



Solid Waste Management System for Smart City using IoT

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ABSTRACT: There has been tremendous increase in solid waste generation in last few years. Solid waste management is a challenging issue of environment in the whole world. Hence, there is a need to develop an efficient system which can eliminate this problem or at least reduce it to the minimum level. In today's era, every government across the globe is planning to build smart cities or try to transform existing cities into smart cities. Collection of solid waste is a crucial point for environment and its impact on society should be considered seriously in smart cities infrastructure. Internet of Things (IoT) technologies can efficiently handle such services in smart cities. In this paper, we have proposed a wireless solid waste management system for smart cities which allows municipal corporations to monitor status of dustbins remotely over web server and keep cities clean very efficiently by optimizing cost and time required for it. As soon as dustbin has reached its maximum level, waste management department gets alert via cayenne via IoT module placed at dustbins so department can send waste collector vehicle to respective location to collect garbage. The objective of the project is to enhance practicality of IoT based solid waste collection and management system for smart city.

KEYWORDS: IoT, Ultrasonic sensor, Solid Waste management, Smart city, PIC microcontroller, Cayenne.

I. INTRODUCTION

Solid waste management is a major issue of environment in the whole world due to large increase in population growth. It is a big issue not only in the urban cities but most of the countries in the world. Hence it is necessary to develop an efficient system to solve this problem or reduce it to certain level to keep our environment clean and green.

In today's era, every government is planning to transform existing cities into smart cities. In a smart city, collection of solid waste and its impact on society must be considered seriously. IoT technologies play a vital role in implementing such type of services. IoT enabled solid waste management system indicates the level of garbage at any time. It allows the waste collectors to plan their daily/weekly pickup schedule.



In many cities, we find garbage bins over flown at various public places. This creates unhygienic surroundings and bad odor which leads to spread of deadly diseases and human illness. To evade an unhygienic situation caused because of poor garbage collection methods, we propose to design IoT enabled solid waste management system for smart cities. In this system, multiple dustbins will be placed throughout the city/campus. These bins will be setup with low cost embedded device which helps in tracking the amount of garbage present in the bins. All the real time information about the bins will be sent frequently to concerned authority. This system plays an important role in maintaining and safeguarding clean and green environment.

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The developed system is one that provides many useful features for any city that wants to optimize its solid waste collection process as well as reduce the overall cost of running the collection. This not only gives the city's waste authorities the ability to handle their waste better, but also gives them the ability to predict and plan better their resources. In addition, the system will mitigate the risk of overfilled bins and unsanitary conditions that are caused by the lack of information that is present in the current collection process.

II. RELATED WORK

Waste management is a consistently developing issue at local and global levels. Normally, human and animal activities emerge has solid wastes and are futile and undesirable. The residential waste items are gathered through waste bins at a typical place at a specific spot for a road/area. Waste bins checking procedure for waste collection is one of the major troublesome tasks. The typical technique by which, a man needs to wander through the distinctive spots and check the spots for waste accumulation. This is to some degree complex and time consuming process. Presently, waste management system is not as effective as it ought to have been taken over the progressions in the advances and technologies that emerged in the current years. There is no surety about the administration/clearing of wastes at all the spots. To conquer this issue another approach, proposed automated waste management system.

Lots of research has been made on waste management throughout the world. But most of them were focusing on manual collection of wastes, its dissemination and its recycling. It is a time consuming process as well as it needs more manpower. Recently, people started using technologies widely around the world. Among those, IoT based solid waste management system is one of the technologies which will be useful for monitoring and collecting the waste in an efficient way.

Approaches made by researchers are:

Mahajan and Chitode have proposed Zig-Bee based waste bins monitoring system. The filled status of the dustbins will be communicated to the municipal corporation through Zig-Bee Network.

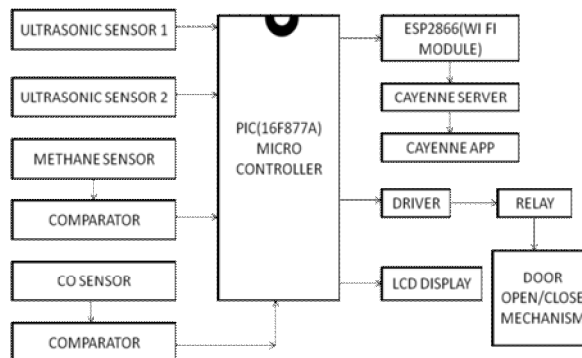
Gupta and Kumar have utilized RFID and GSM technology for communicating status of garbage bins.

