IOT BASED WASTE COLLECTION MONITORING SYSTEM USING SMART PHONES

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ABSTRACT: *Internet of Things (IOT) is playing an important role in many application fields such as home, industry, environment and health. This approach can be applied in the field of solid waste management. In this paper a new cost-effective method is proposed to collect and monitor the waste collection process. Smart bins are placed in the urban are interfaced with microcontroller-based system with ultrasonic sensors and Wi-Fi modules where the ultrasonic sensors detect the level of the smart bin and send the signal. The microcontroller receives the signal and pass the signal to the central system through internet. The data will be received, analysed and processed which displays the status of the garbage in the smart bin on the Dashboard. At the same time the main server system will give an indication to the nearest driver of the garbage collection truck as to which smart bin is completely filled and needed urgent attention. This indication will be given by a notification through an android application which is developed and installed in driver's smart phone. This application will send the vehicle's current location to the main server which is also displayed in the dashboard. Along with these an android application is developed which can be installed in the citizens smart phones/tablets through which the citizen can choose any bin and make complain on it.*

Keyword: Dash board, IOT, Microcontroller, Ultra Sonic sensors, Wi-Fi module.

1. INTRODUCTION

Now a days, there are a number of techniques which are purposefully used and are being build up for well management of garbage or solid waste. The generation of waste is increasing by 1.3% per annum. The urban population which is increasing between 3 to 3.5% per annum generates waste around 5% annually[3] With increase in population, the scenario of cleanliness with respect to garbage management is important. In the present day scenario, many times we see that the garbage bins placed at public places in the cities are overflowing due to increase in the waste every day. The overflow of garbage in public areas creates the unhygienic condition in the nearby surrounding and creates bad smell around the surroundings. It may provoke several serious deadly human diseases amongst the nearby people. It also degrades the valuation of the area. When the bin is filled with garbage it is not collected immediately because waste collection occurs in regular time interval mostly in mornings. Even though the bin is filled in the evening of the previous day, it is collected in the next day morning this is one of the major reason for the environmental pollution in urban areas. This approach often displays unacceptable result with overloaded bins. This has resulted in dissatisfaction of residential and ineffective usage of dustbins.

It has been proved that following fixed routes is a cost ineffective way of waste collection. Urban Local Bodies spend Rs.500/- to Rs.1500/- per ton on solid waste management of which, 60 to 70% of the amount is on collection alone and 20% to 30% on transportation. The amount of fund that is spent on treatment and disposal of waste is minimal and hence crude

dumping of this waste is practiced in most of the cities. [5] The waste collection scheme and all related decisions are drawn based solely on personnel experience and this has increased a considerable amount in cost. Most of the drivers doesn't follow the shortest route to collect the waste and they are targeting to collect waste from the bins. This "rule of thumb" approach sometimes displays an unacceptable result, as it was found that in some cases overfilled waste bins were uncollected for some days, while at the same time other unfilled bins were collected anyway. These inaccuracies result in citizen dissatisfaction and a noticeable cost increase. In the Municipality of Athens [8] it has been estimated that the 60% to 80% of the total cost of waste collection, transportation and disposal is spent during collection. The main factor for reducing the cost is to minimize the distance and duration of the routes. Storage of data is important to make decisions in future. The existing system doesn't provide the facility to store the data from the bin. According to the past data we can decide the location of the bin in future. If the bin is no longer used by the public it can be removed and placed where it actually needed.

The whole waste collection and transporting process must be observed by the authorised party in order to provide an effective service to the public. Most of the project have failed because inappropriate management and less involvement of the public. It is very important to authorized party to monitor the overall process and get the public involved in the project. There are no monitoring mechanism for the waste collection process the authorized person cannot be able to monitor the movement of the waste collection truck and no tracking mechanism for the waste collection truck. Real time information of the bins or current status of the bin must be displayed to the authorized person for the proper management purpose the existing systems doesn't have the facilities to display the current status of the bins.

