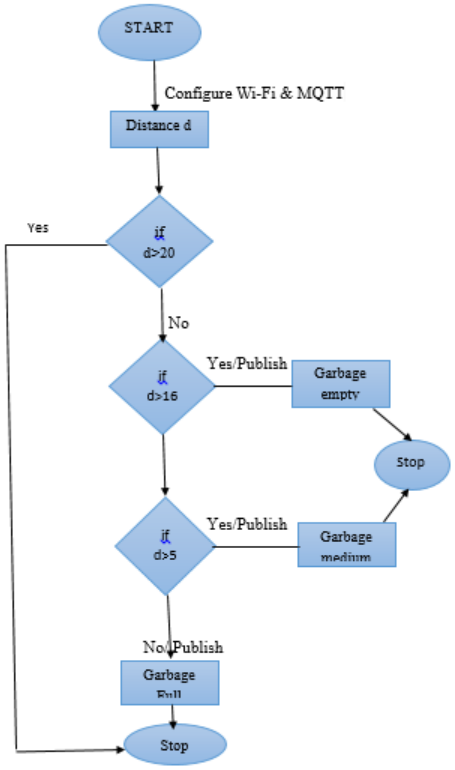

Figure 2: Flow Chart

There are four modules in the smart garbage management system they are Garbage Level Detection, Municipality Monitor (Admin), Workforce and the User

3.5 Garbage Level Detection

The Figure 3 shows garbage level detection module, the level detector consist of ultrasonic sensor integrated with the NodeMCU board. The ultrasonic sound waves produced by the sensor used to detect the garbage level in the bin and using the onboard Wi-Fi module helps to upload the real-time monitoring of the level to the different dashboard

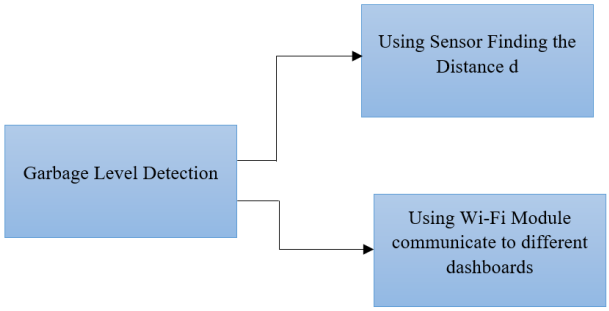

Figure 3: Garbage Level Detection

3.6 Municipality Monitor

The Figure 4 shows the municipality monitor module of system, which includes the functionality of adding and deleting of bins in a particular location, viewing bin status, adding, deleting and viewing driver, checking feedbacks, complaints and taking appropriate action and Report Generation.

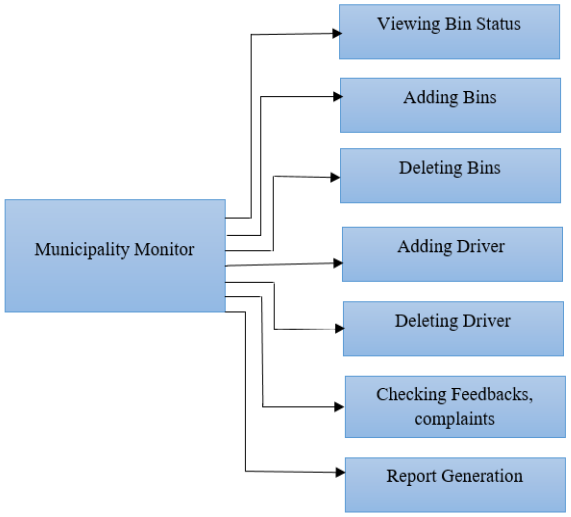

Figure 4: Municipality Monitor

3.7 Workforce Module

The Figure 5 shows the workforce module, here workforce having functionality of viewing bins, tracking bins and collect bins.

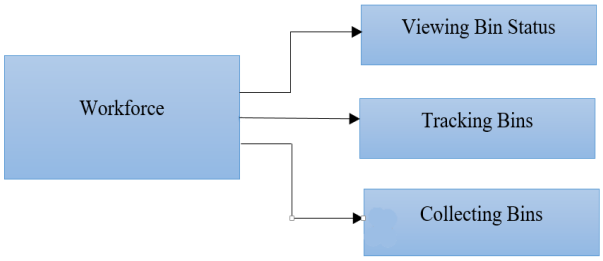

Figure 5: Workforce Module

3.8 User Module

The Figure 6 shows the user functionality includes Viewing the nearest bins in google map and giving feedbacks or complaints.

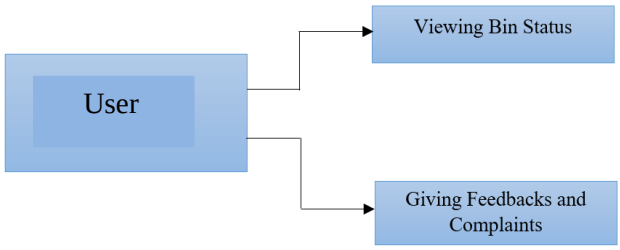

Figure 6: User Module

4. CONCLUSION

The Smart Garbage Management System would give a solution for the increasing waste management problems in a city. The system keeps track of the garbage levels in the bins and allocate cleaning staff accordingly. Shortest path algorithm is added which results in less time and fuel consumption for the garbage trucks. The bin doors are automated which helps to make the surroundings hygienic. Additional features in the system include report generation which gives detailed information about the waste generation in each area. The waste management becomes a difficult task for a smart city authority. The proposed system makes the process easy. The Smart Garbage Management System helps in efficient waste management and it makes a smart city green and clean.

All these components of the system ultimately lead to a cleaner city, citizens getting a convenient method to dispose of their day to day garbage and the government saving resources and even making a profit from recycling in the long term.

5. FUTURE SCOPE

Future work can include many areas. One area that can be improved on, but limited at this time due to trying to making this project low cost, is identifying types of garbage from the bin itself, thus removing human segregation. If this is implemented, in a single location instead of four bins for the four different types of garbage, one large bin can be placed which segments the garbage by itself. Another area which can be improved is instead of each bin connecting to an access point to communicate with the server, bins can communicate with each other and connect to an access point through the main hub. This method may reduce network costs and make the network process more efficient.

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