IoT BasedSmart Waste Management System: India prospective

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Abstract- For building smart cities there is requirement of such a smart system which monitors the dustbin and providesits real time status. In present scenarioMunicipal Corporationsin India doesn't get real time information about the dustbins.In this concern, we are implementing a system based on Internet of Things (IoT) that can send a message to corporation about the overflow and toxicity level of the dustbins. A website is also developed to supervise the data related to the dustbins. Message is sent using GSM module to the mobile phone and data related to the dustbin status is updated on the website. At this website citizens can also submit complaints related to dustbin or waste management.In recommended system, Arduino is used as a microcontroller to interface between GSM/GPRS module with sensors. Ultrasonic sensor and gas sensor are used for measurement of dustbin level and toxicity respectively.

Keywords – Waste Management, IoT, Toxicity level, GSM/GPRS, Ultrasonic Sensor, Gas Sensor, Arduino, Microcontroller.

I. INTRODUCTION

India is one of the most populated country in which one sixth population of the world resides. As the population is high, a large amount of waste are produced from houses and industries. Sometimes waste is decomposed and produce unhygienic gases which pollute the environment[1] [2].

A huge amount of waste is produced from smart cities.Mumbai produce a huge waste amongst 46 other cities. It generates 11,000 tons of waste per day [3]. To manage this waste, dustbins are placed in different areas of a city but mainly they overflows and remains unattended. The municipal corporation doesn't get real time information about overflow of dustbins [2] [4].

We use dustbin to throw the waste but still there are some problem. Such as: -

• Sometimes waste is thrown outside the dustbin. It is not monitored.

• Harmful gases emerged from dustbin but there is no record of it.

• Dustbin overflows and are not cleaned timely.

• Generation of garbage can't be stopped but we can maintain and monitor it. It is necessary to manage the solid waste with proper database.

In India many of the streets are provided with dustbins. People throw their waste in these dustbins and they are cleaned by municipal corporation (MC). But sometimes dustbin overflows and are not cleaned timely. A smart system should be used to get the real time status of dustbin [5].

We are surrounded by technology in different forms so we should use it to get the real time monitoring of all the dustbins in any particular area. When dustbin gets full a message should be sent to the MC who is responsible to clean the dustbin. All the data of dustbin is stored for future use.

II. LITERATURE REVIEW

A large number of researches have been done on smart waste management system and few of them has a very good extent to abolish these problems.

P Haribabu et al. have made dustbin that was implemented using IoT [2]. They have used Arduino board, a GSM modem and the dustbin is equipped with Ultrasonic sensor (HC-SR04). Also, there was a buzzer and some Light Emitting Diodes (LED's) for the display of levels of dust in the bin. In the project "Cloud computing based smart garbage monitoring system"proposed by Jetendra Joshi et al., they are using ultrasonic sensor to measure the level of dustbin. They also provide the shortest path to reach the dustbin using app. Their approach is based on the Stack Based Front End method [5]."Smart garbage monitoring and clearance system using Internet of Things (IoT)" proposed by S. Vinoth Kumar et al. was a good idea but they were unable to predict the hazardous gas produced by the dustbin [6]. One more research done by Krishna Nirde et al. on "IoT based solid waste management system for smart city". They proposed the idea of real time monitoring of the dustbin from two sensing systems: waste filled level sensing, weight sensing.

They were sending a message if dustbin was full but weight sensing is not the ideal way to predict if dustbin is full or not [7].In other research done by Imteaj A et al. on "Dissipation of waste using dynamic perception and alarming system: A smart city application" they design an android based application. Through this application, people would be able to detect nearby dustbin locations with path on OpenStreetMap (OSM) [8].Ankitha S et al. proposed "Smart city initiative: Traffic and waste management" in which they are using smart dustbins with different ID numbers. When the dustbin is full then a message is sent to the server from where all garbage collection vehicles are connected [9].The paper of Trushali S. Vasagade et al. based on IoT they are using many sensors at different position to measure its respective parameters. They are using a sensor outside the container which detect the garbage that is thrown outside the container [10]. In "Autonomous smart waste collection system" proposed by Shujatullah Khan et al. they used Wi-Fi, Bluetooth, Zigbee and another module. Their smart Dustbin works on the basis of Infra-Red (IR) sensors. Global System for Mobile communication (GSM) modem is used to provide data to required authorities when the garbage reaches the threshold level [11]. Hence from all these researches we can say that smart waste management is majorly concerned problem and we can't avoid it.

