Waste Management System for Smart City using Internet of Things

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ABSTRACT: To make the cities greener, safer, and more efficient, Internet of Things (IoT) can play an important role. Improvement in safety and quality of life can be achieved by connecting devices, vehicles and infrastructure all around in a city. Best technological solutions can be achieved in smart cities by making different stakeholders to work together. In the present day scenario, many times we see that the waste bins or Dust bin are placed at public places in the cities are overflowing due to increase in the waste every day. It creates unhygienic condition for the people and creates bad smell around the surroundings this leads in spreading some deadly diseases & human illness.Thus we present a waste collection management solution based on providing intelligence to waste bins, using an IoT prototype with sensors. It can read, collect, and transmit huge volume of data over the Internet. Such data, when put into a spatio-temporal context and processed by intelligent and optimized algorithms, can be used to dynamically manage waste collection mechanism. In this proposed system there are multiple dustbins located throughout the city or the Campus, these dustbins are provided with low cost embedded device which helps in tracking the level of the waste bins. When the level reaches the threshold limit, the device will transmit the level. These details can be accessed by the concern authorities from their place with the help of Internet and an immediate action can be made to clean the dustbins.

KEY WORDS: Internet of things, Smart waste management, Ultrasonic sensor, Microcontroller, Web page, GSM.

I.INTRODUCTION

Recent advances in production of mobile computers and smartphones, smart sensors and sensor networks in connection with next generation mobile networks opened vast opportunities for researchers and developers of various systems and application in the field of Smart Cities and Intelligent Transportation Systems (ITS). Thought some areas like application for monitoring public transport are already well researched, other areas are still working with outdated technologies and models. One of such areas is the management of solid waste collection process. In a Smart City collection of waste is a crucial point for environment and its quality should be considered seriously. In order to understand the concept of Smart Cities in depth, a suitable definition is provided. In this research we use the most suitable definition for the IoT-enabled waste collection in Smart Cities, which is "A Smart City is a city well performing in a forward-looking way in the following fundamental components (i.e., Smart Economy, Smart Mobility, Smart Environment, Smart People, Smart Living, and Smart Governance), built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens". In this definition we can see important component - Smart Environment - which is tightly connected to environmental pollution. The main countermeasure to environmental pollution in terms of a Smart City is the IoT-enabled waste collection. Issues connected to dynamic waste collection could be divided into 2 main problems: (i) when to collect waste form bins (i.e., scheduling), and (ii) what route the trucks will follow (i.e., routing).

In this paper we propose waste collection system enhanced with IoT services which enable dynamic scheduling and routing in a Smart City. We also present the design of a cloud system for organization of waste collection process and applications for waste truck drivers and managers. In this system, we are going to make an IOT based waste monitoring system it will tell us that whether the waste bin is empty or full through the web server and you can know the status of your waste bin from anywhere in the world over the Internet. It will be very useful and can be installed in the trash cans at public places as well as at home. This system will help to minimize the waste disposal problems and help to keep the clean city.

In this system an Ultrasonic Sensor is used for detecting whether the trash can is filled with waste or not and will measure the distance of waste from the top of Trash can and we can set a threshold value according to the size of trash can. We will use Wi-Fi module for connecting the microcontroller to the web server. This system monitors the waste bins and informs about the level of waste collected in the waste bins via a web page. The system makes use microcontroller and Wi-Fi modem for sending data. Thus this system helps to keep the city clean by informing about the waste levels of the bins by providing graphical image of the bins via IoT web development platform.

II. LITERATURE SURVEY

Sunilkumar S. Manvi, Gopal Kirshna Shyam, Priyanka Bharti has proposed an intelligent waste collection system. The system is based on IoT sensing prototype. It is responsible for measuring the waste level in the waste-bins and later sends this data (through Internet) to a server for storage and processing. This data helps to compute the optimized collection routes for the workers[1].

