Intelligent Garbage Collection Using IoT

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Abstract- *The paper is presenting an IoT based framework for garbage collection. The framework is designed to collect garbage in metro cities in a niftier way, each dustbin will be fitted with sensors and communication modules, which will inform the central command regarding the garbage level, and besides this they will have priority level. Depending on the garbage level, the collection van will visit only full garbage bins, and this will save energy and time. Different types of garbage will be having different priority. Also it will maintain the frequency and presence of garbage collection van, bringing transparency and accounting in the process.*

Keywords- IoT, RFID, Smart Cities.

I. INTRODUCTION

Origin of the research problem:

Overflowing trash bins have been another cause of concern for residents in all metropolitan cities. With drastic upsurge in population, the state of sanitation with respect to garbage management is degrading immensely. There have been lots of issues in Mumbai city itself regarding the garbage collection and disposal. With the already prevailing diseases, the open containers are substantiating to be breeding grounds for microorganisms. Usually, municipalities function on weekly routes to pick up trash and recyclable waste on assigned days, regardless of whether the containers are full or not. Apart from these, there is no prioritization of garbage collection spots to be visited depending on the rate of trash generation, type of garbage and sensitivity of the area. This is shown in Figure.1, where the garbage collection truck is visiting all the bins on the path, whether they are full or not and collecting the garbage. [1]

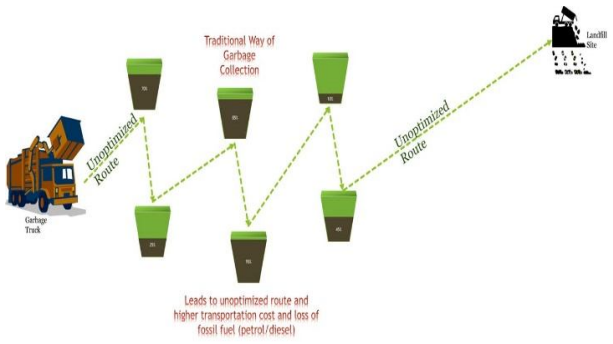


Figure 1. Traditional Garbage Collection System

II. LITERATURE SURVEY

The waste collection process in major cities involve a worker collecting the waste by walking from door-to-door or the residents themselves carry the waste to the nearest garbage bin which is made available to that specific area. The fact that this work mostly involves manual work it is prone to errors thus leading to inefficient disposal of garbage. Furthermore, we know that garbage from the municipality bins is collected and taken for disposal using trucks, if these trucks are filled up to their threshold capacity in middle of the garbage collection process than the remaining garbage bins may just be ignored, thus leading to overflowing garbage bins in some areas. Hence, people tend to dispose off the waste in this overflowing garbage bins and open areas.

To tackle this issues many people have proposed their ideas and various research have been done so far. In [3] authors discussed about Radio Frequency Identification ,Geographic Information Systems (GIS), Geographic Positioning System (GPS), transportation model, trash collection with bin monitoring application. In [5] some studies have done on real time bin monitoring but with some limitations. The researchers collected bin data using GSM/GPRS communication from the bin to the server, which comprises of GSM/GPRS connectivity to each bin causing a large increase of operating cost. In [6] authors used wireless sensor network for monitoring the bins. The researchers used Argos mote with geographical coverage of 430m and the system considers only one parameter for the bin status. Another approach uses wireless sensor network and can respond as soon as someone throw waste inside a bin. The aim of this work is to design a framework that can collect data on bin status in real time, which in turn helps to optimize waste collection. In [7] authors proposed a dynamic routing algorithm, it deals with situations such as when a truck get overloaded or has some problems and need replacement, there they assumed two kinds of trucks for waste collection, low capacity also known as the Low Capacity Trucks (LCTs) and High capacity also known as the High Capacity Trucks (HCTs). In [8] the authors propose to implement Cloud based system for collection and maintenance of waste using Wireless Sensor Nodes and Wireless Personal Area Networks (WPANs).The problem here is the implementation and maintenance cost. In [9] authors have used Dijkstra's algorithm for computing shortest path. They also suggested

Floyd-Warshall based variants algorithm as an alternative approach for finding shortest path. In [10] authors have suggested different algorithms to calculate amount of garbage in bins, and (shortest path algorithm) optimized route for collection of garbage.

The foremost difficulties of the existing solid waste collection process and management system are as follows:

i) Insufficient information about the collecting time and area.
ii) No proper system for observing, tracing the trucks and garbage bins that have been gathered in real time
iii) Less productivity due to inefficient and poor utilization of vehicles.
iv) Poor risk management strategies for risks such as truck accident, failure.
v) Poor communication and response to civilian complaints.

