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Intelligent City Waste Management: An Effort Towards Swatch Bharat Abhiyaan

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ABSTRACT: Smart waste management concept nowadays emerges as a new phenomenon and it is mostly applied in Metropolitan cities where the production of waste is high and management of waste and awareness about waste management among the people is very low. Smart waste management helps to reduce waste, create waste for energy sources also helps to keep the environment clean and neat. All the city's urban local bodies depending upon the available technology have to spend the money and innovate the new concept of waste management which is the main purpose of smart waste management.

This paper is focussing on smart waste management using the Internet of Things (IoT) and Android-based applications. The smart city project needs such a kind of application where using IoT and cloud-based technology the smart waste management will be done automatically using an Android App. We used the firebase cloud database to collect the dry and wet waste from households, restaurants and industry and provided the interface to all entities of Smart waste management like Household users, Waste Pickers and centralized waste dumping stations.

1. INTRODUCTION

India is a fast rapid, growing urbanizing country, where people shifted their employment from agriculture to industrial services oriented base. According to the 2011 census in India, around 31.2% population stayed in urban areas. More than 377 million urban people are staying in town/cities. India is a very diverse country and is divided into 29 states and 7 Union territories (UTs).In India previously 3 megacities are Greater Mumbai, Delhi, and Kolkata where the population found more than 10 million, 53 cities where the population found more than 1 million and 415 cities where the population found 100000 or more than that.

And also people not only migrate for employment but for a better lifestyle and because of that they are mostly attracted to metropolitan cities like Mumbai, Delhi, Bangalore Pune, etc. Therefore this increasing urbanization creates a load on civic infrastructure facilities housing water, sanitation, and solid waste management. Therefore this paper, discusses how this increasing urbanization creates a problem of solid waste in urban areas and because of that, it is difficult to handle the urban local bodies. For a small town, it is easy to manage the solid waste but for Metropolitan cities, it is difficult to manage then for that how to handle the solid waste of big metropolitan cities is not only the responsibility of the municipalities of that city but an equal responsibility to the cities citizen of that city. Municipal Solid Waste management is one of the serious matters in the direction of making our cities strong, healthy, sustainable, clean and neat. And this is only possible if we manage that solid waste properly by (RRR) method like reduce, reuse, recycle, by doing the segregation on the source like dry waste and wet waste, then the people who come to collect for them also it will become easy. Also making the waste to energy resource of wet waste is one the best way of reduction of waste, but for doing all these we have to do awareness in between society. Unmanaged waste affects health, and also creates uncleanliness in the surroundings. Therefore for our good, healthy future, everyone has to manage their waste properly.

The government of India on October 2, 2014, launched a mission regarding cleanliness, Open defecation-free India that is Swachh Bharat Mission in English it is called as Clean India Movement. This campaign aims to clean and make an open defecation-free India by October 2, 2019, on the

150th Birth anniversary of Mahatma Gandhi. This campaign is moved all over India's schools, colleges, and academic Institutions to do awareness of cleanliness among people.

By taking inspiration and motivation from Swatch Bharat Abhiyaan, we are trying to develop IoT based Smart Waste management system using an Android Application which will reduce the burden on the civic body of the metropolitan city. We aim to create a complete automated system using IoT and the cloud which will enable and utilize smart waste management for metro cities.

2. TECHNOLOGIES AVAILABLE FOR ACHIEVING 100 % DOOR-TO-DOOR COLLECTION OF SOLID WASTE

To meet this high demand on the above limits, advanced communication technologies, and solutions like RFID, GPRS, GPS and GIS must be used. [1][2]. This document discusses available technology for achieving municipal corporation 100% door-to-door collection, segregation and transportation of solid waste. Radiofrequency identification (RFID) and the IT solution have the potential to meet the municipal objective[3]. So, integrating RFID and communication technologies for the collection of solid waste from municipal companies, segregation, and the transportation system. RFID, GPS, GPRS, GIS and cameras have been incorporated and developed into the smart bin and smart truck surveillance systems. In this article, the theoretical framework and interface algorithm between communication technologies such as RFID, GPRS, GPS and GIS was developed to implement the prototype. The interface algorithm on the control server is capable of analysing the location of the trucks and estimating the waste in the tray and its surrounding area. In this way, the proposed system could address the problem raised by a sound solution.

