Concept Design and Implementation of an IoT Enabled Garbage Management System for Smartcities

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Abstract- *The exponential growth in the human population and its direst consequences is one of the major concerns across the globe. The pressure towards city management has triggered various smart city initiatives by both government and private sectors. Prime Minister launched Swachh Bharat Abhiyan to make India clean .The internet of Things has also gained attention by the time. An efficient garbage management system is thus a need of the hour .The system develops a garbage management system using the sensor technology ,location based intelligence and .smart bins are placed across the cities. Each one is equipped with an ultrasonic proximity sensor connected to an arduino board. The smart bins senses the level of the trash and it is send to the cloud database by using wifi shield..The garbage management system monitors the bin levels, send the data to the cloud,finds the shortest path to the disposal area, detects the failure of the bins, provides a survey and automatically segregates the wastes as bio and non-biodegradable by using inductive and proximity sensors.*

Keywords- IoT,Ultrasonic Proximity Sensor, Inductive sensor, Capacitance sensor.

I. INTRODUCTION

The internet of things and the smart cities are two things that has gained attention from industry and academia.Eventhough both consolidate the same idea they have different origins. The internet of things is a concept that has the potential to impact how we live and also how we work. With the wide availability of broadband internet ,the decrease in the cost of connectivity, more devices are connected with wifi capabilities and sensors are built into them, the cost of technology is going down and the skyrocketing Smartphone penetration is creating a perfect storm for the IoT.The concept of IoT is thus connecting anything and everything with the internet. Due to the advancements in the cloud and sensor technology, storage capability and processing and the decreased production cost, the growth of sensor deployments has increased over the last few years.Iot allows things and people to be connected anytime ,anywhere with anything and anyone using any path and any service.Iot is primarily drawn by the technological advancements and not by any application or any user needs at the same time smart cities were developed to solve the problems in the modern cities. Smart cities are expected to solve the problems of waste ,traffic etc.

The surging population growth and rapid urbanization has led to increase in the production of waste all over the world. With the development of smartcities,,waste management has become one of the pressing challenges. The stuff that we send down our chutes, put on curb and discard at work is a striking by product of the civilization. Hence it is the need of the hour to curb the garbage rates. To accelerate the cleanliness drive PM launched Swachh Bharat Abhiyan,the most significant cleanliness campaign by the government of India.

The proposed system develops a smart garbage management system to efficiently monitor, collect segregate and dispose the garbage in a cost efficient manner. The system features surveillance of the smart bins placed across the cities, it finds the optimized path for transporting the garbage, it detects failure of various bins ,segregates the wastes as biodegradable and non-biodegradable by using inductive and capacitive sensors. The system uses ultrasonic proximity sensor for sensing the garbage levels. When the garbage level reaches a threshold value, an alert message is send to the truck drivers. Each time the bin gets filled, the fullness of the bin is updated to the cloud. The details are displayed on the android application. There are two users admin and the truck driver Admin initializes the bins and allocates the truck drivers .The truck driver in turn follows the optimized paths, collects the garbage and replace the damaged bins. Waste reduction and operational efficiency are the two main features of the garbage management system.

This paper is organized as follows. Section II presents related work in the area of IoT enabled waste collection in smart cities. Section III describes the main features of the system and some scenarios of usage. Section IV describes the model architecture. Section V concludes the paper and discusses the future enhancement.

II. RELATED WORKS

The garbage monitoring systems and route planning and optimization is a well researched area and many intelligent transport systems already exist. The monitoring of the garbage levels using ultrasonic proximity sensor and arduino microcontroller has been proposed. RFID one of the most promising and anticipated technologies in the recent years has been used .A transportation model by using the GIS for the storage, collection and disposal is being proposed in [1] for a city. In[2] an optimized routing and scheduling waste collection model is proposed for Finland.[3] .Most of the garbage monitoring systems uses level sensors ,weight sensors ,load sensor and camera to find out the fullness of the bin. The details will be displayed on LCD screen. There are systems using GSM, Infrared sensor and microcontroller to find the bin levels. Another system use load cell sensor, microcontroller and GSM system.RFID, GPS, GPRS and GSM are used for finding the trash bin levels but using RFIDS are more expensive and complex. The traditional waste segregation method involves separating the wastes manually .But this is not an efficient method for waste segregation. Later on few systems implemented pick and place robot to separate the wastes. But none of the systems were efficient to effectively monitor, segregate, transport and dispose the wastes. Many dynamic routing models have also been proposed.