III. PROPOSED WORK

Proposed work aims to optimize trash collection and ultimately reduce fuel consumption. When holders are situated at particular position smartphone is required to detect its particular latitude and longitude for single time. This decreases the rate of overall system; as GPS will not be required then.

Basically, the framework will shoot sonar waves to know how much waste is inside the container. Data gathered from the sensors are sent over a network (Wi-Fi or GPRS) for analysis and displayed on web platform which is a website for customers.

A list of containers from which garbage is to be collected can then be sent to drivers to plan an efficient route. The project also includes real-time monitoring of civic body's garbage vehicles using RFID. The truck owner has to flash his RFID card so that who when and at what time garbage bins were emptied can be accounted for. It will curb laziness of municipality's garbage collectors [1] [2].Besides this the garbage bins will be given priority tags as follows:

1. Hospital Waste
2. Biodegradable waste
3. Recyclable waste
4. Electronic waste
5. Non-Recyclable waste

Depending on their surroundings and contents of the waste the garbage collection system will be given priority.

Optimized paths can be calculated using Dijkstra's algorithm or any other shortest path algorithm as mentioned in [9] [10].

Figure 2. Garbage collection on Optimized Route

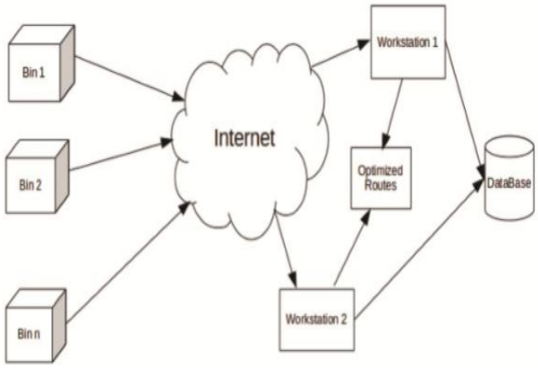


Figure 3. System Architecture [11]

The architecture consists of following:

A. Garbage bins: They are fitted with Arduino UNO boards which will sense the amount of garbage in the bins along with other information such as temperature and humidity.
B. Workstations: Every region will have a workstation/server at the municipal office. These workstations/server receive and stores the data sent by the smart bins in that region in real-time. The workstation then calculates the shortest path to collect maximum waste in that region by considering bins filled more than some threshold value. The workstations predict estimated fill-up dates for other remaining bins, and predicts estimated dates to collect that waste. These workstations backup all the data at the end of the day to a central server.
C. Central Server: All data generated will be stored in this central server which thus can be used for generation of reports and there making sure the system is running efficiently.

D. Web Interface: This can be used by civilians, Government officials or any other organizations to monitor or review the garbage collection process or to lodge a complaint.

Apparatus of the required Implementation

- HC-SR04 Ultrasonic sensor
- ESP8266 Wi-Fi module
- Arduino Uno – Microcontroller Module
- SIM 900 GSM Module
- 7833 voltage divider
- Breadboard
- Connecting wires
- Batteries

1. HC-SR04 Ultrasonic Sensor:

This type of sensor is utilized for measurement of the distance with high precision and stable readings. It can measure distance from 2cm to 400cm or from 1 inch to 13 feet. It discharges an ultrasound wave at the frequency of 40 KHz in the air and if the entity will come in its way then it will bounce back to the sensor. By using that time which it takes to reach the object and comes back, you can measure the distance.

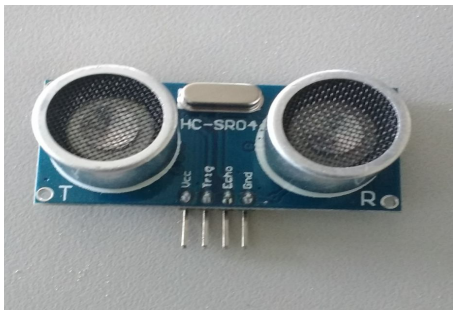


Figure 4. HC-SR04 Ultrasonic Sensor

The ultrasonic sensor has four pins. Two are VCC and GND which will be linked to the 5V and the GND of the Arduino while the other two pins are Trig and Echo pins which will be connected to any digital pins of the Arduino. The trig pin will send the signal and the Echo pin will be used to receive the signal. To produce an ultrasound signal, we will have to make the Trig pin high for about 10us which will send a 8 cycle sonic burst at the speed of sound and after hitting the object, it will be redirected to the Echo pin.

2. ESP8266 Wi-Fi Module:

ESP8266 is a Wi-Fi module which will give this project access to Wi-Fi or internet. It is a very inexpensive device but it will make your projects very influential. It can communicate with any microcontroller and make the projects wireless. It is in the list of most leading devices in the IOT platform. It runs on 3.3V power supply and if you will give it 5V power supply then it will get damage.

