SMART WASTE MANAGEMENT SYSTEM

USING IOT

A Project report submitted in partial fulfilment of 7th semester in degree of

BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE AND ENGINEERING

Submitted by

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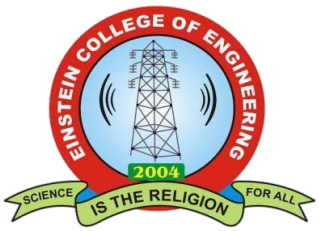

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BONAFIDE CERTIFICATE

Certified this Report “SMART WASTE MANAGEMENT SYSTEM” for the project, is the bonafide work of R.ASHA DEVI(950619104009) S.GAYATHRI (950619104020)V.GOWSALYA(950619104022)W.JESSYANGEL(950619104026) who carried out the project work under my supervision. Certified further that to the best of my knowledge the work reported here in does not from part of any other thesis or dissertation on the basis of which a degree or award was co-offered on the earlier occasion this or any other candidate.

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CHAPTER 1
INTRODUCTION

Today big cities around the world are facing a common problem, managing the city waste effectively without making city unclean. Today's waste management systems involve a large number of employees being appointed to attend a certain number of dumpsters this is done every day periodically. This leads to a very inefficient and unclean system in which some dumpsters will be overflowing some dumpsters might not be even half full. This is caused by variation in population density in the city or some other random factor this makes it impossible to determine which part needs immediate attention. Here a waste management system is introduced in which each dumpster is embedded in a monitoring system that will notify the corresponding personal if the dumpster is full. In this system, it is also possible to separate wet and dry waste into two separate containers. This system provides an effective solution to the waste management problem.

1.1 PROJECT OVERVIEW

In our project we are getting the data from sensor and sending messages to the webpage cloud server so the respective authorities can give the instructions to cleaning staff to collect the garbage from exact locations. We are going to propose a system for the immediate cleaning of the dustbins. As dustbin is considered as a basic need to maintain the level of cleanliness in the city , so it is very important to clean all the dustbins as soon as they get filled.

We will use ultrasonic sensors for this system. The sensor will be placed on Top of bin which will help in sending the information to the respective authorities that the level of garbage has reached its maximum level. After this the bin should be

emptied as soon as possible. The concept of IOT when used in this field will result in a better environment for the people to live in. No more unsanitary conditions will be formed in the city. With the help of the system minimal number of smart bins can be used around the whole city and the city will be much cleaner.

1.2 PURPOSE

With an increase in population at an unprecedented rate, the scenario of cleanliness with respect to garbage management in terms of collection, sorting and finally disposal is facing an increasing number of challenges .The overflow of garbage in public areas creates the unhygienic condition in the nearby surrounding which may cause serious diseases. To avoid this and to automate the cleaning and ensure end to end efficient garbage disposal “IOT BASED SMART WASTE MANAGEMENT SYSTEM” is proposed.

CHAPTER 2
LITERATURE SURVEY

2.1 EXISTING PROBLEM

In the existing system garbage is collected by corporation by weekly once or by 2 days once. Tough the garbage shrinks and overflows the garbage bin and spread over the roads and pollutes the environment. The smell will be heavy and produces air pollution and spreads disease. The street dogs and animals eat the waste food and spreads over the area and creates dirty environment to avoid such situation we are planning to design IOT Based Garbage Management For Smart Cities.

2.2REFERENCES

- Smart Garbage Monitoring System for Waste Management - MATEC Web of Conferences – 2017
- Xu Li, Student Member, IEEE, Performance Evaluation of Vehicle-Based Mobile Sensor Networks for Traffic Monitoring.
- Xu Li, Student Member, IEEE, Performance Evaluation of Vehicle-Based Mobile Sensor Networks for Traffic Monitoring.
- www.setfirelabs.com(ultrasonic sensor interfacing with arduino and node MCU)

2.3PROBLEM STATEMENT DEFINITION

This project combats the problem of overflowing solid waste bins which pollute the surroundings. The level of garbage present in any bin is determined by the ultrasonic distance measuring sensor. When the garbage level in any garbage bin exceeds a pre-