Dr. N. Sathish Kumar, B. Vijayalakshmi, R. Jenifer Prarthana, A. Shankar had developed alert system for a proper waste management. This paper proposes a smart alert system for waste clearance by giving an alert signal to the municipal web server for instant cleaning of dustbin with proper verification based on level of waste filling. This process is aided by the ultrasonic sensor which is interfaced with Arduino UNO to check the level of waste filled in the dustbin and sends the alert to the municipal web server once if waste is filled. After cleaning the dustbin, the driver confirms the task of emptying the waste with the aid of RFID Tag. This system averts the irregular cleaning of the dustbins by sending alerts to the concerned individual at regular intervals[2].

Parkash, Prabu has proposed a system there are multiple dustbins located throughout the city or the Campus, these dustbins are provided with low cost embedded device which helps in tracking the level of the waste bins and an unique ID will be provided for every dustbin in the city so that it is easy to identify which waste bin is full. When the level reaches the threshold limit, the device will transmit the level along with the unique ID provided. These details can be accessed by the concern authorities from their place with the help of Internet and an immediate action can be made to clean the dustbins[3].

S.S.Navghane, M.S.Killedar, Dr.V.M.Rohokale implemented smart waste management system using IR sensor, microcontroller and Wi-Fi module. These dustbins are interfaced with microcontroller based system having IR wireless systems along with central system showing current status of waste, on mobile web browser with html page by Wi-Fi. Hence the status will be updated on to the html page. This system assures the cleaning of dustbins soon when the waste level reaches its maximum. If the dustbin is not cleaned in specific time, then the record is sent to the higher authority who can take appropriate action against the concerned contractor. This system also helps to monitor the fake reports and hence can reduce the corruption in the overall management system. This reduces the total number of trips of waste collection vehicle and hence reduces the overall expenditure associated with the waste collection. It ultimately helps to keep cleanliness in the society[4].

Akshay Bandal, Pranay Nate, Rohan Manakar, Rahul Powar had developed Smart Wi -Fi Dustbin system design consisting of two main modules:
1. Hardware module which include Dustbin with sensor, and Display
2. Software module which include Web Application.
3. Also Wi-Fi Router for providing Internet.
They have set with some specific functions.
In this system author proposed a system IoT Based Smart Garbage. When somebody dumps trash into a dustbin the bin ashes a unique code, which can be used to gain access to free Wi-Fi. Sensor check garbage fills in dustbin or not and Router provides Wi-Fi to user. Major part of the project depends upon the working of the Wi-Fi module; essential for its implementation. The main aim of this project is to enhancement of a smart city vision[5].

III. PROBLEM DEFINITION

As we have seen number of times the dustbins are getting overflown and concern person don't get the information within a time and due to which unsanitary condition formed in the surroundings, at the same time bad smell spread out

due to waste, bad look of the city which paves the way for air pollution and to some harmful diseases around the locality which is easily spreadable.

A. Disadvantages of the existing system

i. Time consuming and less effective: trucks go and empty containers whether they are full or not.
ii. High costs.
iii. Unhygienic Environment and look of the city.
iv. Bad smell spreads and may cause illness to human beings.
v. More traffic and Noise.

B. Advantages of the proposed system

i. Real time information on the fill level of the dustbin.
ii. Deployment of dustbin based on the actual needs.
iii. Cost Reduction and resource optimization.
iv. Improves Environment quality
    -Fewer smells
    -Cleaner cities
v. Intelligent management of the services in the city.
vi. Effective usage of dustbins.

IV. SYSTEM ARCHITECTURE

The IOT based Waste Monitoring system is a very innovative system which will help to keep the cities clean. This system monitors the waste bins and informs about the level of waste collected in the waste bins via a web page. For this the system uses ultrasonic sensors placed over the bins to detect the waste level and compare it with the waste bins depth. The system makes use of microcontroller & Wi-Fi module for sending data whereas a web page is built to show the status to the user monitoring it. The web page gives a graphical view of the waste bins and highlights the waste collected in order to show the level of waste collected.

