IoT-Based Smart Waste Management System

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Abstract. IoT (Internet of Things) a new age communication technique without requiring human-to human interference can provide effective solutions to Environmental issues and challenges. Through this project, we address the problem of garbage downpour by using smart dustbin. The garbage level of the dustbin can be sensed by using the ultrasonic sensor. The levels of the bin are sensed at periodic intervals and those values are updated to the cloud to analyze them. We make use of ESP-32 Wi-Fi based component to report notice to the concerned authorities when the dustbin is full to alert them. The Smart Dustbin is designed to be a solution for municipal garbage workers to manage their waste collection in an efficient way. Concerned authorities can take effective steps to clean the dustbin after receiving the notification from the smart dustbin. This helps in timely removal of garbage keeping the surroundings clean and hygiene around dustbins and also reduces the burden of continuous monitoring of dustbins by the municipal workers.

Keywords: IoT · Smart Dustbin · Wi-Fi

1 Introduction

Disposal of the waste and management is a major concern in a country like India due to high population. The Ministry of Environment Forests and Climate Change, Govt of India categorically estimated that the usual waste production in the country has been alarming and statistics put this at 62 Million tons (MT) annually. However, per annum 5.6 million tones is plastic waste, 0.17 million tones is biomedical waste, hazardous waste generation is 7.90 million tons and 15 lakh tones is e-waste. The per capita waste generation is at 450 grams/day. Further, only about 75–80% of the municipal waste is presently collected and only 22–28% of this waste is processed and treated. Mostly waste is deposited along roads, water bodies and low-lands, affecting health and Environment.

The present project provides an efficient method to prevent overflow of garbage. The model includes a dustbin which is equipped with sensors interfaced with the processor to indicate the level of the bin at regular time intervals [1]. The model also alerts the respective municipal authority regarding the same in cases when dustbin is about to overflow. With the rapid increase in population, the waste generation is also rising and creating lot of nuisance in the surroundings.

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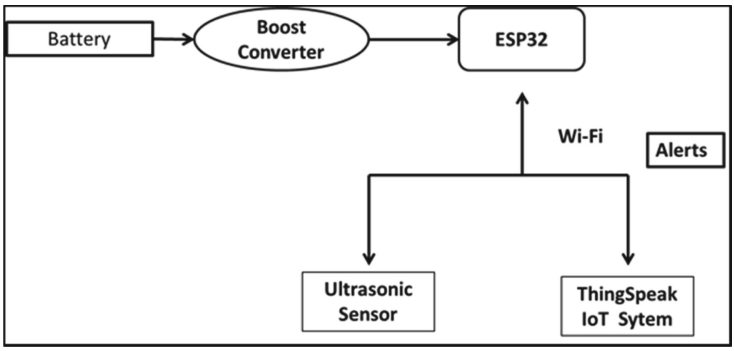

Fig. 1. Flow chart of the IoT-based smart dustbin management [9, 10].

Internet of things IoT consists of two words Internet and Things. IoT has been wonderful and enabling technologies to execute remote sensing, actuating and live inspection of certain data and communicate and exchange data with other connected devices/instruments for better monitoring of the enabling systems [2, 3]. IoT requires certain technologies to support its operations Viz. Wireless sensor Network, Cloud Computing (CC), Big data, Embedded systems, Security Protocols, Web services, Internet and Search Engines, Wireless Network. Thus, the IoT is an effective tool which has self-configuring potentialities and providing typical and interoperable communication. They are operable seamlessly integrated into the information network to operate efficiently [4] (Fig. 1).

All these subsystems are integrated to enable data and information exchange for smooth functioning. Cloud Computing: Cloud computing provides Internet based computing, shared resources and other services as and when it is required. They are available in different structures viz. IaaS, PaaS, SaaS, Daas etc.

Big Data Analytics: Big data analytics is makes investigations relating to hidden patterns, association, trends in the data, customer choices and additional useful business data. Communication Protocols: They form core processing unit in the system and facilitate exchange of data over the network and perform specific tasks. Embedded Systems: It consists of collectively hardware and software components to execute certain jobs. It has microprocessor/microcontroller, RAM/ROM, networking components, I/O units and storage devices [5].

2 Methodology of Work

The smart dustbin performs smart activities to handle the waste dumped into it [2]. The dustbin sends information on the level of waste present in the dustbin. The sensor will find the level and inform the Centre regarding the contents. The smart dustbin with help of ultrasonic sensor, it will detect the level of the waste and sends a text communication to the collection center about the level of the dustbin. Figure 2 shows how the Ultrasonic Sensor senses inside the dustbin. In this system, the communication is established with the database i.e., ThingSpeak which is a server. Here, we selected a

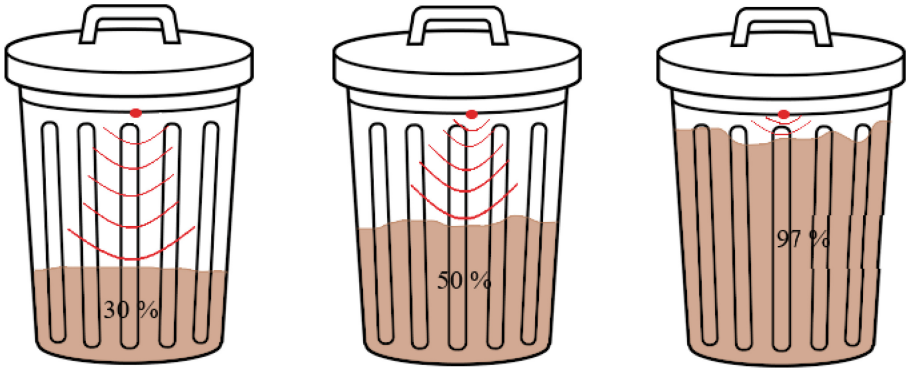

Fig. 2. The dustbin level sensing diagram (Adopted from [6])

wireless communication method to convey the message and retrieve it from the database because wired communication methods like Ethernet are not handy with Smart dustbin. To make communication possible, we made use of ESP32 [6]. It has an inbuilt Wi-Fi module along with the GPIO pins which are used to interface external devices.