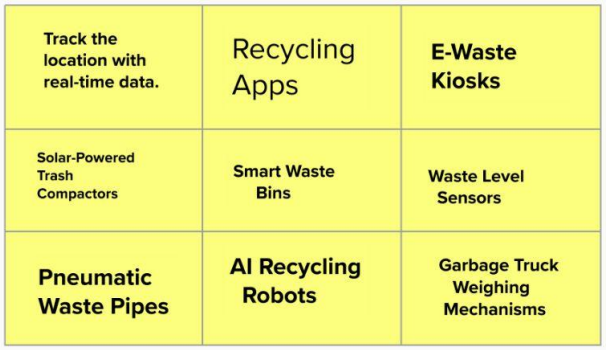
defined level, then the microcontroller send an alert message to the e-monitoring station, and, the workstation then assigns the nearest garbage collecting truck to collect the garbage from such bins, which have sent an alert message. It informs when the container is at full capacity and when it needs to be emptied, thus allowing the sanitation specialists to work more efficiently and cut unnecessary costs.

CHAPTER 3

IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

3.2 IDEATION & BRAINSTORMING



3.3 PROPOSED SOLUTION

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	With the existing methods of collecting and disposal it is near impossible to manage such amount of waste in the future as around 30% of waste end up on the roads and public

		places due to ineffective disposing and collecting methods.
2.	Idea / Solution description	Smart waste management is about using technology and data to create a more efficient waste industry. Based on IoT (Internet of Things) technology, smart waste management aims to optimize resource allocation, reduce running costs, and increase the sustainability of waste services.
3.	Novelty / Uniqueness	Through its unique smart waste management technology, Sensoneo is redefining the way waste is managed. Sensoneo solutions cover from asset tracking for bins all the way to the automated on-demand collection planning
4.	Social Impact / Customer Satisfaction	Using IoT and smart sensors, waste management companies can increase operational efficiency, cut costs, and enhance customer satisfaction
5.	Business Model (Revenue Model)	Waste Management generates revenue through the provision of various

		waste management and disposal services and recycling solutions to residential, commercial, industrial, and municipal clients. The Company derives its revenue in the form of various fees associated with its service offerings
6.	Scalability of the Solution	scalable system for waste bins that can senseand send accurate waste level of the bins while consuming lessresources and having cost-effective components. The system operates by utilizing ultrasonic sensors that senses and transmits waste fill-level estimations. The system wasmodelled, simulated using MATLAB and physical implemented. In the implementation, RFID technology is employed having an active RFID tags that stores the information as well as RFID readers that reads and interpret the information.

3.4 PROBLEM SOLUTION FIT

Project Title: Smart Waste Management System For Metropolitan Cities | Project Design Phase-I - Solution Fit Template | Team ID: PNT2022TMID49848

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

The process by which you divide your customer into segment based on common characteristic

6. CUSTOMER CONSTRAINTS CC

The process is not always cost-effective
The resultant product has a short life

5. AVAILABLE SOLUTIONS AS

The sources of Smart Waste Managenent include presidential,commercial,and industrial.

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS J&P

Create and put the plans in place to provide a reliable and efficient service for the collection, transportation and disposal of waste

9. PROBLEM ROOT CAUSE RC

Lack of Public Awareness
Refusal to Learn About Compliance
Insufficient Investment in Waste Management
Lack of Proper Machinery

7. BEHAVIOUR BE

Use sensors placed in waste receptacles to measure fill levels and to notify city collection services when bins are ready to be emptied.

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS TR

It provide hygienic, efficient and economic solid waste storage, collection, transportation and disposal of waste without polluting the atmosphere..

4. EMOTIONS: BEFORE / AFTER EM

It performs intelligent compaction of waste by monitoring fill level in real-time using sensors

10. YOUR SOLUTION SL

Smart waste management focuses on solving solid waste management problems using sensors, intelligent monitoring systems, and mobile applications. The first smart waste management solution to make the waste collection process more efficient is sensors.

