IoT based Connected Dustbins for Waste Management in Commercial Places

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Abstract - *Waste management is one of the biggest jobs in any commercial places like offices, school, colleges, shopping malls etc. The collection of solid waste like the paper, plastic bags, food waste, and other garbage (that are being thrown away by the working staff, students and common people) is a very difficult job in the recent times due to the increased population. The maintenance people has to come near every bins that are placed in different places to see whether it is filled or not. So, an IoT based Connected Dustbin System is developed to monitor the garbage levels of all the dustbins that are being utilized in the above mentioned places. The details about the garbage bins can be viewed through an app. The app shows the details of the bins like its location in the particular place, the amount of garbage in it, the time it was cleaned previously. This system of connected bins helps the maintenance people to collect the waste from the dustbins that are fully filled and those needs urgent cleaning. The above mentioned system could eliminate the unwanted inspection of empty dustbins.*

Keywords: Waste management, IoT, WSN.

1. Introduction

Waste management is an important function or the very essential action that has to be done in the commercial places like, offices, school, college, shopping malls and other public places. One of the most common way of collecting the waste from the public is through the means of the dustbins. The collection of the waste thrown into the dustbin is an important job to be performed. Because when the waste is left un-collected this could lead to the environmental degradation.

Currently the waste is collected in-person by the maintenance people those who work in the public places. They will be going to every location where the dustbins are located, to collect the waste from the bins. They are going to the bin location without knowing the amount of garbage, i.e. they will also be going to the dustbin which is not filled enough to be cleaned. This make them to lose their energy and time.

Internet, now has become a part of our lifestyle. Internet of Things is the concept of connecting several devices/appliances through a communication protocol to transfer data from one another. The usage of internet for this purpose has been very drastically increased that more than 7.3 billion devices will be connected through the internet by 2020. Currently the application of the IoT is in almost all the fields like transportation, manufacturing aerospace and etc. IoT is now mainly used for the environmental monitoring and remote actuation process etc.

The concept of using connected technology for the waste management has led to the following ideas, *IoT Based Smart Garbage and Waste Collection Bin*[1], *IOT Based Smart Garbage alert system using Arduino UNO*[2], *RFID-based Real-time Smart Waste Management System*[3] and many other innovations.

2. Basic Concept

The basic concept in the above mentioned system is the Wireless Sensor Network(WSN). WSN is a network of sensors/things that are to a single point or inter-connected sensors/things to transfer data. In the above proposed system the all the dustbins are connected to a single database/platform so that the data could be transferred from the dustbin to the database and to the mobile app.
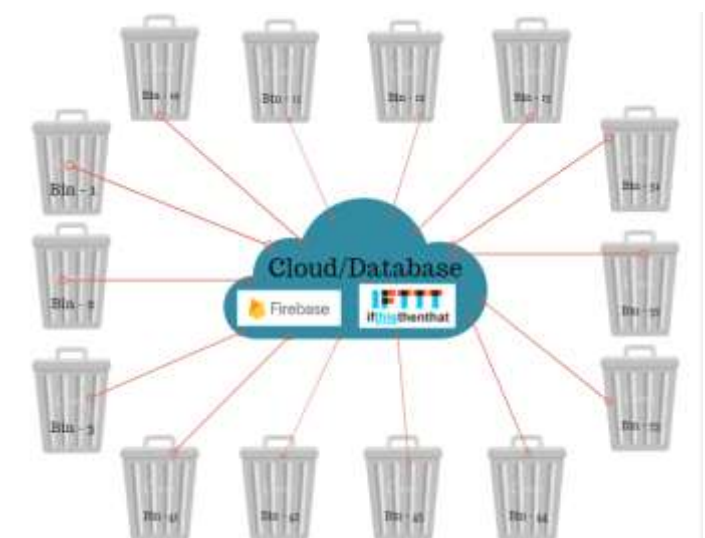

Figure 1: Connected Bins as WSN concept

The above mentioned figure(Figure 1) is a representation which explains how various dustbins are connected to a single point(database).

3. Proposed System

The proposed system is simply about integration of the smart dustbins that are placed in a commercial places. This makes the job of a maintenance crew a very easy one. They can view the garbage level, the location of the bin through the mobile app itself. If the bin is fully filled and it has to be cleaned immediately, then an SMS can be sent to the same maintenance crew. If someone tries to steal or move out the dustbin from its original position then an alarm/alert will be sent to both the securities in the place and the maintenance crew.
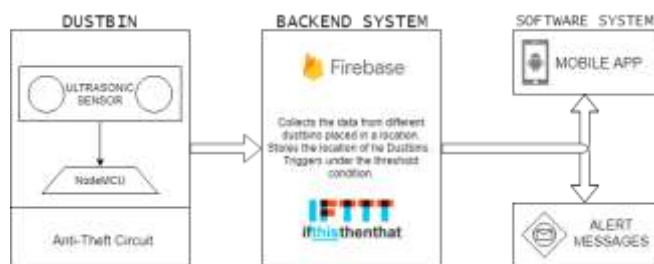

Figure 2: Proposed System

The above representation(Figure 2) explains the different layers of the proposed system.

The system is totally of three levels-hardware setup, back-end system and the mobile app. The hardware setup is the physical device that collects the data from the dustbin and then transmit those collected data to the back-end system. The hardware setup includes the ultrasonic sensor, anti-theft circuits and the microcontroller(NodeMCU). The back-end system is virtual storage that is used to collect the data from the dustbin and this is also linked to the mobile app. The mobile app is to collect the data from the back-end and to show the dustbin data to the user/maintenance crew.