2. RELATED WORK

[1] Dynacargo is an ongoing research project that introduces a breakthrough approach for cargo management systems, as it places the hauled cargos in the center of a haulage information management system, instead of the vehicle. Dynacargo attempts to manage both distribution and collection processes, providing an integrated approach. In the context of Dynacargo project, a set of durable, low cost RFID tags are placed on waste bins in order to produce crucial data that is fed via diverse communication channels into the cargo management system. Besides feeding the management system with raw data from waste bins, data mining techniques are used on archival data, in order to predict current waste bins fill status. Moreover easy-to-use mobile and web applications will be developed to encourage citizens to participate and become active information producers and consumers.

[3] This research proposes a trash level measurement polling algorithm to cut the power consumption of the smart trash bin by dynamically adapting

the time interval for measurement. This algorithm works by analysing past data to determine the time when trash level would reach the threshold. Experiments have been conducted to identify an actual trash level fluctuation behaviour. From the experiment results, we confirmed that our proposed algorithm can be implemented in actual smart trash bin system.

[4] This research focused on the implementation of an IoT based embedded system which integrates Radio Frequency Identification (RFID), Sensors, Arduino controller and GSM for solid waste bin and truck monitoring system with their performance measured in real time environment. Web based android applications were developed to interface with a web server to intimate the municipality regarding the cleaning process performed by the workers.

[5] A system is developed to collect waste, when the garbage reaches the level of the sensor, then that indication will be given to ARM 7 Controller. The controller will give indication to the driver of garbage collection truck as to which garbage bin is completely filled and needs urgent attention. ARM 7 will give indication by sending SMS using GSM technology. Zigbee and Global System for Mobile Communication (GSM) are the latest trends and are one of the best combinations to be used in the project.

[7] These dustbins are interfaced with microcontroller-based system having IR wireless systems along with central system showing current status of garbage, on mobile web browser with html page by Wi-Fi. Hence the status will be updated on to the html page.

[8] Every smart bin is equipped with ultrasonic sensors which measure the level of dustbin being filled up. The container is divided into three levels of garbage being collected in it. With its continuous use the levels get filled up gradually with time. Every time the garbage crosses a level the sensors receives the data of the filled level. This data is further sent to the garbage analyser as instant message using GSM module. Every message which is received at the garbage analyser end is being saved as data which is further used for the process of analysis and predictive modelling.

[9] 'Smart garbage management system' is proposed in this research. In the proposed system, the level of garbage in the dustbins is detected with the help of Sensor systems, and communicated to the authorized Control room through GSM system. Microcontroller is used to interface the sensor system with GSM system.

3. PROPOSED SYSTEM ARCHITECTURE AND METHODOLOGY

3.1 Proposed System Architecture

There are multiple smart bins located throughout the city/urban area. These smart bins are interfaced with microcontroller-based system with ultrasonic

sensors and Wi-Fi modules, where the ultrasonic sensors detect the filled level of the smart bin and send the signal to the microcontroller. Wi-Fi module is connected with the Arduino-Uno and it helps to access the Wi-Fi available in the region, which is important to connect the device with the internet and sent the data to the main system.

Microcontroller receives the signal and through the available internet it passes the signal to the central system. The data will be received, analysed and processed which displays the status of the garbage in the smart bin on the dashboard. When a particular bin is filled the central system finds the nearest driver and send a notification to the driver's phone this notification includes the bin NO which requires some urgent attention. This is achieved by the android application developed and installed in the driver's mobile phone.