8. CHANNELS of BEHAVIOUR CH

Smart waste management is also about creating better working conditions for waste collectors and drivers

Identify strong TR & EM

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Login	Login through Email Login through Gmail
FR-4	Dashboard	Access the dashboard

4.2 NON - FUNCTIONAL REQUIREMENTS

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	A smart application has been proposed to make the waste sorting more simple and accurate, and improve the user experience, usability, and satisfaction
NFR-2	Security	This waste segregation at initial level will make the recycling process easy and addresses major environmental issues.

NFR-3	Reliability	Developed to estimate the reliability of a smart waste management system. Provided information regarding the possibility to finish the clean-up in time.
NFR-4	Performance	helped in improving levels of hygiene and sanitation, green waste reuse
NFR-5	Availability	Based on IoT x (Internet of Things) technology, smart waste management aims to optimize resource allocation, reduce running costs, and increase the sustainability of waste services.
NFR-6	Scalability	Based on IOT (Internet of Things) technology, smart waste management aims to optimize resource allocation, reduce running costs, and increase the sustainability of waste services.

CHAPTER 5

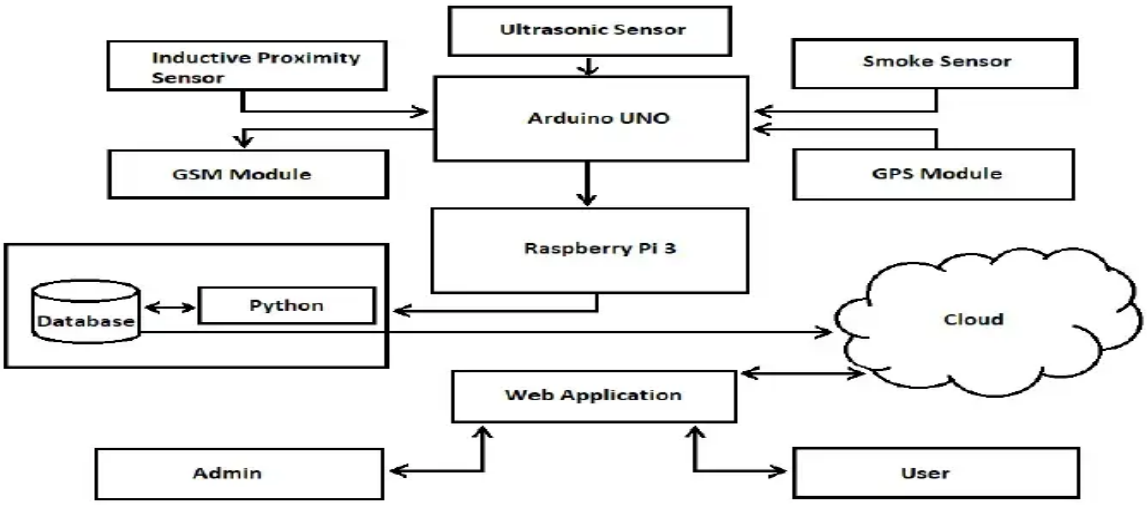
PROJECT DESIGN

5.1 DATA FLOW DIAGRAM

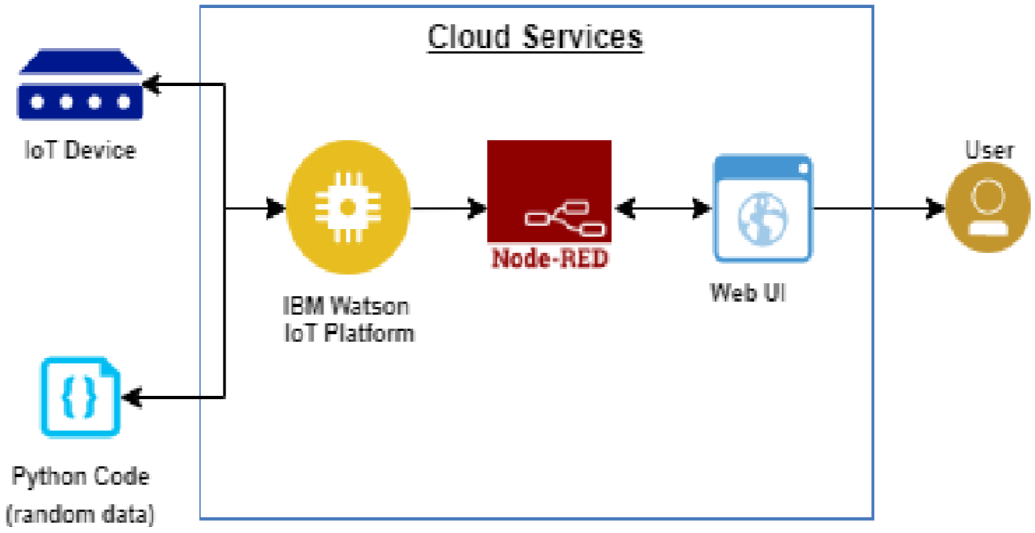
5.2 SOLUTION & TECHNICAL ARCHITECTURE

Solution Architecture

A system consist of an inductive proximity sensor on the conveyor belt and ultrasonic sensors at the top of the dustbin,a smoke sensor to detect fire sensor each smart bin is assigned with GPS to provide the location and a GSM to send the message to the workers. All the sensors and modules are connected directly to ardino and they are controlled by the Raspberry Pi board. Ardino’s programs monitors sensors and issusesaction based on the status of the bin.



Technical Architecture



5.3 USER STORIES

User Type	Functional Requirement (Epic)	User Story Number	User Story / Tas	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail		Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Sprint-1