Bhor introduced a system where the extent of garbage in the bins is spotted with the help of sensor systems and will be communicated to the authorized person through GSM system. To monitor the required information about the bins at different locations, a GUI is also developed.

Against this background regarding the untidy and mismanagement of garbage collection system, IoT enabled solid waste management system is studied. The collective aim of this project is to assist Municipal Corporation to efficiently monitor and collect solid wastes from garbage bins in their region using this system.

III. PROPOSED METHODOLOGY

Things that are associated with the Internet and occasionally these things can be checked from the web regularly are called IoT i.e., Internet of Things. In this framework, dustbins are arranged at different locations. These bins are related with the web to get the ongoing status.



BLOCK DIAGRAM OF PROPOSED SYSTEM

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Two ultrasonic sensors are settled at the highest point of the dustbin to avoid inaccurate level measurement and is interfaced with PIC microcontroller. Gas sensors are placed at the dustbins and are additionally interfaced with the controller to recognize the amount of carbon monoxide and methane gas filled in the dustbins. Both the sensors send the signals to the microcontroller.

In our system, we are making use of IoT technology to send the sensor data to the gateway devices. This is a new technology and is best suited for long range communication.

A complete IoT system integrates four distinct components: sensors/devices, connectivity, data processing and a user interface. First, sensors collect data from their environment. Next, that data is sent to the cloud. The device can be connected to the cloud through a variety of methods including Cellular, Satellite, Wi-Fi, Bluetooth or Low power Wide Area Networks. Once the data gets to the cloud, software performs some kind of processing on it. Next, the information is made useful to the end-user in some way. This could be via an alert to the user.

The external communication layer of the system typically consists of a mobile app. The mobile app is used by the garbage collection department to get alerts from the smart bins and also to get the level of the gas generated from the garbage bins. There is an open/close door mechanism included in the bins when it gets emptied/filled.

IV. IMPLEMENTATION

We have developed a solid waste management system using IoT for smart cities in which garbage bin will be provided with two ultrasonic sensors to sense the level of garbage as well as gas sensors to sense the amount of harmful gas emitted from the garbage, together will be sent to cloud through internet and will be analyzed to give utility based android application for municipality corporation.

Ultrasonic sensors measure the sound waves with higher frequencies which human being normally does not sense. These sensors typically do not require physical contact with the target. Ultrasonic sensor plays an important role in the proposed system. HC-SR04 Ultrasonic sensor is used to sense the depth of the bin to get the garbage level. The following figure shows the ultrasonic sensor.



ULTRASONIC SENSOR HC-SR04

Carbon monoxide and methane sensors are used in the proposed system to sense the amount of their emissions from garbage. Carbon monoxide is a colorless, odorless gas, tasteless and toxic air pollutant produced in the incomplete combustion of carbon containing fuels such as gasoline, natural gas, oil, coal and wood. The location that continues to have higher concentrations of CO tends to cause many serious health effects for human beings.

The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities.

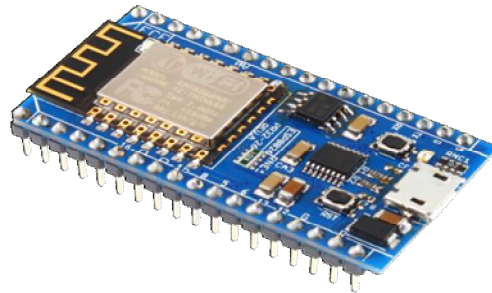
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The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack which gives access of Wi-Fi network to any microcontroller. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.