Once the notification is received by the driver it will open up a window of android application, in the window the driver can see his location and bins locations as well. Using the notification, he received he can find the bin in the window using the name of the bin's marker. He has to click the bin which needs the urgent attention and the android application will show the shortest path to reach the destination. The dashboard shows the current location of all waste collection trucks in the urban area, the current state of the bin and public complaints with bin number. Data received from the bins are stored in the database for future use. Along with this an android application is developed which will be installed in the citizen's mobile phones or tablet. Using the application the publics can take a photo and make a complaint, if the garbage is not collected in correct time. Many projects have failed because of the less involvement of the citizen. The purpose of the application is to motivate people to participate in sustainable waste management
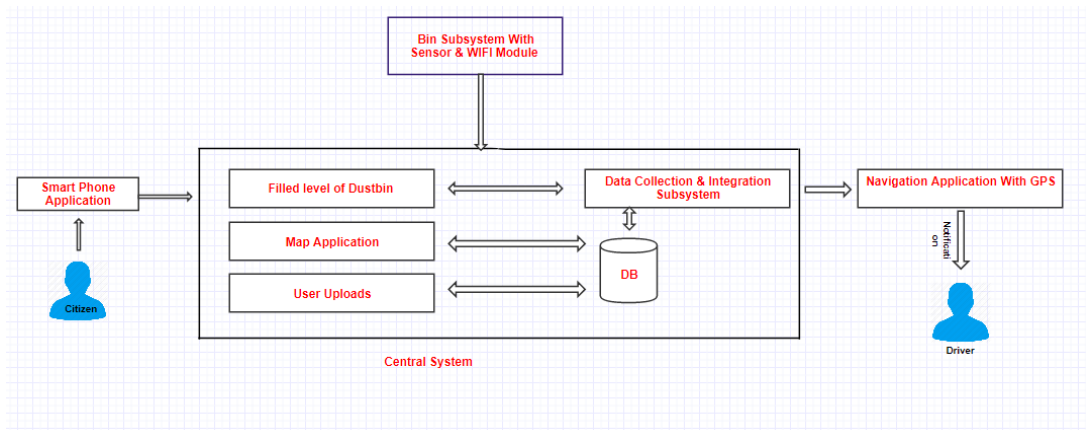

Figure 1. Overview of proposed model

3.2 METHODOLOGY

3.2.1 Android SDK & Android Studio
The Android SDK (software development kit) is a set of development tools used to develop applications for Android platform. The Android SDK includes required libraries, Debugger, An emulator, relevant documentation for the Android application program interfaces (APIs) and Sample source code. Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It is available for download on Windows, macOS and Linux based operating systems. It is a replacement for the Eclipse Android Development Tools (ADT) as primary IDE for native Android application development.

3.2.2 XAMPP server
XAMPP is an open-source web server package that works on various platforms. It is actually an acronym with X meaning "cross" platform, A for Apache HTTP server, M for MySQL, P for PHP, and P for Perl. XAMPP was designed to help webpage developers, programmers, and designers check and review their work using their computers even without connection to the web or internet. So, basically XAMPP may be used to stand as pages for the internet even without connection to it. It can also be used to create and configure with databases written in MySQL and/or SQLite. And since XAMPP is designed as a cross-platform server package, it is available for a variety of operating systems and platforms like Microsoft Windows, Mac OS X, Linux, and Solaris.

3.2.3 Bootstrap
Bootstrap is the most popular HTML, CSS, and JS framework for developing responsive, mobile first projects on the web. Bootstrap can be boiled down to three main files, which are bootstrap.css, bootstrap.js and glyphicons. Additionally, Bootstrap requires jQuery to function. jQuery is an extremely popular and widely used JavaScript library that both simplifies and adds cross browser compatibility to JavaScript.

.3.2.4 FIREBASE
Firebase is a technology that allows us to make web applications with no server-side programming so that development turns out to be easier and quicker. Using Firebase, we don't have to stress over-provisioning servers or building REST APIs with just a very little configuration; we can give Firebase a chance to take every necessary step: verifying users, storing data, and implementing access rules.

3.2.5 ARDUINO
Arduino is an open-source platform [21] used for constructing and programming of electronics. It can receive and send information to most devices, and even through the internet to command the specific electronic

device.it uses a hardware called Arduino Uno [14] circuit board and software programme (Simplified C++ [9]) to programme the board. In these modern day, Arduino are used a lot in microcontroller [4] programming among other things due to its user friendly or easy to use setting, like any microcontroller an Arduino is a circuit board with chip that can be programmed to do numerous number of tasks, it sends information from the computer programme to the Arduino microcontroller and finally to the specific circuit or machine with multiple circuits in order to execute the specific command.

3.2.6 ULTRASONIC SENSOR
The ultrasonic Sensor HC-SR04 is used to measure the level of garbage in waste bin. The range of the garbage measurement varies from 2cm–400cm without non-contact. The module provides ultrasonic transmitters, receiver and control circuit. The length of the implemented garbage bin is 20cm.

