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Smart Dustbins and Smart Compost BINS (Aiding Hon'ble PM Modi's Smart City Mission and Swachh Bharat Mission)

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Abstract: ***There has been a very rapid urbanization across India in the past two decades but unfortunately it has not been planned properly leading to congestion in urban cities. Too many people live in overcrowded society apartments at these urban centers which creates a problem for the concerned authorities to administer these areas properly, especially in the domain of WASH (Water Sanitation and Health). Our Project focuses on designing and implementing a system on a large scale to ensure smart and efficient management of waste collected in societies, apartments, office complexes as well as generate compost from the waste collected in office building complexes across various cities in India at a low cost with the help of technology. For this purpose, we have developed dustbins and compost bins integrated with GSM/GPRS based smart controllers which would contribute in aiding PM Modi's "Smart City Mission" and "Swachh Bharat Mission" to a very large extent and help in better management- both in terms of cost and efficiency and proper disposal or utilization of waste on a large scale.***

Keywords: Smart Dustbins, Smart Compost Bins, Sensors, GSM/GPRS module, Microcontroller, GPS, PHP, MySQL, Mobile Application

1. Introduction

In the housing society and apartments, large open dustbins are kept which often overflow due to delay in timely collection of waste from them, causing pollution and unhygienic environmental conditions. In large commercial complexes such as offices, hotels etc. a lot of food waste gets generated on a daily basis and it is usually dumped along with other recyclable and non-recyclable waste. This causes issues such as filthy smell emanating from the waste. If managed properly, this food waste and other organic material such as fallen leaves, paper etc. can beused to generate compost using compost pits which can be further put to various productive uses in spreading greenery around.
Thus, our system has been designed to ensure timely collection of waste and to harness the maximum possible output from compost by speeding up the process of composting by using artificial methods. Some of our initial systems have been installed in specially designed dustbins and compost bins across the cities of Gurugram, Lucknow, Gwalior and Bhubaneswar for its pilot. The status of these smart dustbins and smart compost bins is relayed onto web application hosted in the cloud so that these can be monitored from anywhere in the world through secured credentials and access can be made on web-browser as well as mobile app for regular remote monitoring. This would also ensure safety and security and could act as an early warning measure in case of fire or other suchunforeseen harmful conditions.

2. Related Works

[1] In this paper they have used implemented a smart way to handle the garbage by the use of IOT protocol for transmitting the status of dustbins wirelessly by using esp8266 Wi-Fi module to generate e-mails to notify the user. Once the Wi-Fi gets connected to the microcontroller, and the level of dustbin is checked using an ultrasonic sensor, the smart e-dustbin can move based on either line follower mode or based in predefined programed path with the help of proximity sensor installed to avoid obstacles. AVR microcontroller is used to take decisions and an LCD display is used to project the situation of dustbin. It is a very cost-effective project. [2] In this paper they have proposed a system of a smart dustbin that is based on an alert system to monitor waste disposal in efficient way. The ultrasonic sensor senses the bin's fullness and sends status and report readings to concerned authorities by using SPI interface in Ethernet modem from Arduino UNO or LAN based connection, which can be accessed using a website. Apart from this their product has additional features like automatically close the doors with help of relays and motors when the dustbin is full or in case of rains, which can be detected using rain sensors. The buzzer will avoid the littering around of waste near dustbin by detecting it using IR sensors. [3] In this paper they proposed a design of network of smart garbage bins based on stack based front end approach of integrating wireless sensor network with cloud computing and used machine learning techniques like to make the system more efficient. In the network of bins, the level of bins is measured by using ultrasonic sensor node and all the data is sent to a sink node. To cut down the cost, instead of using GPS for location of bins, they assigned a geolocation manually for each device ID. From the sink nodes, the data is sent to a gateway node, which uploads it on the cloud. Here they have used machine learning techniques such as decision forest regression for level prediction. Thereafter, the data of predictive analysis and current status of bins is sent to a client app which schedules