Figure 5. ESP8266 Wi-Fi Module

The ESP8266 has 8 pins; the VCC and CH-PD will be attached to the 3.3V to enable the Wi-Fi. The TX and RX pins will be liable for the communication of ESP8266 with the Arduino. The RX pin works on 3.3V so it is mandatory to use voltage divider for it.

3. Circuit Diagram and Explanation:

First of all we will connect the ESP8266 with the Arduino. ESP8266 runs on 3.3V power supply and if you will give it 5V power supply from the Arduino then it won't work properly and it may get damage. Link the VCC and the CH_PD to the 3.3V power supply pin of Arduino. The RX pin of ESP8266 usually works on 3.3V power supply and it will not communicate with the Arduino when we will connect it directly to the Arduino. So, we will have to use a voltage divider for it. The 7833 voltage divider will do the work for us. Link the Vin pin of 7833 to the pin 11 of the Arduino and link the Vout pin of 7833 and RX of esp8266 as shown in the figure below and also the TX of the Arduino to the pin 10 of the Arduino.

Now it's time to connect the HC-SR04 ultrasonic sensor with the Arduino. Connections of the ultrasonic sensor with the Arduino are very simple. Connect the VCC and the ground of the ultrasonic sensor to the 5V and the ground of the Arduino. Then link the TRIG and ECHO pin of ultrasonic sensor to the pin 8 and 9 of the Arduino respectively.

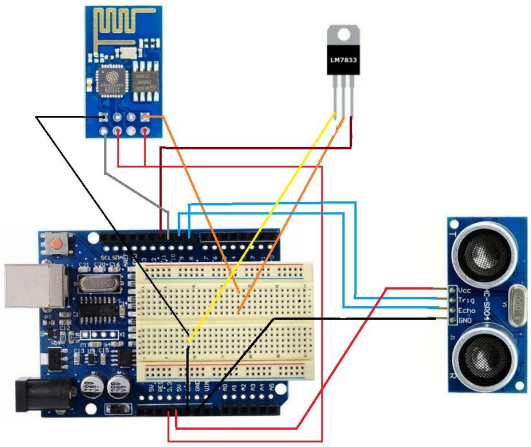


Figure 6. Circuit Diagram for Wifi-Connectivity and Bin content level detection

Connections for this Temperature and Humidity Monitoring module are very simple. Here a LCD is used for displaying Temperature and Humidity, which is directly connected to Arduino in 4-bit mode. Pins of LCD are namely RS, EN, D4, D5, D6 and D7 are linked to Arduino digital pin number 14, 15, 16, 17, 18 and 19. This LCD is voluntary.

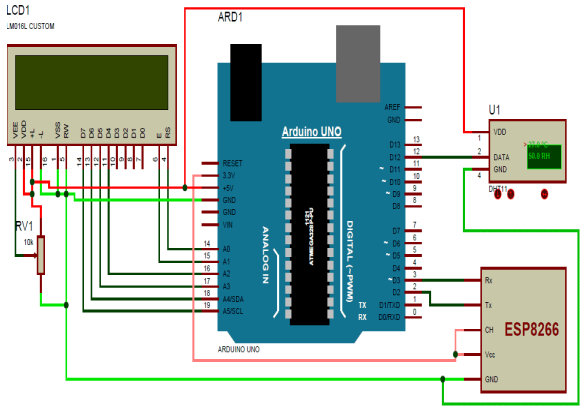
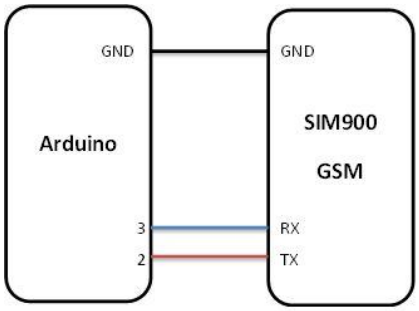


Figure 7. Circuit Diagram for Wifi-Connectivity and Bin content level detection

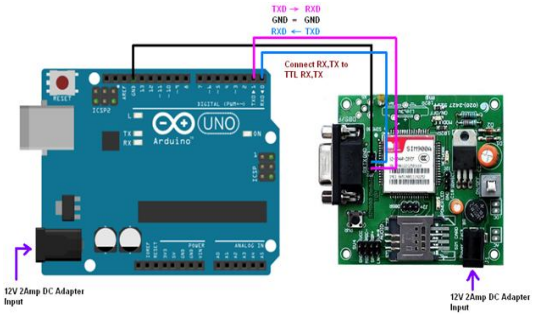
DHT11 Sensor Module is linked to digital pin number 12 of Arduino. Wi-Fi module ESP8266's which comprises of Vcc and GND pins are directly linked to 3.3V and GND of Arduino and CH_PD is also connected with 3.3V. TX and Rx pins of ESP8266 are straight linked to pin 2 and 3 of Arduino. Software Serial Library has been used here to allow serial communication on pin 2 and 3 of Arduino. This is the very first part of the Intelligent Garbage Bin, in this IoT part we are going to Monitor Humidity and Temperature over the internet using Thing Speak where we will show the current Humidity & Temperature data over the Internet using the ThingSpeak server. It is consummate by the data communications between Arduino, DHT11 Sensor Module, LCD and ESP8266 WIFI module. Celsius scale thermometer and percentage scale humidity meter displays the ambient temperature and humidity through a LCD display and also sends it to ThingSpeak server for live monitoring from anywhere in the world.