3.2.7 Wi-Fi Module
The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost-effective board with a huge, and ever growing, community.

4. IMPLEMENTATION

4.1 Implementation of public App
Aim of the application is to involve public in sustainable waste collection and management process. There are number of operations implemented using this application

- User Registration: Once the app is installed to the publics' mobile phone, they have to register the application with their mail and password. When the password is given, they have to give a valid password it should contain numbers, symbols, block and simple letters
- Loading photo to application: Once they click browse image button it will open up "Open from" window, from the window they can choose the image
- Typing bin number: There is a space to type the bin number on which they going to make complaint.
- Change password option: Using this option user can change the password
- Sign out the account: This option is used to sign out from the application
- Resetting the password if password forgets: If the password is forget user can enter his mail ID and press "RESET PASSWORD", a mail will be sent. Using the link user can create his new password

- Remove the Account from server: It allows you to remove your account from server

4.2 Implementation of driver's Application

This application is developed and installed in driver's mobile phone in order to achieve

- Receive pop-up message from server: when the bin is filled the system finds the nearest driver and sends the notification to the driver

- Shows location of bin and drivers' current location: When the driver opens up the message it will open a window and shows the current location of the driver and bins' locations using markers.

- Find shortest route to reach the bin: When the driver touch the location of the bin, the application shows the shortest path to reach the destination

- Send the current location of driver: This application continuously sends drivers' latitude and longitude to the server

4.3 Implementation of web dashboard

This web dashboard is developed to monitor overall waste collection process. This is developed to achieve number of tasks

- Display the filled level of dustbin in a pie chart: Filled level of dustbin is displayed to concern party.

- Display public's complaints with respective bin number: Public's complaints with its number downloaded from the server and displayed in the dashboard

- Display of dustbins and truck's current location: Latitude and longitude are received and that is displayed in the dashboard using markers

6. Result and Discussion

6.1 Driver's Android Application

After the testing of my application this android application is installed in driver's smart phones successfully. When the driver receives the notification, he has to open the application to find the shortest path to reach the destination. Below output shows the notification, current location of the driver and location of the dustbin. Red marker indicates the current location of the driver and blue markers indicates the location of the bins. The driver

needs to select the bin to get the shortest path, the blue line indicates the shortest path to the destination

6.2 Public App

This application is developed and installed in citizen's smart phones. This application helps to motivate citizens to participate sustainable waste collection. In this application user needs to create an account with their e-mail and password. Once he creates an account his account is registered and a message will be sent to his application.

6.3 Dashboard

Dashboard is developed to monitor overall process of the waste collection. Filled level of the bin, public's complaints and movement of the vehicle are displayed in the dashboard.

7. Conclusion and future work

7.1 Conclusion

An efficient, cost effective waste management and monitoring system is introduced in this research. This system provide mechanism to display filled level of dustbin, sending notification to driver, finding shortest route to reach the destination, receive complaints from the citizen and display the current location of trucks. It has been estimated that huge amount of money involved in waste collection process we have implemented Google map API to reduce the cost involved in collection process. Driver's application sends the latitude and longitude to the server so we can display the current location of waste collection trucks it will avoid unnecessary slow in waste collection process. Main objectives of this system can be achieved by implementing this system. There are more benefits such as it reduces the traffic in the city indirectly because in major cities the garbage collection vehicle visit the area's everyday twice or thrice depends on the population of the particular area.
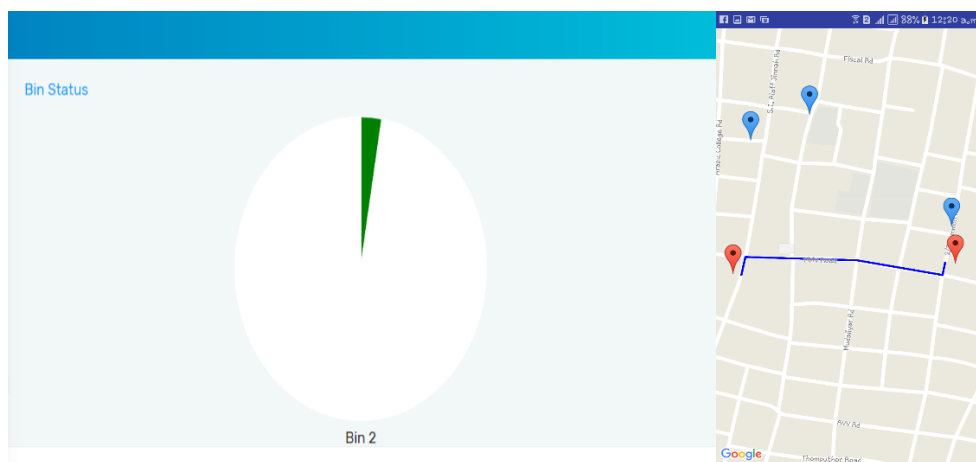