The ultrasonic sensor will check the dustbin level periodically say every 20 min and updates the values to the cloud (ThingsSpeak). At the same time if the last value that read is lesser than the specified threshold level in the program, then a mail is sent to the Id of the authority saying that the dustbin is full. The ultrasonic sensor works at 5V. Thus, we used a boost converter to convert the battery supplied from 3.7 v to 5V. The charge controller is used to charge the lithium battery and to provide stable current to the ESP32 preventing it from damage. The entire programming is done in Arduino IDE by downloading the necessary libraries and installing those files [7, 8].

The various hardware and software used in the present work are listed below:

ESP32, Ultrasonic Sensor, Charge Controller, Lithium Battery, ThingSpeak, and Arduino IDE (Integrated development environment) [7].

3 IoT Concept in the Project

In this Project, the sensor used is Ultrasonic and it is interfaced with the ESP32 Wi-Fi module. The ESP32 which is powered by a Lithium battery connects to the Internet through Wi-Fi provided; the readings from the sensor through this module are communicated to the Cloud Platform ThingSpeak where the Storage, representation, and analysis of the values sensed takes place. Here, we connect the sensor and cloud through a communication module where we can see the IoT concept's application. Figure 3 shows an overview of how communication takes place through Wi-Fi.

4 Results and Discussions

This section discusses the simulation results of the proposed smart waste management. After interfacing the respective components with the esp32, we tested it with the threshold level written in the code. We took the sample time as 20 sec for convenience, but for

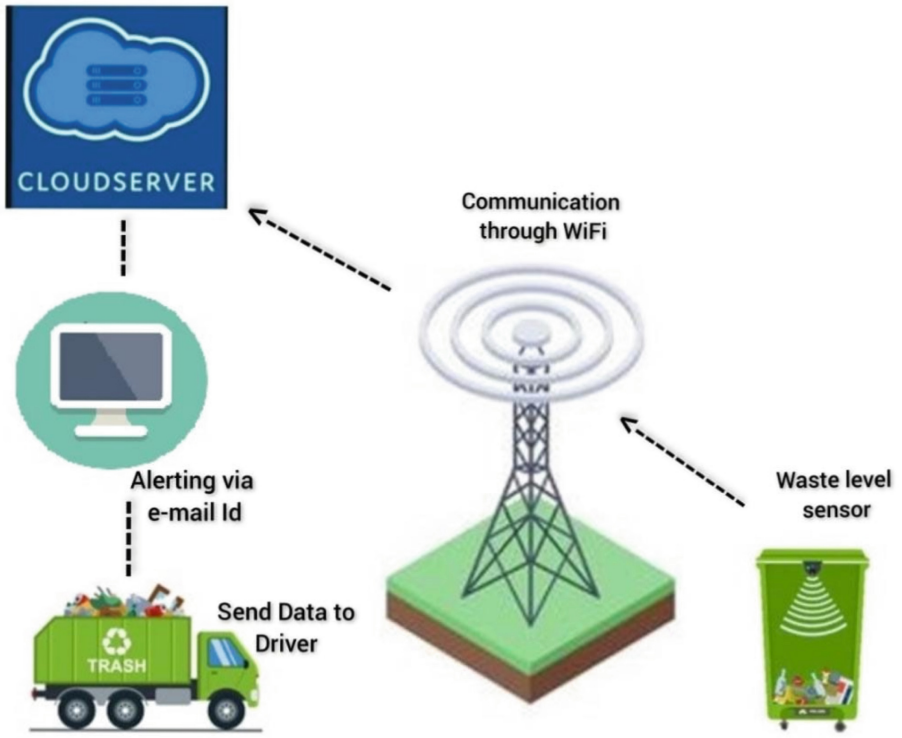

Fig. 3. The IoT Concept in the present work based on the works of [7]) Representative Figure.

the real-time deployment, it should be a little higher say 20 min. The dustbin level is measured in inches and those values are updated to the ThingSpeak channel using a Wi-Fi module for communication as shown in the Fig. 2. When the sensed level is lower than the threshold level then mail is sent to the person registered to take immediate action as shown in Fig. 2. We can also download the CSV file from ThingSpeak for further analysis of the collected data.

5 Conclusions

With ever increase in population and urbanization has resulted in huge amounts of waste. An average individual generate roughly about 0.56 ~ 0.74 kg of waste. The conventional waste management and supervision is not successful in handling these huge amounts of waste. The implementation of smart garbage gives a solution for unsanitary environmental condition in a city. This project is designed to provide an optimal solution for the waste collection by the municipal authorities. Thus, it makes the urban areas cleaner. The present work is an attempt to manage the waste on real time basis by adopting smart dustbins to prove the level of dustbins frequently. The information on smart bin and the bin level can easily be observed from anywhere and at any time by the responsible person and accordingly decisions are taken when an alerting notification is

received. In bigger cities, the waste collection has been a difficult task and quite often, garbage vehicles visit the local areas on weekly two or three times depending upon the local conditions. Therefore, our present dustbin management will notify the condition of dustbins for effective policy intervention and decision making. By the implementation of the present system, the environment and sanitary conditions improve significantly. The advantages of the present work include Low cost and resource optimization, Timely removal of garbage, retaining of environmental hygiene, best technological solution to the global concern.

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