A. Block Diagram

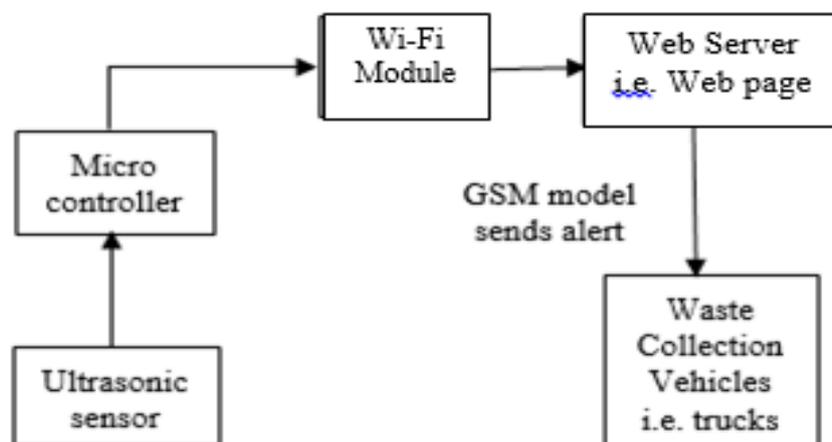The block diagram of the proposed system is as follows:

Fig. 1: Smart Waste Management System BlockDiagram

The Ultrasonic Sensor sends out a high-frequency sound pulse and then times how long it takes for the echo of the sound to reflect back. The sensor has 2 openings on its front. One opening transmits ultrasonic waves, (like a tiny speaker), the other receives them, (like a tiny microphone). The speed of sound is approximately 341 meters (1100 feet) per second in air. The ultrasonic sensor uses this information along with the time difference between sending and receiving the sound pulse to determine the distance to an object. Microcontroller gets information from sensor and process on it. It compares the received data with the threshold level set and accordingly output is generated. The output of the microcontroller is transmitted over the internet with the help of Wi-Fi modules. This Wi-Fi module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. 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. It is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

Web page is used to show the status of the several waste bins located all over the city to the user monitoring it. The web page gives a graphical view of the waste bins.GSM Module is used to send message to the waste collection depot if the waste bins exceeds the set threshold level. With the help of GSM module interfaced, we can send short alert messages to the required municipal office. GSM module is provided by SIM uses the mobile service provider and send messages to the respective authorities as per programmed.

### B. Algorithm
Algorithm: Smart Waste Management Algorithm

Inputs:
    i.   Amount of Wastes generated
    ii.   Number of Waste bins embedded with IoT devices

Output:
Alert message to the workers

Description:
    i.   Install several waste bins at multiple locations in city
    ii.   Embed each of waste bins with IoT devices
    iii. Define threshold value for wastes for each waste bins
    iv. Collect the wastes in the waste bins
    v.   Send the collected data over the Internet to the servers
    vi. Store and process the information in the server
    vii. Send the alert message to the vehicles for waste collection
    viii. Empty the wastes from the identified waste bins.