3.1   Hardware System

The hardware setup consist of the following parts that combines to perform the sensing and data transmission element. The different components that are used in the development of the proposed idea are discussed below.

3.1.1   Ultrasonic Sensor

The ultrasonic sensors are the sensors that are used to find the distance. The working of these sensors based on the SONAR principle. The time taken for the ultrasonic rays to reflect back is taken into consideration to calculate the distance travelled by the ultrasonic rays from which the distance can be calculated.

Figure 3: Ultrasonic Sensor Working

Speed of sound, v = 340 m/s

Time(t) = distance(d)/speed(v)

*Therefore, d = t*340*

Here the distance(d) is related to the level to which the garbage is filled. Then, on comparing with the total height of the dustbin bin the percentage of dustbin volume filled can be calculated.

3.1.2   Micro-Controller

Since the data is sent to back end system, a Wi-Fi based microcontroller called NodeMCU is used. NodeMCU is a ESP8266 based Single Board Microcontroller. It has a RAM size of 128Kb and a memory of 4MB.   It totally consist of a 9 digital pins and a single analog pin.

Figure 4: Micro-Controller(NodeMCU)

3.1.3   Anti-Theft Circuit

The anti-theft circuit is used indicate when the dustbin is being moved from its original position or when the power supply is being removed. This anti-theft circuit is based on the PNP transistor, which actuate the microcontroller to send data that power supply is removed. The limit switches are used to sense the presence of the dustbin in its position. When the dustbin is not sensed at its position, then alert message and the buzzer is activated.

3.2   Software System

3.2.1   Arduino IDE

It is an open-source development platform through which a microcontroller can be programmed. The necessary library needed to program the NodeMCU is installed and so it becomes easy for programming it.

3.1.1   Android Studio

Android Studio is an IntelliJ IDEA based development platform through which the android apps are developed. An app is developed to indicate the garbage level in a dustbin and the location of the dustbin.

3.3   Backend System

The backend system is used to store the location, the status, the garbage level of a dustbin. This backend system collects the data from various dustbins placed in a particular location. The backend system servers as link between the dustbin and the mobile app. In this proposed system, the backend system used is Google's FIREBASE services.
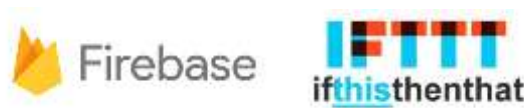

Figure 5: Backend System

The IFTTT(If This Then That) service is used to trigger an SMS when a dustbin needs to cleaned immediately. It is HTTP based service that could be executed by simple POST/GET methods.

4.   Outcome

The output of the above proposed system is given in three ways. One way is to show the garbage of each dustbin is shown in the mobile app(Figure 7) with other details like location and the time when it was cleaned last time. The second way is that alert message is sent to maintenance head when any of the dustbin needs to cleaned immediately. The last way of output is the buzzer sound when someone tries to move the dustbin from its original position.
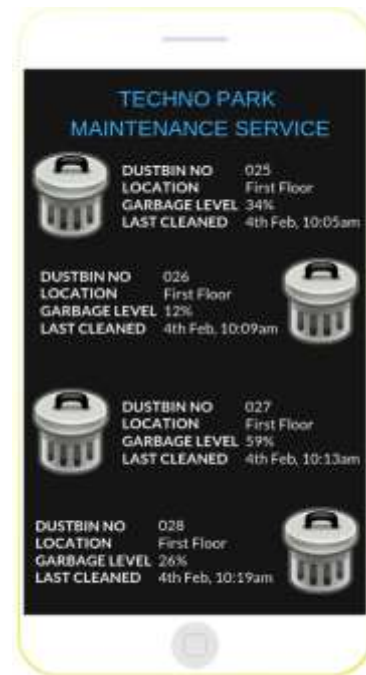

Figure 6: System Use case

The above diagram(Figure 6) explains how the system works in real-time.

Figure 7: App UI

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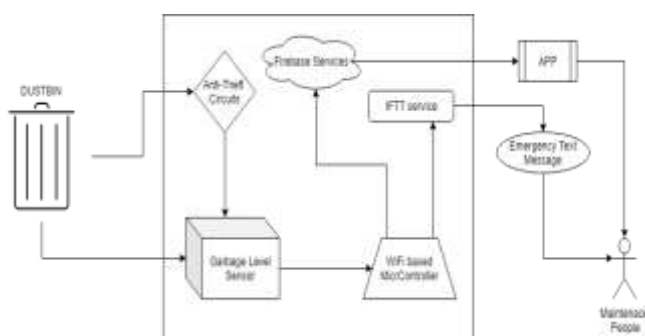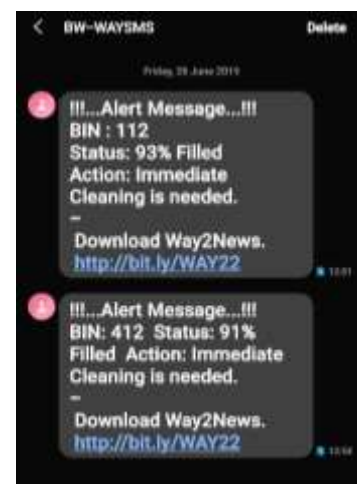

Figure 8: SMS Alert Message

5.   Other recommendations

Further development in the proposed waste management system is to link the digitalized rest room/toilet cleaning system, which could also cover the total maintenance in

any public or commercial place. So a single superior could govern the maintenance in that place.

References

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