III. SYSTEM MODEL ARCHITECTURE AND APPLICATIONS

The system aims at providing two main services. First one is the software as service for the customers. The customers are the companies involved in waste collection; truck driver's etc.The first service involves the monitoring, safest and cost effective transportation of waste to the recycling organizations or the city dumps. Second main service provided by the proposed system is to develop a system that helps all the stakeholders who are dealing with solid waste management in the smart cities to communicate.

The proposed system is as given below:

The smart bins are placed in various locations in the smart cities. Each bin consists of an ultrasonic proximity sensor connected with the arduino uno board .The sensor measures the level of the bin. Threshold level is being set and once the threshold level is reached an alert message is given to the truck drivers. The data's from the smart bins are directly send to the cloud storage by using the wifi module. The datas are stored by using Amazon web services. The fullness of data will be displayed in the mobile application. the truck drivers collect the bins and follows the shortest path to the disposal area. The detailed description of the proposed system is given below.

A. Sensor connectivity

Mainly three sensors are used in the proposed framework. The ultrasonic proximity sensor, the inductive sensor and capacitance sensor. The ultrasonic proximity sensor is used to know the level of the garbage bins. The inductive sensor is used to detect the metallic objects. These sensors are characterized by its extreme ruggedness and long service life. The capacitance sensor are used to detect the non-metallic objects. Thus both sensors help to segregate the biodegradable and non-biodegradable wastes. The ultrasonic proximity sensor is connected to the arudino Uno board. And this setup is placed above each of the waste bins. Further the arudino is connected to the wifi module too.The sensed values are updated in the cloud storage .The proposed system uses amazon web services. The data's are being fetched by the android application and it is displayed in the android application.

B. Survey system

Once of the main application of the proposed system is that it provides a survey on the amount of the waste collected on a weekly basis. Each minute the level of the bins are updated on the cloud database. The proposed framework calculates the amount of the waste collected by each bin on a single day and for a week. It takes the average amount of waste collected per week. If the amount of waste generated is very less or is zero compared to the previous record, then it indicates that the bin has failed or has lost connection.

C. Failure Detection

The smart garbage management system enabled by IoT Includes a feature called failure detection and management. Failure detection is done by the truck drivers. From the survey details one can understand whether the bin is working or not. If it is found to be damaged or has lost connection, the bin will be replaced.

D. Route Optimisation

Route optimization is the process of finding out the most cost efficient route for transportation of the garbage. Route optimization is a very complex process. Many route optimization techniques have been employed before. The main steps involved in route optimization are bin initialization and distance calculation. Bin initialization is done by the admin user. Each bins are numbered and are placed in various locations. The latitude and longitude of each location is calculated. The distance from a common point ie the waste disposal area is chosen .The distance from each bin and the

common pint is being saved in the database. When a bin becomes full, the path is chosen in such a way that the shortest and cost efficient path is selected. Google maps are integrated to the application so that the location of the bins and the route are visible to the drivers.

E.Segregation

The smart bins are smashed and the wastes are collected and disposed in a common bin. The segregator sorts the waste into three major classes: dry, wet, metallic and non-metallic. The inductive proximity sensors are used to separate the metallic objects. The capacitive sensor is used to separate non-metallic objects the inlet section of the segregator consist of an open and close mechanism .This is to regulate the flow of the waste to the conveyor. The inductive proximity sensor is used for detecting the metallic waste. When the inductive proximity sensor signals a push mechanism is initiated to discard the metallic waste. A blower mechanism is used to segregate the dry and wet waste. The movement of the conveyor belt is also controlled by the microcontroller.

VI. CONCLUSION

In this paper a novel IoT based system for garbage management is being presented. The system uses sensor technology, cloud storage services and location based intelligence. This IoT based system solves a lot of problems like the overflowing of the bins, sending optimized route to the drivers, fuel consumption by the vehicles are reduced as the routes are optimized. The system also proposes a waste segregator by using the inductive and capacitive sensing methodologies. The waster segregator help to sort out the biodegradable and non-biodegradable wastes. An automated system using artificial intelligence can be employed to segregate and dispose waste so that cost, time and resources are optimized

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