GPS Functions

The GPS is a satellite navigation system made up of satellites placed in orbit to record places on Earth. Satellites periodically transmit radio signals to GPS receivers to compute and display the exact location, speed and time. The GPS works precisely in any weather, day or night, 24 hours a day and around the world. The GPS is used for tracking the position of the vehicle on an electronic chart and assists drivers to set and selecting a route for waste collection with their tracking position. Modern systems automatically create a route and provide turn-by-turn directions in designated areas [4]. GPS is used in this system for tracking the position of the truck and bin location[3]

GIS Functions

GIS integrates software and hardware for the storage, collection, management, mapping, data analysis and presentation of all forms of geographic information in a computerized system. It assists in the visual analysis of data and examines trends, trends and relationships that may not be visible in tabular or text form. The tabular form is associated with spatial characteristics, which are stored in a system of coordinates of a particular place on earth. A GIS is different from other information systems because it incorporates common database operations such as queries and statistical analysis with the advantages of visual and geographical analysis through maps. GIS can be used for scientific investigations, resource management, monitoring and development planning. For example, with the help of the GIS in the control server, the solid waste bin can be detected, monitored and managed, respectively.[5]

The Role of RFID

RFID is designed to allow readers to capture data from labels and transmit it to a computer system without any physical connection to a radio frequency range. An RFID system consists of three components: an antenna, tag and reader. Radio waves are used to transmit a signal which activates the transponder. When activated, the beacon transfers the data to the antenna. Low-frequency RFID systems have a short transmission range and high-frequency RFID systems provide a larger transmission range. As such, the integrated RFID technologies, the proposed system would provide real-time truck tracking and a container monitoring system.[3]

GSM and GPRS Functions

GSM is an open digital cellular technology used to transmit mobile voice and data services with SMS communication. GPRS is a wireless data service developed from the current GSM system and can be linked to the INTERNET. It provides a connection between mobile users and the data network as well as broadband wireless IP. GPRS used packet switching technology which can take several wireless

channels to transmit data at a rate of up to 160 Kbps. The GPRS network has broad coverage and can achieve real-time sending and receiving [6].

HOW DOES RFID and IT solutions WORK?
The RFID tag is used for the waste collection process The RFID tag, stick on each household bin. In this process, when waste collection vehicles come from the waste collection before reaching the waste collection route an alarm call is given to all households on this collection route. When the empty dust tray is in the garbage collection vehicle at this time the RFID reader marks the presence, on the entry of the respective household in the database after completing the waste collection itinerary absent the property sends a message to the respective household [7].

3. METHODOLOGIES

It is very essential to synchronize the whole operation of the collection of waste with transportation for effective management of the waste and for achieving economy in the process.

The 100% door-to-door coverage of the segregated collection of solid waste is achieved by using the integration of GIS, GPS, RFID, GSM/ GPRS, Android Application, Web application, Data Server etc.[8][9][10].

Figure 1 explains the modelling framework. In this framework for collecting the waste, we had identified some areas like household apartments, commercial buildings and bungalows. The waste collection vehicle will be having IoT kit with an RFID card reader to find out the level of dustbins from the individual waste of households. This IoT kit consists of Arduino Uno with a built-in GSM model. By using this kit waste picker vehicles can track the location of apartments, and bungalows to collect the waste.