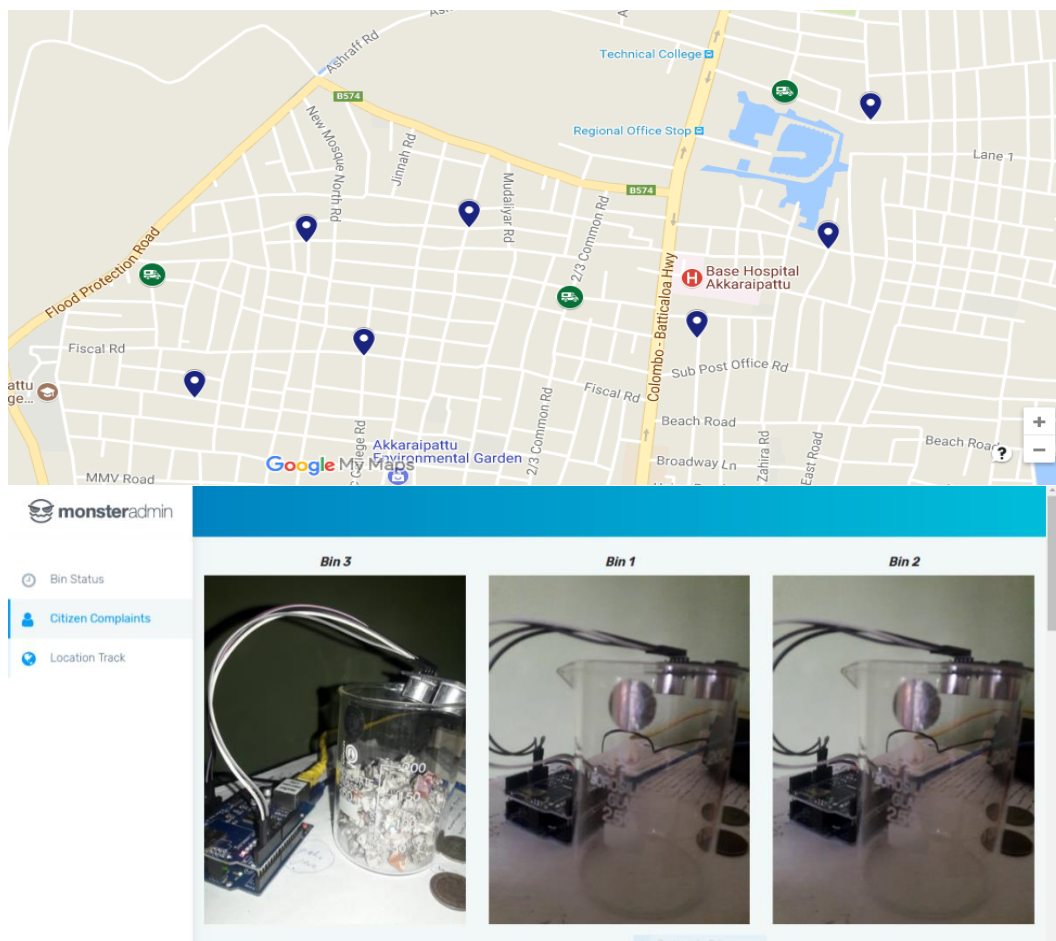*Figure 2. Image of bin & Drivers' App*

Figure 3. *Image of Dash board & Public complaints*

7.2 Future Work

In future data mining and prediction subsystem can be created based on the data gathered, so that the various data mining scenarios can be realized. The data mining process is quite exploratory, as the parameterization of the applied methods and their analysis in order to select the more efficient ones, is a process quite empirical. The scope for the future work is this system can be implemented with time stamp in which real-time clock shown to the concern person at what time dust bin is full and at what time the waste is collected from the smart dustbins.