III. PROPOSED METHODOLOGY

In this project we are using Internet of Thing (IoT) based technique and GSM/GPRS technique for interfacing between transmitter and receiver [7]. Our proposed "IoT based smart waste management system: India prospective" provide the real time status of dustbin. It measures the percent filling of the dustbin and level of toxicity. It sends data to website so it can be seen in future. It stores the time and date in the database with percent filling and toxicity level of the dustbin. It sends message to the concern person when dustbin is full or toxicity is high. Our whole system is described in the fig.1. Arduino is connected with ultrasonic sensor and Gas sensor that sends data through the GSM module to the municipal corporation.

The proposed system can also be understood using flow chart in fig.2.

1. Ultrasonic sensor senses the filling level of dustbin [4].

2. Gas sensor measures the toxicity level of dustbin. Due to presence of waste, dustbin produces hazardous gases which increases toxicity of dustbin.

3. If level is less than 10 cm or toxicity of gases is high then message is sent to MC through GSM module.

4. The data of dustbin is also sent to the website after a fixed interval of dustbin so this information remains store on the website.The information is saved with date and time.

5. If MC get to know about filling of dustbin then it will send truck driver to clean it. In this way the dustbins are cleaned timely.
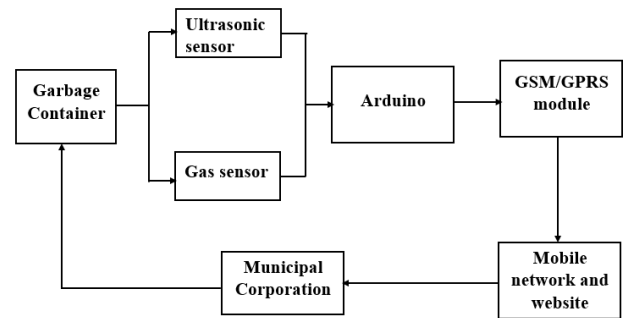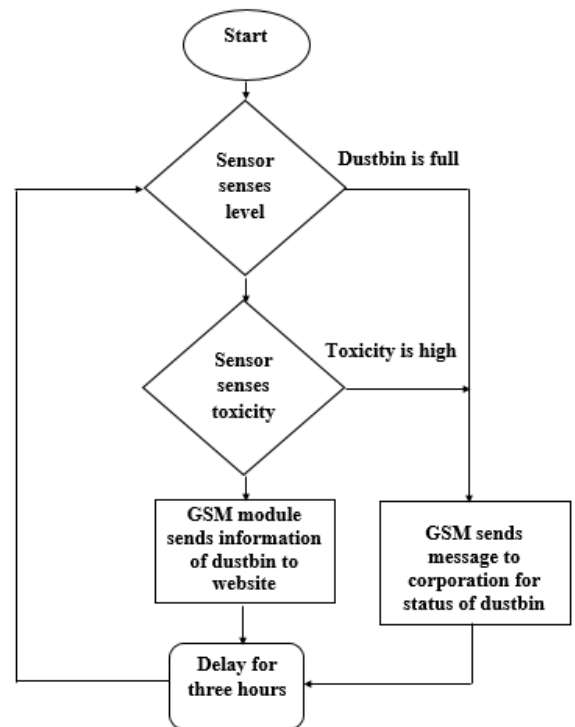

Fig.1: Block diagram of proposed system

Fig.2: Flow chart of the system

Whole system is described below in following parts.