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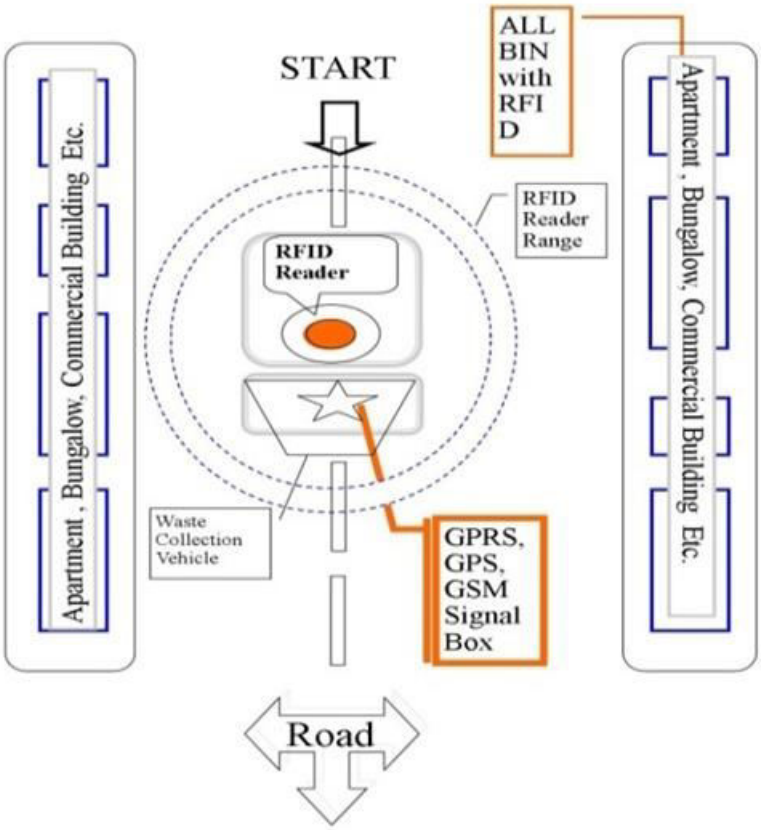

Figure 1: Modelling Framework

Figure 2 below represents the overall system architecture of waste pickup management. In the proposed system we are creating an Android Application and web application interface for acces

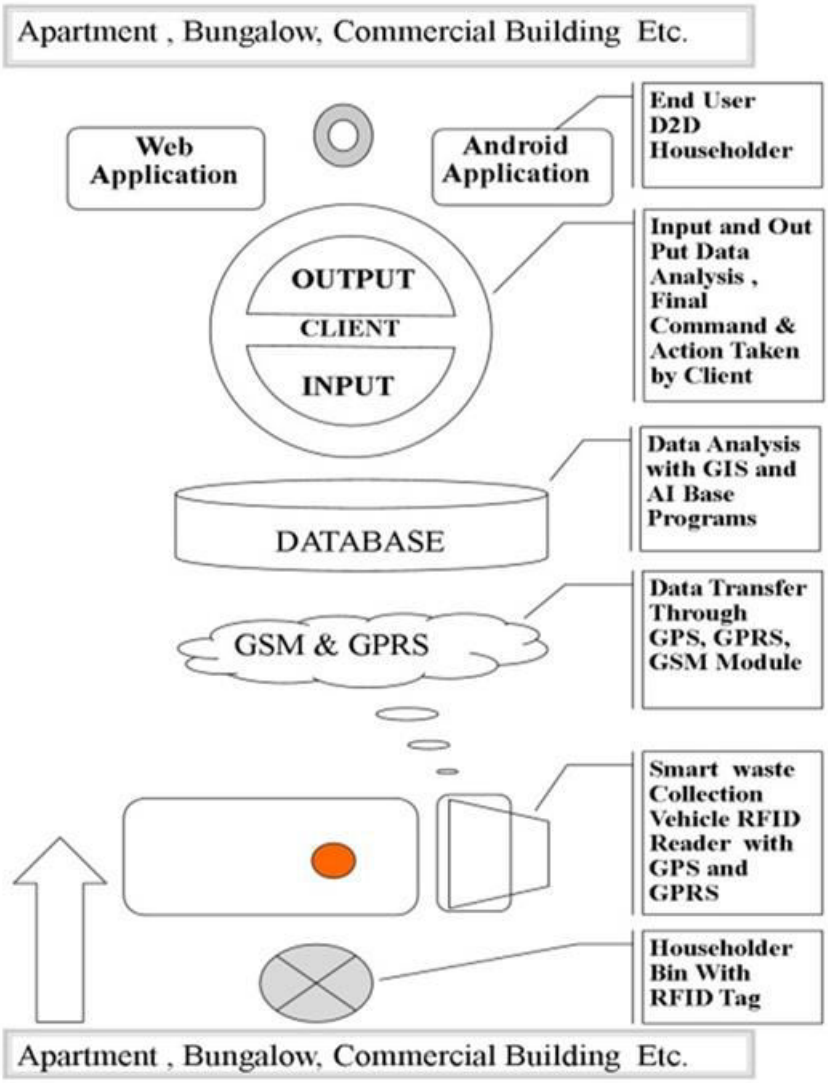

Figure 2: System Architecture

sing all information related to smart waste management. In this paper, we are discussing more on Android application which we had developed for displaying various activities for smart waste management.