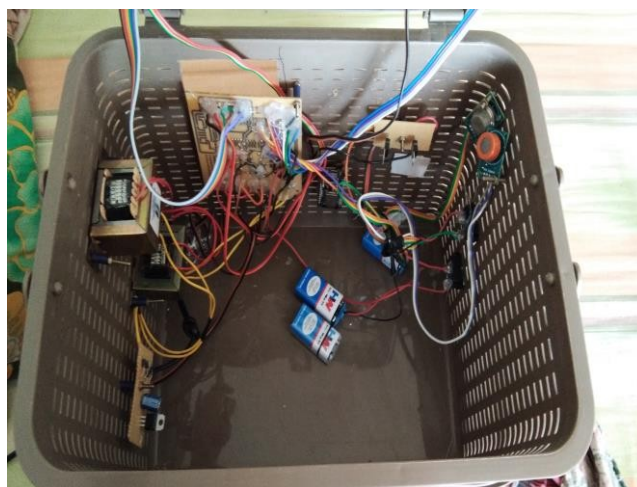
IoT COMMUNICATION MODULE-ESP8266

The open-source Arduino Software is used for writing a code and uploads it to the board. The environment is written in Java. This software is use with Arduino UNO R3 board. The data which is sensed by HC-SR04 will be sent over the internet through Wi-Fi module ESP8266. Transmitted data will be collected at cloud so we will be able to access data from anywhere using internet. The continuously sensed data from garbage bins are stored in cloud server and can be further used by both waste management authority and as well as garbage collection truck drivers.

Centralized information system will be setup at waste management authority or municipal authority site to monitor the overall system which will provide real-time status of garbage bin located in particular region.

V. RESULTS AND DISCUSSIONS

IoT based waste management system was implemented and tested. The following figure shows the final prototype built for the proposed system.



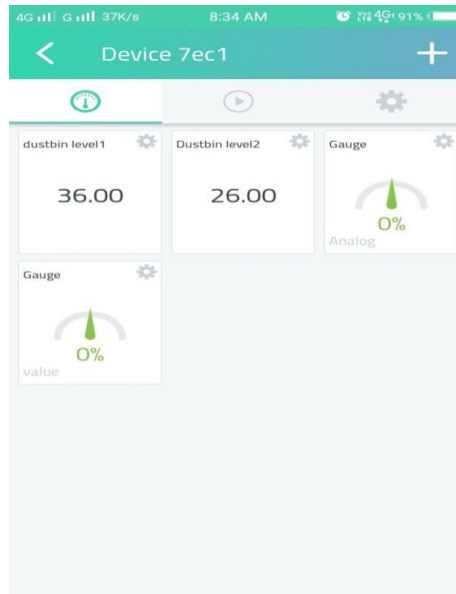
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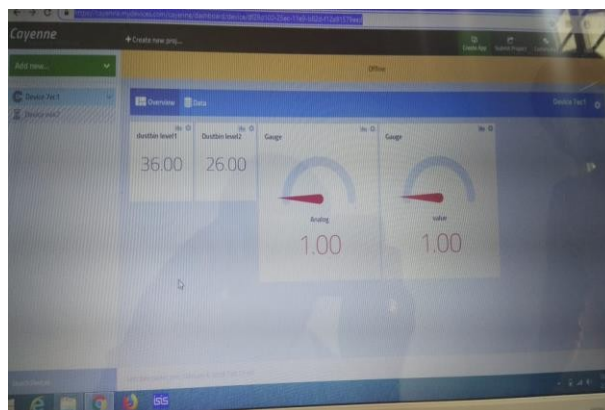
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Cayenne application is used for visualization of the sensed data from garbage bins. The statistics of wastes in bins using Cayenne is given below



If the bin gets filled or if any gases are sensed, it will be indicated by red color in Cayenne.

The statistics can also be viewed through our PC as follows



VI. CONCLUSION

The proposed system improves the practicality of IoT based solid waste collection and management system for smart city. This pays a lot towards clean and disinfected pollution less environment in building a smart city. As these technologies are new in India, there should be appropriate consciousness and alertness among the public before the operation of this technology. Otherwise, sensitive devices like sensors must be spoiled due to rough action of the users. It is an automatic dustbin monitoring system in order to sense the full condition of the bins. This provides the authorized users appropriate updates of the bins and thus eliminates the need of intermittent manual checks and overflowing bins. This method finally helps in keeping the environment clean. Thus, garbage collection is made more efficient, effective and operative.



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In future, the problem of waste segregation could be taken into consideration, as it is yet one of the major parts where huge amounts of money is spent and is the problem faced by many countries. Also, the extended version of this paper could include a better approach for waste analysis that has a better approach to monitor the levels of the bins.

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