pickup based on 4 eligibility settings. However, their system is limited to a small coverage area and not for implementation on a large scale for cities. [4] Their paper proposed a system to use IOT devices to transmit the level of garbage in dustbins along with GPS coordinates through SMS alert message to the concerned authorities. The level is detected using HC-SR04 Ultrasonic sensor and ATmega2560 microcontroller is used with AVR architecture. In addition to this, 2 flame sensors are also placed for safety purposes which will show the threat using a LCD screen. [5] In this paper they have focused on the harmful gases such as methane that are responsible for pollution of our environment and composting of the waste. proposed a system that is used to monitor the formation of compost. Their system comprised to various sensors like DTH 11 temperature and humidity sensor, MQ2 and MQ4 gas sensor to detect levels of methane hydrogen and propane, moisture sensors, to monitor the parameters composting inside the bin. They provided solutions for maintaining ideal conditions for composting like turning on heaters or water taps. This way they were able to make nutrient rich compost with least emission of methane gas. They are using Atmega328 microcontroller and the compost metrics can be monitored and processed remotely via a web server created using HTML. [6] Their paper has focused on two main parameters responsible for composting i.e., temperature and airflow, and have provided a temperature control feedback system. It is an embedded controller for automatic temperature and air flow control for the composting plant that would help in minimum maturity time period under best provided conditions and provide a nutrient rich compost. The temperature is controlled to provide heat for the destruction of pathogens which cause hindrance in composting and a fan is used to control the airflow. They have used PIC16C71 microcontroller with RISC architecture.

3. System Features

3.1 Proposed System

The system comprises of a hardware component, web-based database and a mobile application. The hardware component is installed in specially designed dustbins and compost bins. The environmental conditions of bins like temperature, humidity, level of garbage or compost in the bins, gas emission etc. are taken as inputs by the different sensors installed, after which that data is transmitted to the server using GSM/GPRS module by a sim establishing a 2G connection to the server. The mobile application connects to the server via internet and displays the location and other information on screen in real time whenever the server gets updated.

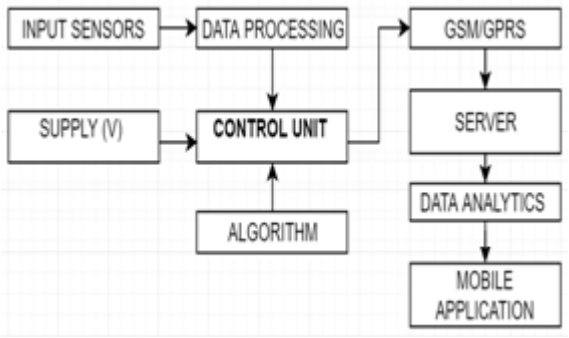

Figure 1: Block diagram of proposed system

3.2 Working of Smart Dust bins

The hardware component of the product comprises of several components like a GPS to geo-locate the smaller smart dustbins that may be moved from one place to another, while the bigger underground immobile dustbins are given an ID mapped to a particular location. We alsouse a microcontroller- Atmega328/Atmega2576 or similar, GSM/GPRS module and various kinds of sensors. The level of garbage is detected using a waterproof ultrasonic sensor. We use an algorithm to update the server regarding the level of garbage in the bin and other environmental conditions like temperature or humidity in case of emergency situations. Once the garbage level reaches a set value, it is displayed on the mobile application. Every area in which the dustbins are located are assigned to a pickup van driver. As soon as the 'full' level is notified via the application, the pickup truck collects the garbage from that location and empties the bin. This prevents unnecessary trips to the location before it is full, thus saving us fuel and manpower costs. In case of emergency situations, like extreme temperature or fire, concerned authorities get a notification and risk mitigation measures could be taken to avoid any mishap.

3.3 Working of compost monitoring system

The functioning of smart compost bins is same as the smart dust bins. Here all the organic waste is collected in the compost bins for composting. A heavy-duty shredder is used to shred all waste that goes into the compost bin. Waste generally gets collected gradually and composting takes time. So, in order to maintain the suitable environmental conditions inside the compost bins, we use an algorithm that takes inputs from the sensors installed and switches on the heaters inside the bin to maintain a proper humidity and temperature for the conversion of waste to valuable compost. Due to favorable conditions provided through the system, it leads to decrease in the time of composting thereby increasing the production rate and quality.

3.4 Working of the mobile application

The mobile application is connected to the server via internet connection. It displays all the information about the dustbins and compost bins like location, temperature, humidity, level of garbage, gas emission for composting, etc. The authorities have different levels assigned for managing the waste across the cities. Different amount information in the application can be accessed at different levels depending

upon the authorization of that particular level. The application also maintains a proper record regarding the time of collection of waste for transparent and efficient management. The application gets a notification about the full status of bins.

4. Design of the System

4.1 Hardware

4.1.1 Sensors

4.1.1.1 Ultrasonic sensor

We are using waterproof ultrasonic distance sensor JSNSRO4 to detect the level of garbage or compost in the bins from the base which is assigned already at fixed value. The distance is measured in centimeters which can then be displayed in terms of percentage of bin fill level in the application. The sensors take the input at regular time intervals. There are three main criteria we have set to measure the distance. If the distance from the base to the sensors is less than 50%, it will be considered empty. When the distance is between (50-75) % it will be considered half full. When the distance is more than 75% it will be considered full, after which notification will be sent to pick up the waste or empty the compost.