	Dashboard					

CHAPTER 6

PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

Sprint	Functional Requirement(Epic)	User Story Number	User Story/Task	Story point	Priority	Team members
Sprint-1	Registration	USN-2	As a user, I can register for the application by entering my email, password, and confirming my password	2	High	R. Asha Devi
Sprint-1		USN-2	As a user, I will receive confirmation email once I have register for the application	1	High	R. Asha Devi
Sprint-2		USN-3	As a user, I can register for the application through Gmail	2	Low	V. Gowsalya
Sprint-1		USN-4	As a user, I can register	2	Medium	W. Jessy Angel

			for the application through Gmail			
Sprint-1	Login	USN-5	As a user, I can log into the application by entering email & password	1	High	R. Asha Devi

6.2 PRINT DELIVERY SCHEDULE

Sprint	Total Story point	Duration	Sprint Start Date	Sprint end Date(planned)	Story Point Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	26 Oct 2022	31 Oct 2022	20	31 Oct 2022
Sprint-2	20	6 Days	1 Nov 2022	6 Nov 2022	20	6 Nov 2022
Sprint-3	20	6 Days	7 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	13 Nov 2022	18 Nov 2022	20	18 Nov 2022

CHAPTER 7

CODING & SOLUTIONING

7.1 FEATURE 1

```
 #define trigPin 12
#define echoPin 13
void setup()
{
Serial.begin (9600);
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
}
void loop()
{
long duration, distance;
int max = 80; // Let consider as Height of the Garbage Bin is = 80 cm.
float diff, perc;
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance = (duration/2) / 29.1;
diff = max - distance; // 'diff' variable tells u that, how much the Garbage Bin is Left to fill.
perc = (diff/max)*100; // 'perc' variable tells u that, how much percentage the Garbage Bin is filled.
```

```
if (perc>=90)
{
Serial.println("Garbage Bin is FULL."); // When the Garbage Bin
is filled more than 90%, then this Error Message will Displayed.
}
else
{
Serial.print("Garbage Bin is Filled ");
Serial.print(perc);
Serial.println(" %."); // These 3 Lines are print, that howmuch the Garbage Bin is Filled...Ex. "Garbage Bin is Filled 70%.".
}
/*
if (distance >= 400 || distance <= 2)
{
Serial.println("Out of range");
}
else
{
Serial.print(distance);
Serial.println(" cm");
}
*/
```