A. For Controlling System

In proposed system Arduino is used as a Controller. It interface with Sensors and GPRS module. It is programmable control device. Arduino is programmed in Arduino IDE software through which we can control all devices. It works on 5 volt power supply. Both the sensors consume power

from Arduino Board. It has 14 digital input/output pins. Out of these 6 are Pulse width modulation (PWM) outputs. There are 6 analog pins also. Gas sensor is connected to analog pin and Ultrasonic sensor is connected to digital pin. GSM is connected to PWM pin. Arduino is shown in fig.3.

Fig.3: Arduino UNO R3

Table.1: Specifications of Arduino

Parameter	Specifications
Operating Voltage	5 Volt DC
Input Voltage	7-12 V
Clock Speed	16 MHz
DC current per I/O pin	40mA

B.For measurement of level of dustbin

For measurement of level we are using ultrasonic sensor which measure the distance between device and obstacle [12]. We are considering obstacle as garbage. It has Transmitter and Receiver sections. Transmitter emits high frequency sound pulses at regular intervals. These waves propagate in the air at the velocity of sound [1][2][10]. The waves are reflected back by the obstacleand total time is measured. Ultrasonic sensor is shown in fig.4.

Following formula is used to calculate the distance between sensor and obstacle:

(2*Distance= Speed*Time)

The specific parameters of Ultrasonic sensor are shown in table.2.

Table.2: Specifications of Ultrasonic Sensor

Parameter	Specifications
Operating Voltage	5 Volt DC
Operating Current	15 mA
Frequency of Operation	40 Hz
Range	2cm-400cm

C. For measurement of toxicity

In our system natural methane gas sensor (MQ4) is used for detecting the presence of hazardous gases evolve from dustbin.This sensor is highly sensitive to methane gas. These gases mainly evolve from biodegradable waste i.e. eggs, dead animals, rotten fruits and vegetables [13]. Methane gas sensor is shown in fig.5 and the specifications of MQ4 gas sensor is shown in table.3

Fig.4: Ultrasonic Sensor HC-SR04

Fig.5: Natural Methane Gas Sensor MQ4

Table.3: Specifications of MQ4 Gas Sensor

Parameter	Specifications
Operating Voltage	5 Volt DC
Heater Voltage	4.8V - 5.2V
Heater Resistance	28 ohm - 34 ohm
Load Resistance	20K ohm

D. For communication

To communicate the system to mobile network we are using the Global System for Mobile Communication (GSM) based technique. GSM is an open digital technology used for transmitting the data in binary form. The data transfer speed of

GSM is 9.6 Kbps. It can send message and voice calls. It works on the 900 MHz to 1800 MHz frequency in India. In our system GSM sends one message when dustbin overflows. Here GSM is also providing information on the website.The specific values of SIM900A is shown in table.4. SIM900A is shown in fig.6.

Table.4: Specifications of SIM900A

Parameter	Specifications
Operating Voltage	5V - 12V
Operating Current	2 Ampere
Frequency of operation	900/1800 MHz
Operation Temperature	-40^0 C to $+85^0$C

Fig.6: GSM/GPRS Module SIM900A

E. To send data on internet

IoT is a network of physical devices, vehicles, home appliances, and other objects embedded with Electronics, software, and sensors, actuators which enable these things to connect, collect and exchange the data [5].

In our proposed project website is developed using HTML code for having report and real time data of dustbin. All data is sent through GSM/GPRS module [14-15]. Website saves real time data into database and it can be seen when required. It will be used for future use also. We have created one website which stores the time and date when dustbin gets full. It has one complaint box also where citizens can write their complaint. Through this system dustbins will be cleaned time to time. If any complaint is submitted then administrator (admin) can check the status of dustbin online. On this website we have admin login page where one concerned person can login as admin. He can check the data of all the dustbins.On this website one

other block is there where latest news are displayed. Updated news can be seen on website.

IV. RESULT AND DISCUSSION

All the connections of Arduino and GSM module are done. It is working properly and sends SMS when it becomes full or toxicity is high. It is sending the data on website after every 3 hours.

