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# Smart Waste Management System for Metropolitan Cities

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**ABSTRACT** -The present paper is to design and implement the smart waste management system using IoT Technology. The Garbage bins are placed at public places in the cities are overflowing due to increase in the waste every day. The proposed paper aims to design Garbage Monitoring System using IoT. In this proposed system, the garbage level detection is done and alerts the authorized person to empty the bin whenever the bins are full. The data are transferred to the cloud and from the cloud sends the data to the web application. Garbage level of the bins can be monitored through a web App. This system can be viewed by the location of every bin in the web application by sending GPS location from the node red. The garbage bins are built with a sensor module (Ultrasonic sensor) which continuously monitors the garbage bin. Any moment the garbage level passes over the critical level (i.e. 80%), the system generates a notification to the monitoring panel (admin panel /garbage cleaning team) and so cleaning team collects the garbage from the identified garbage bin.

**KEY WORDS:** Ultrasonic sensor, IOT, GPS, Web App.

## I. INTRODUCTION

Rapid population growth has resulted in poor waste management in cities, which has increased pests and disease transmission. Now a days, waste is collected by a garbage collecting vehicle (GCV) twice or three times per week. The problem is therefore an abundance of waste on the roads. The garbage cans are equipped with sensors and connected via a network in the proposed work. The sensors installed in the trash cans gather data at predetermined intervals. It sends a request to the GCA when the threshold is reached (Garbage Collector Agent). This agent gathers all of the filled smart bin requests and uses an IoT framework to communicate.

## II. RELATEDWORK

The major goal of this proposed system is to prevent the dustbin from overflowing of wastes in the road side and in nearby communities. This can make the area around the dustbin neat and clean while preventing waste from overflowing outside the dustbin as the result of routine dustbin cleaning.

The following are the objectives: To design sensor based smart bins that can access the amount of waste and communicate that information directly to the municipal corporation. In order to save time, the municipal corporation receives an alert when the smart waste bin is full, and the trucks from the corporation takes the shortest route possible to collect the garbage. The suggested systems specific component can be quickly and simply replaced with a new one if there are any issues.

## III. METHODOLOGY

In this proposed system, the garbage level and weight of the bins are detected. The garbage levels are classified into three levels, Low level, medium level, High level. When the smart bin is empty or below fifty percentage, it is considered to be low. When the bins are equal to fifty percentage, it is considered to be medium level. When the bins are above eighty percentage, it is considered as high or critical level. After reaching the critical level, it sends the notification to the admin. The admin sends the location to the curbside collector, then they collect the garbage through shortest path. Admin communicates with the smart bin status using a GPS, to enable the efficiency of waste management system. In order to create an autonomous system, Ultrasonic sensors, Node RED, Servomotors, and GPS sensors are integrated.

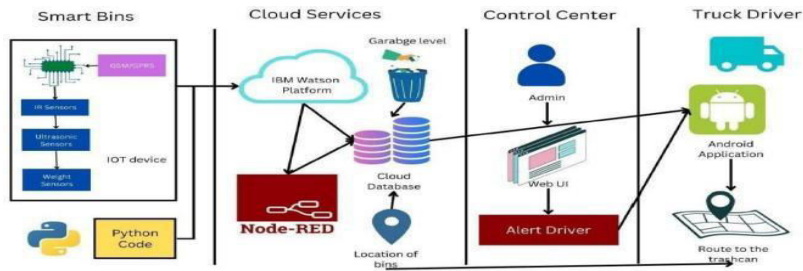


Fig 1: Block Diagram

### A. Smart bins

A short overview is managing the collection of waste by using smart bins which alerts the garbage collector when it is full so, that they can be emptied. This is done by web application the circuit design and simulation is done by WOKWI platform when the circuit is simulated the ultrasonic sensor detects the level of garbage and when the threshold is crossed it gives an alert otherwise the level is considered as safe. The safe message is viewed on the test simulation. The hardware is programmed using python which when it executed gives the level of garbage and weight along with latitude and longitude values to track the location of bins.

### B. Cloud services

The python program is done along with the provided IBM credentials, it is just random execution before the hardware connection. The backend connection is done by using IBM Watson IOT platform where the devices are added by using API key and each device has a unique id and recent event tab shows live stream of data coming and going from any devices. Many devices can be added or removed. The sensor value received in JSON format every time when the program is executed. Node-red is used to create a web application it is a programming tool for wiring together hardware devices, APIs, etc. Separate nodes are created for GPS, distance, latitude, longitude, and notification.

Each node has its own property that can be edited when each node is clicked a separate window opens to reveal its property and the message it has to return. Each node is connected to the respective function like ultrasonic sensor node connected to distance node, latitude and longitude node is connected to the GPS node and ultimately GPS node connected to World map. A separate node is created for data storage in the cloud after editing the values of each node deployment is done after the successful deployment. The cloudantDB is the database which stores the sensor data in different formats like in table, metadata, and in JSON.