7.2 FEATURE 2

```
import requests
import json
import ibmiotf.application
```

```
import ibmiotf.device
import time
import random
import sys
# watson device details
organization = "4yi0vc"
devicType =  "BIN3"
deviceId = "BIN3ID"
authMethod= "token"
authToken= "123456789"
#generate random values for randomo variables (temperature&humidity)
def myCommandCallback(cmd):
  global a
    print("command recieved:%s" %cmd.data['command'])
    control=cmd.data['command']
    print(control)
try:
        deviceOptions={"org": organization, "type": devicType,"id": deviceId,"auth-
method":authMethod,"auth-token":authToken}
        deviceCli = ibmiotf.device.Client(deviceOptions)
except Exception as e:
        print("caught exception connecting device %s" %str(e))
        sys.exit()
#connect and send a datapoint "temp" with value integer value into the cloud as a type
of event for every 10 seconds
deviceCli.connect()
```

```
while True:
    distance= random.randint(10,70)
    loadcell= random.randint(5,15)
    data= {'dist':distance,'load':loadcell}
    if loadcell < 13 and loadcell > 15:
       load = "90 %"
    elif loadcell < 8 and loadcell > 12:
         load = "60 %"
    elif loadcell < 4 and loadcell > 7:
         load = "40 %"
    else:
         load = "0 %"
    if distance < 15:
         dist = 'Risk warning:' 'Dumpster poundage getting high, Time to collect :) 90 %'
    elif distance < 40 and distance >16:
         dist = 'Risk warning:' 'dumpster is above 60%'
    elif distance < 60 and distance > 41:
         dist = 'Risk warning:' '40 %'
    else:
         dist = 'Risk warning:' '17 %'
    if load == "90 %" or distance == "90 %":
     warn  = 'alert :' ('Risk Warning: Dumpster poundage getting high, Time to collect :)'
    elif load == "60 %" or distance == "60 %":
         warn = 'alert :' 'dumpster is above 60%'
    else :
         warn = 'alert :' 'No need to collect right now '
```

```
    def myOnPublishCallback(lat=10.939091,long=78.135731):
        print("Thirumanilayur, Karur")
        print("published distance = %s " %distance,"loadcell:%s " %loadcell,"lon = %s "
%long,"lat = %s" %lat)
        print(load)
        print(dist)
        print(warn)
        time.sleep(5)
    success=deviceCli.publishEvent ("IoTSensor","json",warn,qos=0,on_publish=
myOnPublishCallback)
    success=deviceCli.publishEvent("IoTSensor","json",data,qos=0,on_publish=
myOnPublishCallback)
    if not success:
        print("not connected to ibmiot")
    time.sleep(5)
    deviceCli.commandCallback=myCommandCallback
#disconnect the device
deviceCli.disconnect()
```

7.3 DATABASE SCHEMA

1) User
    a) User_id
    b) Email_id
    c) Gender
    d) Occupation
    e) Name
    f) Address_line_1

g) Address_line_2
h) garbage_collection_area.area_id
i) Mobile
j) Age

2) Garbage_collection_area
    a) Area_id
    b) Name
    c) Latitude
    d) Longitude
3) User Waste production
    a) Date
    b) User_id
    c) Biodegradable_weight
    d) Nonbiodegradable_weight
4) Vehicle
    a) Vehicle_id
    b) Driver_name
    c) Driver_phone
    d) Garbage_collection_area.area_id
5) Complaint/Query/Suggestion
    a) Complaint_id
    b) User_id
    c) Complaint_text
    d) Image_source
    e) Garbage_collection_area.area_id
    f) complaint_date
    g) Complaint_time

h) Complaint_resolved_time
i) Complaint_resolved_date
j) Complaint_status

6) Collection data
   a) Date
   b) Time
   c) Area_id
   d) Vehicle_id

CHAPTER 8

TESTING

8.1 TEST CASES

Test case description	**Required input**	**Information and related requirements**	**Test case status indicating pass or fail**
The user or concerned service provider should register with the required details	User input details for registration	User name,email ID, Phone Number, and security password	Pass
The user or concerned service provider tried to log in to the monitoring portal with registered details	User login details	User name,security password	Pass or fail
Monitoring website portal indicating home,user,SGB status	User monitoring home screen should be display	The developed prototype for Smart Garbage Bin must be kept ‘ON’	pass

8.2 USER ACCEPTANCE TEST

Test case description	**Testcase notation**	**Input**	**Requirement**	**Test case status**
Sends an alert message and displays on the web browser monitoring page as garbage bin found to be	T1	Null	Garbage bin should not have waste in it	Pass