4.1.1.2 Temperature and Humidity sensor

We are using a DHT22 temperature and humidity sensor in the compost bins and dustbins. It is beneficial in detecting unusually high temperature like in case of fire. It also takes inputs at regular time intervals. If the temperature is lower than set value (around 45 degree C) it is be detected and the heaters are turned on to stabilize the environmental conditions for faster production of compost from the organic waste.

4.1.12.1 Gas sensor

MQ series low cost Gas Sensors are installed in the compost bin to monitor the gas emission taking place while the formation of compost. This reduces the risk of fire in case of excessive buildup of methane and other gases.

4.1.1.3 GPS

The L80 GPS module from Quectel installed in our device provides the location of the smart dustbins and smart compost bins in the mobile application, making it easy for the pickups to reach the location of smart bins.

4.1.13 Microcontroller

All the other hardware components like sensors, GSM etc. will be connected to ATMEGA328/ATMEGA2560 microcontroller.

4.1.1.4 GSM module

The GSM SIM 800A installed is responsible for establishing a 2G internet connection via mobile sim to the server to provide all the information about the dustbins taken as inputs via sensors. This would allow us to send data at low cost at wide ranges all across the cities.

Figure 2: Hardware GSM/GPRS Module

4.2 Mobile Application

The mobile application displays the information about the dustbins taken from the server via internet connection and the location of the smart dustbins and compost bins. The location can be seen using google maps as the user taps on the dustbin the information such as level temperature humidity etc. are displayed on a pop-up window. The application is made from user point of view only and the server can be accessed by the admin which are the concerned authorities to monitor the records for collection of garbage and other parameters.

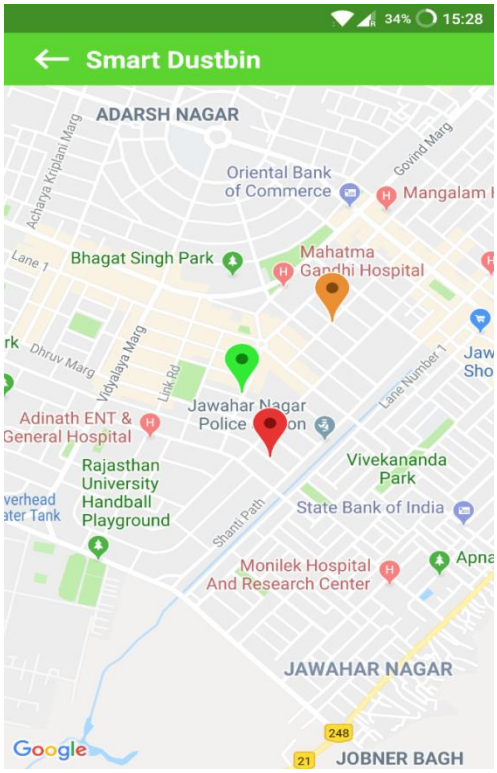

Figure 3: Application screenshot showing location of dustbins installed in an area