### C. Control center

Copying the URL copy it into a new tab to view the map's default monitoring; this is the setup place for the smart bins. The location of the bins, as well as the amount and weight of the trash, are shown on the map. When the bins change, the administrator checks the Web UI whether the bins are filled, and the garbage collector is sent a warning signal.

### D. Truck driver

When the notification is sent through a web application, the truck driver goes to the appropriate spot. Curbside collector searches for the shortest route before arriving at the specified place.



Fig 2: Smart Bin Location

#### IV. COMPONENTS AND TECHNOLOGY

##### I. HARDWARE:

###### A. Ultra sonic sensor

It measures the distance of top of garbage to the base of it using ultrasonic waves. A transducer is used to send and receive ultrasonic pulses. As the name, ultrasonic sensors indicates to measure the level of garbage bins by using ultrasonic waves. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic Sensors measure the level of garbage to the target by measuring the time between the emission and reception.

###### B. Lithium Ion Battery

A lithium-ion (Li-ion) battery is an advanced battery technology that uses lithium ions as a key component of its electrochemistry, positive to the negative electrode.

###### C. Wifi Module

A self-contained SOC with integrated TCP/IP protocol stack, the ESP8266 WIFI Module allows any microcontroller to access your WIFI network. Data transmission and reception over Wi-Fi are handled by WIFI modules or WIFI microcontrollers. They can also be utilised for device-to-device communication. The Internet of Things is where they are most frequently used.

##### II. SOFTWARE:

###### A. Application

It is the platform for interacting with user and the admin (municipality corporation). Admin verifies the Web UI and alerts the truck driver to collect the garbage.

Programming Language: Python

###### B. Wokwi:

This proposed system can create paper with the browser-based Wokwi Arduino simulator. Numerous Arduino boards, including the Arduino UNO, Arduino Mega, and Arduino Nano, are available. Many different peripherals are included, including LEDs, resistors, pushbuttons, slide switches, OLED displays, humidity sensors, PIR motion sensors, and more! All of these accessories are available for free usage when creating your own paper.

A substitute for Tinker cad's Arduino simulator is the wokwi Arduino simulator. The circuit design and simulation are done by using wokwi platform when the circuit is simulated the ultrasonic sensor detects the level of garbage and when the threshold is crossed it gives a alert otherwise the level is considered as safe.

###### C. Node red:

Node red is used to create a web application. It is a programming tool for wiring together hardware devices API etc. Separate nodes are created for GPS, distance, latitude, longitude and notification. Each nodes have its own property that can be edited when each node is clicked a separate window opens to reveal its property and the message it has to return. The output as the program is executed. Each node is connected to respective function like ultrasonic sensor node connected to distance node Latitude and longitude connected to GPS node and ultimately GPS node connected to World map

#### 4. Smart bin when it should be collected:

When the distance is varied and the weight is changed there is a popup notification. So when the distance and weight exceeds the threshold value then the garbage should be collected. When the smart bin is fill it will be collected by the garbage collector. Detection of garbage levels in containers. Getting the garbage's weight into the trash can. When ever the bins are full, it notifies the designated person to empty the trash. Through a web app, the garbage level in the bins

can be tracked. By sending a GPS location from the device, we can use the web application to see where each bin is located.



Fig 3: Weight of the bin

### V. DATA FLOW DIAGRAM

The traditional visual representation of how information moves through a system is a data flow diagram (DFD). A tidy and understandable DFD can graphically represent the appropriate amount of the system requirement. It demonstrates how information enters and exits the system, what modifies the data, and where information is kept.

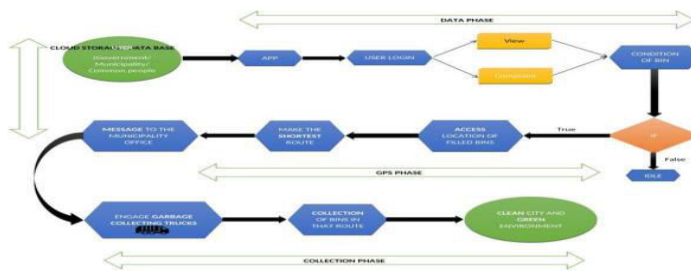


Fig4: Data Flow Diagram

### VI. CONCLUSION

A Smart Waste Management system that is more effective than the one in use now is achievable by using sensors to monitor the filling of bins. Our conception of a "smart waste management system" focuses on monitoring waste management, offering intelligent technology for waste systems, eliminating human intervention, minimizing human time and effort, and producing a healthy and trash-free environment. The suggested approach can be implemented in smart cities where residents have busy schedules that provide little time for garbage management. If desired bins might be put into place in a metropolis where a sizable container would be able to hold enough solid trash for a single unit. The price might be high.

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