‘EMPTY’.				
Sends an alert message and displays on the web browser monitoring page as garbage bin found to be ‘MEDIUM’.	T2	Garbagr filling	Garbage bin should be filled to its intermediate level	Pass
Sends an alert message and displays on the web browser monitoring page as garbage bin found to be ‘NEARLY FULL’.	T3	Garbage filling	Garbage bin should be filled to its maximum level	Pass
Sends an alert message and displays on the web browser monitoring page as garbage bin found to be ‘FULL’.	T4	Filled	Garbage bin should be filled to a level that crosses the threshold limit	Pass
Sends an alert message and displays on the web browser monitoring page as garbage bin found to be ‘THRESHOLD CROSSED’.	T5	Spill over		pass

CHAPTER - 9

9.1 Performance Metrics

This system monitors the garbage bins and informs about the level of garbage collected in the garbage bins via a web page. For this the system uses ultrasonic sensors placed over the bins to detect the garbage level and compare it with the garbage bins depth.

CHAPTER - 10

Advantages

- It saves time and money by using samrt waste collection bins and systems eqipped with fill level sensors. As smart transport vehicles go only to the filled by containers or bins. It reduces infrastucture,operating and maintenance costs upto 30%.
- It decrease traffic flow and consecutively noise due to less air pollution as result of less waste collection vehicles on the roads.This has become possible due to two way communication between smsrt dustbins and service operators.
- It keeps our surroundings clean and green and free from bad odour of wastes, emphazes on healthy environment and keep cities more beautiful.
- It further reduces man power requirements to handle the garbage collection process.
- Applying smart waste management process to the city optimizes management, resources and costs which makes it a “smart city”

Disadvantages

- System requires more number of waste bins for separate waste collection as per population in the city. This results into high initial cost due to expensive smart dustbins compare to other methods.
- Sensor nodes used in the dustbins have limites memory size.
- Wireless technologies used in the system such as zigbee and wifi have shorter range and lower data speed, In RFID based systems, RFID tags are affected by surrounding metal objects.
- It reduces man power requirements which results into increase in unemployments

for unskilled people.

- The training has to be provided to the people involved in the smart waste management system.

CHAPTER 11

CONCLUSION

On the final note, it can be inferred that, a real time waste managemet system is the key to achive a better waste management system. This would optimize logistics and human resources for any morden municipal agency. The above proposed waste management system would solve various scenario specific issues in morden cities when it comes to waste collection and disposal to ensure better community hygiene. As discussed, this submitted sytsem would be cost effective solution to achieve a real – time waste bin level sensing by reliable and centralized cloud data intergration. The prototypes and proof of concept shown in this paper can be upgraded to industry standard hardware and software for real world deployement. But point to be noted the concept, idea, systematic, approach and technique used will remain unchanged. Further as discussed work as opened new opportunities to work in the domain of data analytics to further optimze the based collection vechile route by implementing better algorithms with more relevant and practical parameters, which may come in to picture in a real world scenario.

CHAPTER 13

APPENDIX

SOURCE CODE

```
#define trigPin 12
#define echoPin 13
void setup()
{
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pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
}
void loop()
{
long duration, distance;
int max = 80; // Let consider as Height of the Garbage Bin is = 80 cm.
float diff, perc;
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance = (duration/2) / 29.1;
diff = max - distance; // 'diff' variable tells u that, how much the Garbage Bin is Left to fill.
```

```
perc = (diff/max)*100; // 'perc' variable tells u that, how much percentage the
Garbage Bin is filled.
if (perc>=90)
{
Serial.println("Garbage Bin is FULL."); // When the Garbage Bin
is filled more than 90%, then this Error Message will Displayed.
}
else
{
Serial.print("Garbage Bin is Filled ");
Serial.print(perc);
Serial.println(" %."); // These 3 Lines are print, that howmuch the Garbage Bin is
Filled...Ex. "Garbage Bin is Filled 70%.".
}
/*
if (distance >= 400 || distance <= 2)
{
Serial.println("Out of range");
}
else
{
Serial.print(distance);
Serial.println(" cm");
}
*/
```

GITHUB LINK

https://github.com/IBM-EPBL/IBM-Project-47594-1660800362

PROJECT DEMO LINK

https://youtu.be/6yakTWpYjIM