C. Flowchart
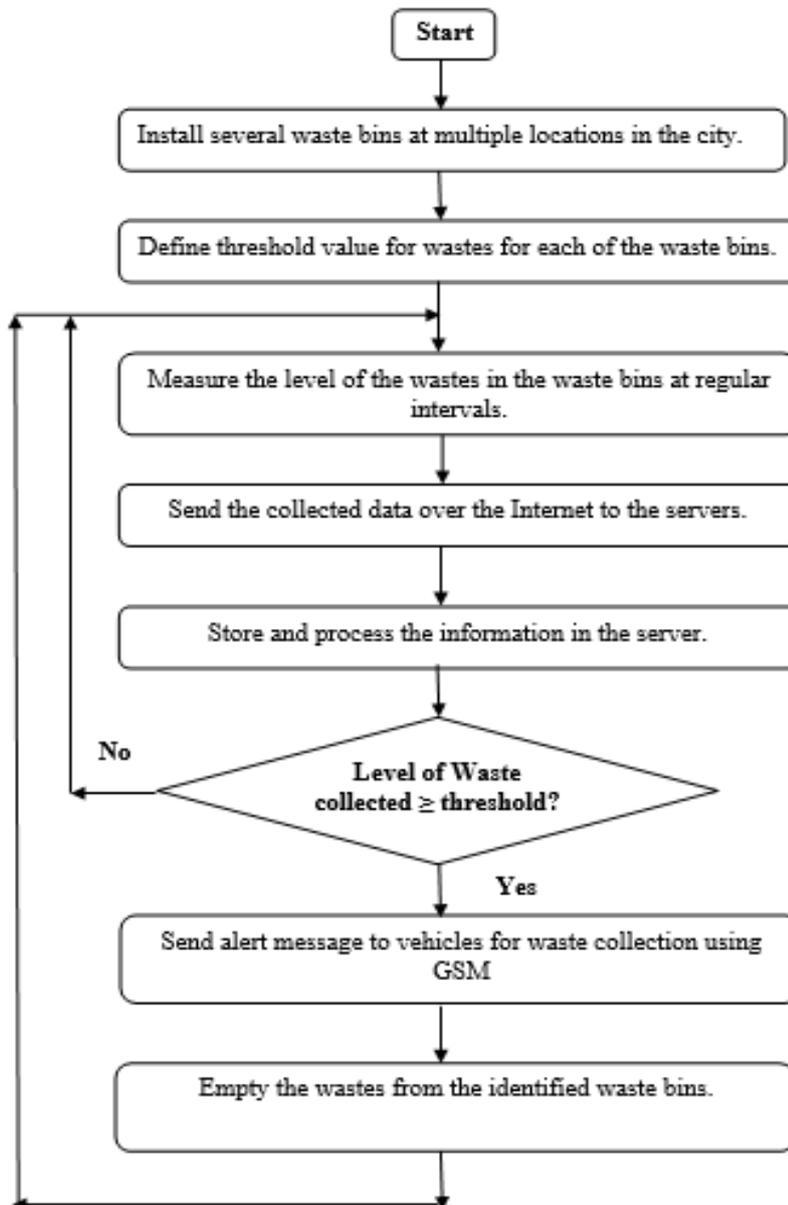
Flowchart 1: Smart Waste Management System

V. ADVANTAGES

1. Waste Level detection inside the waste bins. Transmission of the information wirelessly to concerned officials.
2. System can be accessed anytime and from anywhere.
3. Real-time data transmission and access.
4. Avoids the overflows of waste bins.
5. Using this system, waste collection would become efficient and also reduction in transportation costs can be witnessed.

6. To keep our Environment clean & green.

7. The cost & effort are less in this system.

VI. APPLICATIONS

1. This project can also be used in the" SMART CITY".

2. This project is also helpful in the government project of "SWACHH BHARAT ABHIYAN".

3. This project can only be used by municipal authorities or other private firms to tackle the current problem of urban waste collection.

4. This system has no individual use, but can be used by a city, state or a country

VII.CONCLUSION

In this paper, an integrated system of Wi-Fi modem, IoT, GSM, Ultrasonic Sensor is introduced for efficient and economic waste collection. The developed system provides improved database for waste collection time and waste amount at each location. We analysed the solutions currently available for the implementation of IoT. By implementing this project we will avoid over flowing of waste from the container in residential area which is previously either loaded manually or with the help of loaders in traditional trucks. It can automatically monitor the waste level & send the information to collection truck. The technologies which are used in the proposed system are good enough to ensure the practical and perfect for solid waste collection process monitoring and management for green environment.

This implementation of Smart Waste Collection System using IoT, assures the cleaning of dustbins soon when the waste level reaches its maximum. If the dustbin is not cleaned in specific time, then the record is sent to the higher authority who can take appropriate action against the concerned official. This reduces the total number of trips of waste collection vehicle and hence reduces the overall expenditure associated with the waste collection.The project aims at cleanliness of the areas where trash bins are located and the very basic management that it contains with it. It aims at advanced management of the whole waste collection system. We use ultrasonic sensors (details mentioned above) and its other hardware microcontrollers and processors for analysing the waste levels and sending information about it to administrators and then waste trucks are being deployed by them. Another very important aspect of our project is the web portal that is designed in such a way that operators and citizens both will find it user friendly to monitor the waste information of various places. Hence, IoT based software project with electronic devices used, is the one that will be a great service to the world and make it a better place to live in, to some extent. It is ultimately helps to keep cleanliness in the society.

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