4. GSM Interface – for GSM Connectivity (If Wi-Fi is not available)

This module is used for informing the control center about the status of the Bin if the Wi-Fi signal is not available, this will use the GSM network and send the details over it. For this connectivity we are using GSM 900 GSM module linked to Arduino. This is shown below.



(a)



(b)

Figure 8. Circuit Diagram for GSM-Connectivity and Bin content level detection.

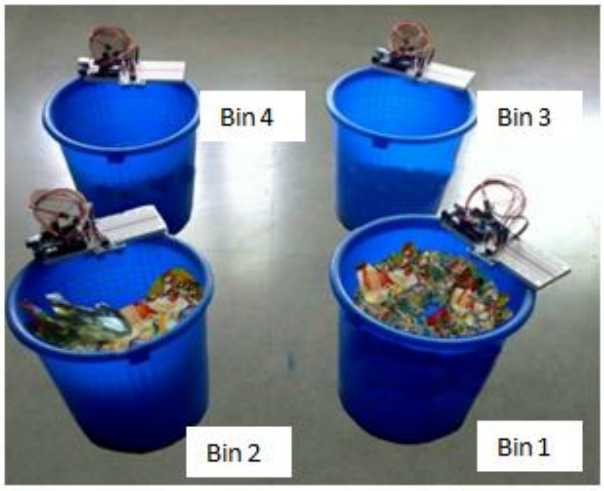


Figure 9.1. Dustbins with garbage

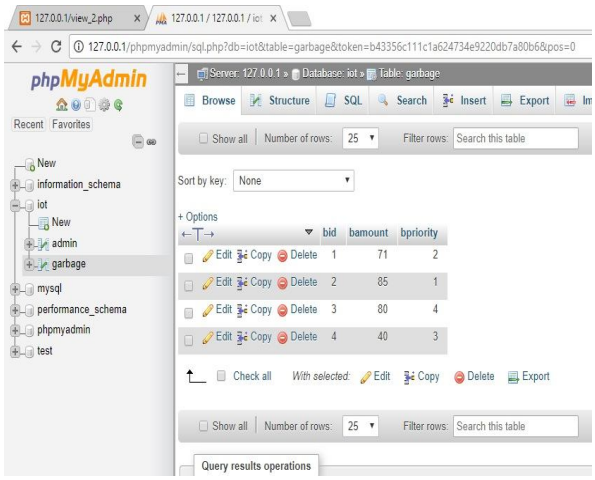


Figure 9.2. Screenshot of database

bid	bamount	bpriority
1	85	2
2	80	1
3	40	4
4	60	3

Figure 9.3 Tabular representation of data

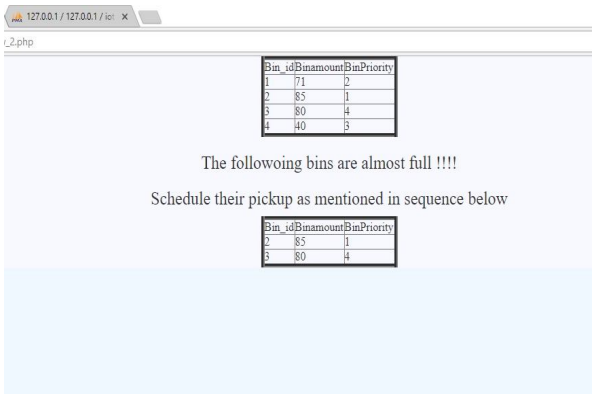


Figure 9.4. Screenshot of alert

Figure 9. The Prototype of System.

Figure 10. The Final System.

V. CONCLUSION

The proposed system will save the fuel, cost and bring accountability in the Garbage collection process, by smartly detecting the level of bins, and prioritize them to guide the garbage collection van for optimum path, time and fuel consumption. It will bring transparency and accountability in the garbage collection process. Also the scope of this system will not be restricted to smart cities, it can also be implemented in less developed cities or towns with no or little modifications in existing systems. Thus leading to clean and healthy environment.

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