REFERENCES

[1] Design and Implementation of IoT Based Waste Management System *J. Kokila, K. Gayathri Devi, M. Dhivya and C. Haritha Jose*Dr. N G P Institute of Technology, Coimbatore, India

[2] International Journal of Innovative Research in Computer and Communication Engineering *(An ISO 3297: 2007 Certified Organization)* Vol. 4, Issue 2, February 2016 IoT Based Waste Management for Smart City Parkash1, Prabu V2PG Diploma Student, Dept. of Embedded System Design, NIELIT, Calicut, Kerala, India**1** PG Diploma Student, Dept. of Embedded System Design, NIELIT, Calicut, Kerala, India**2**

[3] International Journal of Innovative Research in Science, Engineering and TechnologyWaste Bin Monitoring System Using Integrated Technologies Kanchan Mahajan1, Prof.J.S.Chitode2Department of Electronics Engineering, Bharati Vidyapeeth College of Engineering, Pune, India1

[4] Overview for Solid Waste Bin Monitoring andCollection System, 2012 International Conference on Innovation, Management and Technology Research (ICIMTR2012), Malacca, Malaysia :21-22 May, 2012, Md. Shafiqul Islam, Maher Arebey, M.A. Hannan, Hasan Basri

[5] International Journal of Advance Engineering and Research Development Volume 3, Issue 6, June -2016,Smart Dustbin overflows Indicator using IOT, Vishesh Kumar Kurre1,Swati Sharma2 **1**M.TechScholar, Electronic and communication, Kalinga University, Raipur, Chhattisgarh, India **2**Assistant Professor, Electronic and communication, Kalinga University, Raipur, Chhattisgarh, India

[6] IoT Based Smart Garbage and Waste Collection Bin, International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 5, Issue 5, May 2016, S.S.Navghane1, M.S.Killedar2, Dr.V.M.Rohokale3*.*

[7] Solid Waste Management Architecture using Wireless Sensor Network technology, Sauro Longhi_, Davide Marzioniy, Emanuele Alidoriy, Gianluca Di Bu`o_,Mario Prist_, Massimo Grisostomi_ and Matteo Pirro__Universit`a Politecnica delle Marche, Dipartimento di Ingegneria dell'Informazione Via Brecce Bianche. snc, 60131 Ancona, Italy

[8] Architecture and Implementation Issues, Towards a Dynamic Waste Collection Management System, George Asimakopoulos, Sotiris Christodoulou, Andreas Gizas, Vassilios Triantafillou, Giannis TzimasComputer & Inform. Engineering Dept.Technical Educational Inst. of Western Greece Antirion, Greece

[9] Smart Bin Implementation for Smart Cities, International Journal of Scientific & Engineering Research, Volume 6, Issue 9, September-2015 ISSN 2229-5518, International Journal of Scientific & Engineering Research, Volume 6, Issue 9, September-2015 ISSN 2229-5518

[10] Smart Garbage Management System, International Journal of Engineering Research & Technology (IJERT)ISSN: 2278-0181 IJERTV4IS031175,Vol. 4 Issue 03, March-2015 Vikrant Bhor1, Pankaj Morajkar2, Maheshwar Gurav3, Dishant Pandya4, Amol DeshpandeDepartment of Electronics & TelecommunicationK J Somaiya Institude of Engineering & InformationTechnology

[12] Implementing Smart Home Using Firebase K.N.Manoj Kumar1, Kailasa Akhi2, Sai Kumar Gunti3, M.Sai Prathap Reddy4 School Of Information Technology and Engineering Vit University, Vellore, International Journal of Research in Engineering and Applied Sciences (IJREAS)