The android application developed will have three users mainly the home users who are responsible for dumping the dry and wet waste into dustbins kept outside their homes. These home users may be from apartments, bungalows etc. The second user of this android application will be a waste picker van that collects the waste from door to door. This small waste picker van will be having IoT kit with an RFID card reader to collect the waste from home users and the RFID card will check the level of the waste picker van and updates the data in the cloud-based database. For this purpose, we used a real-time database called FireBase. As the threshold value of dry and wet waste collected by the small waste picker van (we had set the threshold as 80%), the automatic notification will be passed to the bigger waste picker van who is responsible to dump all the waste into the municipal corporation dump yard. The bigger waste picker van will be the third user of our android system.

4. RESULTS AND DISCUSSION

We used a real-time firebase database to store all the data of users, and dry and wet waste levels of users. The purpose of using the firebase database is basically that we want the information to get updated on a real-time basis. Firebase database supports these features with cloud connectivity and

the android application has built-in support for the Firebase database. Figure 3 shows the information we had a gathering of Dry and wet waste into the firebase database on a real-time basis of different users of our system.

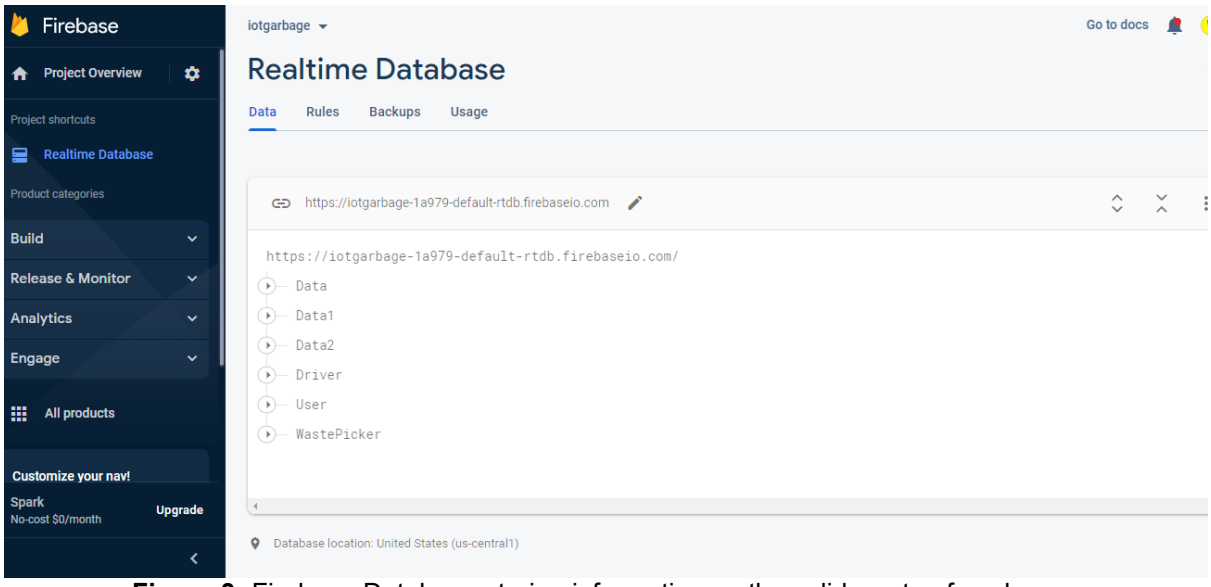

Figure 3: Firebase Database storing information on the solid waste of each user

The android application had login and registration options for every individual user to use our system of smart waste management. The admin of the system will authenticate every user with the proper authentication process. Once the authentication is done by the admin then only the users can further access the system for smart waste management. Following Figures 4 (a), and (b) show the android application screenshot of the Registration and Login Page.