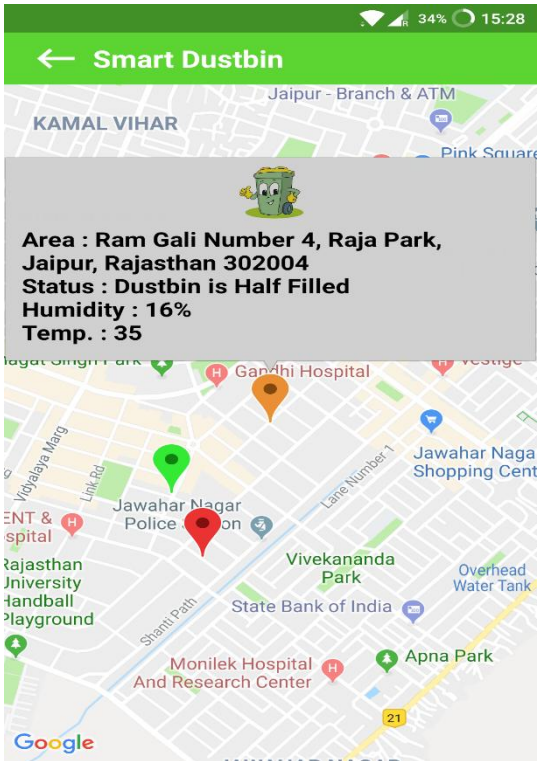

Figure 4: App displaying half-filled bin

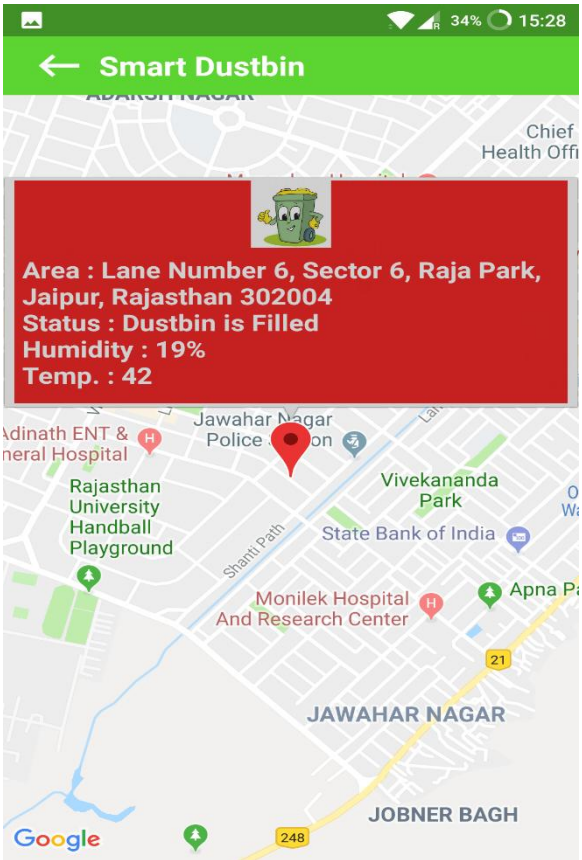

Figure 5: App displaying bin is filled

5. Flowchart and Algorithm

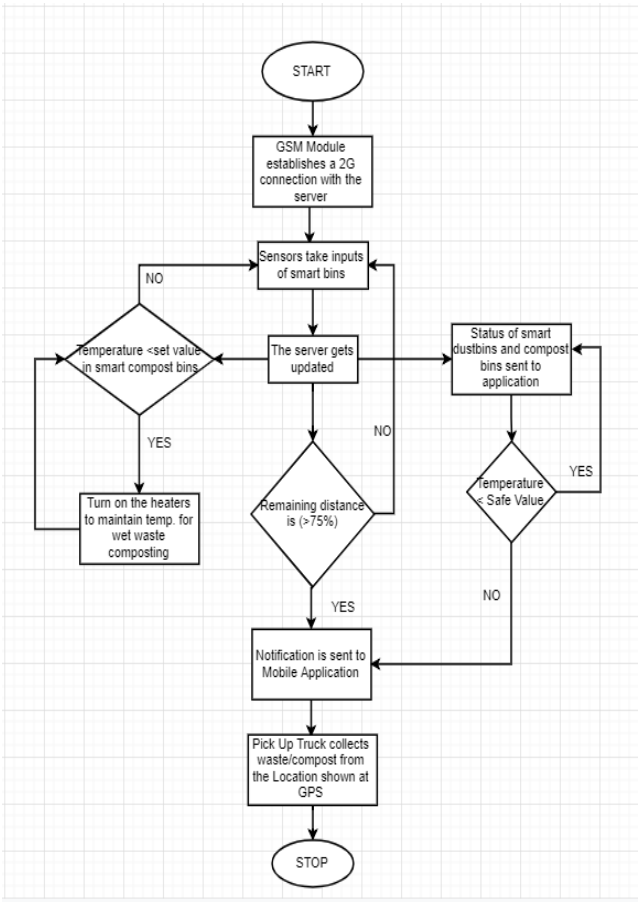

Figure 6: Flowchart

6. Future Aspects

We look forward to update our project with the help of technology to make it even more cost effective. We also look forward to explore new areas in which we can implement our product and make it more practical to implement on a large scale. Our immediate next aim is to find solutions to make our product more power efficient and promote the use of technology and its implementation to make our cities "smarter".

7. Conclusion

The core idea of smart dustbins and smart compost bins is to implement this technology on a large scale at a low cost for efficient management of waste and to utilize waste in maximum beneficial way possible as it can prove to be a very important resource.

The project had a very positive impact in the areas related to environmental concerns as well as in the development of our urban cities, by making them more technologically advanced. Thus, our product contributed in a major portion of the government schemes like Swachh Bharat Mission and Smart Cities Mission.

The project also set up a perfect example of smart development of our urban cities while sustaining and rather improving the condition of our natural environment by

reducing pollution, conserving fuel and creating organic compost from waste at a faster rate. It also eradicated many socio-economic problems which were earlier being faced by people living in societies to a great extent by improving the management of waste across the city centers.

Figure 7: Smart dustbins

Figure: Smart Compost Bins

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