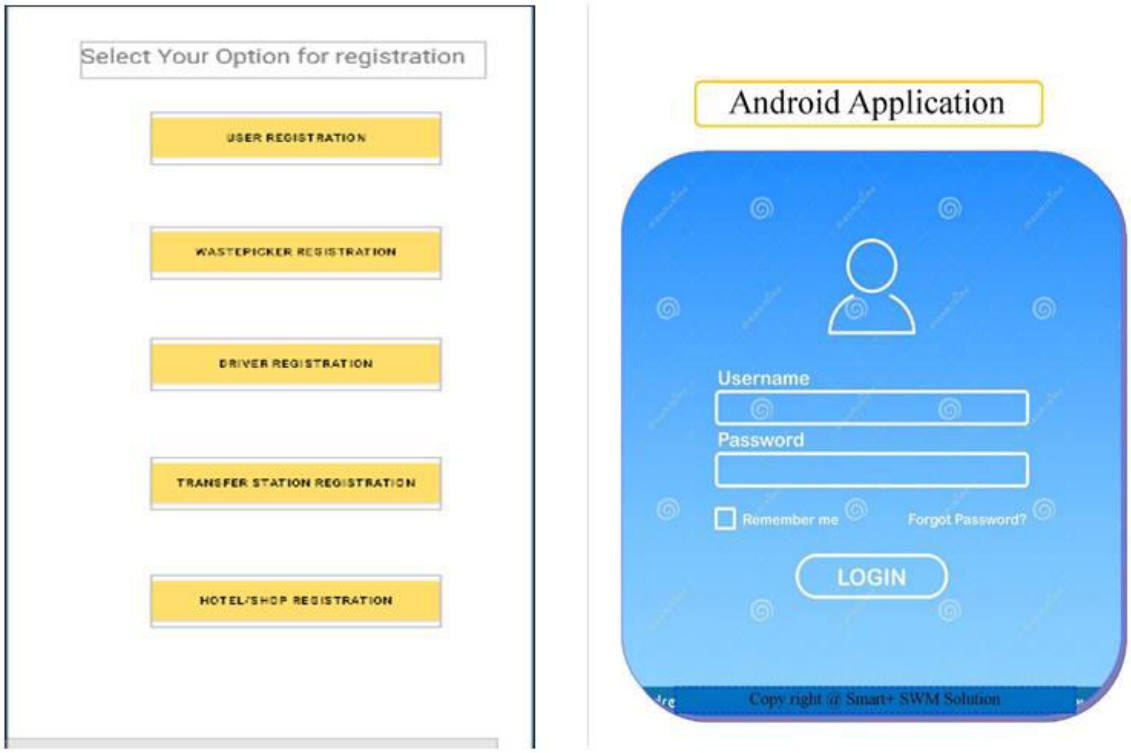

Figure 4: (a) Registration Screen (b) Login Screen

The transfer station interface will have various options in our android application. The transfer station will get an idea of total waste collection, the Number of vehicles communicating right now for collecting the waste with exact routes of every vehicle. Total Waste picker van details will be identified through this interface as well. The total percentage of Waste level with exact distribution of Wet, Dry Mix will be also identified and notified with the interface given for the Transfer station. All this will be real-time as we had used the firebase database.

Figure 5: Transfer Station Interface

5. CONCLUSION

The management of solid waste (MSWM) is today one of the challenges of modern societies because of the evolution of consumption patterns and uncontrolled urbanization and industrialization. However, urbanization, population growth and industrialization in India's smart city have led to serious solid waste management issues in several cities in India. By considering these issues, we developed the smart waste management system using IoT, Android and Firebase cloud database. When done the experimentation, we could able to collect the dry, wet waste from households, apartments, and bungalows which are then collected by waste picker vans and through the bigger waste picker van it is then transported to the final waste dumping station of the municipal corporation. All this had been done using an RFID card scanner and the system had been built completely with automation, proper notification will be received by each user of this system.

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