We have first implemented our project on Proteus and then simulate it on one board. Coding is done on Arduino IDE. The program is run on a computer with 2.20 GHz processor (AMD A4-3330MX APU) and 2 GB memory. All the required parameters are observed and we get expected output.

When ultrasonic sensor measures the distance less than 10 cmor gas sensor detects the high level of toxicitythen it sends SMS on the mobile as "your dustbin is full located at MLVTEC, azad nagar, Bhilwara No-001 or toxicity is high" as shown in fig.7.
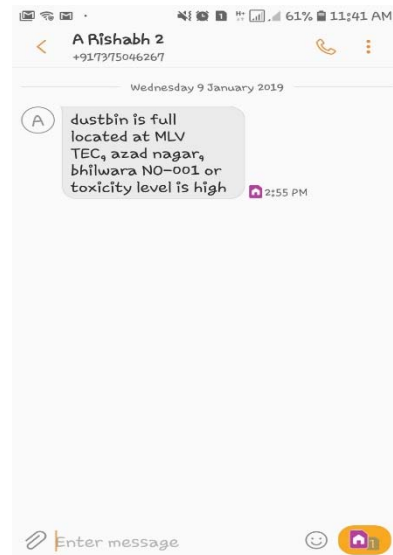

Fig.7: Screenshot of message sent

The website has been developed regarding the monitoring of dustbin. It has following features:-

- Complaint desk
- Newsfeed
- Admin Login
- Detail of dustbin using ultrasonic and gas sensor data with time and date.
- Admin can insert news.
- Admin can see the complaints with name and mobile number.

The homepage of the website is shown in fig.8:
The information of dustbin is available on the webpage which is seen by admin. This webpage contains toxicity level and percent filling of dustbin with date and timeas shown in fig.9.

On the admin dashboard page admin can see the complaint written by citizens with Date, Time, name and mobile numbers as shown in fig.10.

Fig.8: Homepage of website

Fig.9: Details of the dustbin

Fig.10: Complaint Desk

LED Signboard and the Bio Enable gas sensors can also be used in the dustbins. There are some features applicable for the multipurpose smart dustbins such as: -

1. Smart Dustbins with different sensors.

2. Street Information Boards

3. For public information there will be LED display system

4. Using Wi-Fi module it can be used on railway stationso it will consume low power.

5. CCTV Camera

6. Dustbin Tracking System

7. In future, the energy required by sensors and devices to operate will be generated automatically using Piezoelectric or solar panels.

8. This system can be implanted in present existing dustbins instead of having new garbage container. The existing dustbin is shown in fig.12. The comparison between different projects is shown in table.5.

Table.5: Comparison of Projects

S. No.	Name of the existence Project	Author name	Level Sensor	Toxicity Sensor	Web/ App support
1.	Implementing of Smart Waste management System Using IoT	P Haribabu et al. [2]	Present	Absent	Present
2.	Smart Garbage Monitoring and Clearance System	S. Vinoth Kumar et al. [4]	Present	Absent	Present
3.	IoT Based Solid Waste Management System for Smart City	Krishna Nirde et at. [5]	Present	Absent	Present
4.	Dissipation of Waste Using Dynamic Perception and alarming System	Imteaj A et al. [6]	Absent	Absent	Present
6.	Autonomous Smart Waste Collection System	Shujatullah Khan et al. [9]	Present	Absent	Present
7.	(Our Proposed System)	-----	Present	Present	Present

Our proposed model is shown in fig.11.

Fig.11: Smart Dustbin

This project can be implemented on various places like parks, railway stations, and bus stop and historical Monuments etc. In future all the Railway stations and bus Stop will have Wi-Fi connectivity so there will be facilities like Wi-Fi Hotspot instead of GSM module in Smart dustbin.

We have implemented one dustbin but many dustbins can be implemented with different ID so they can be easily tracked from any of the place of earth. According to unique ID, the message should be sent to the respective concerned person who is responsible to clean the dustbin.

Fig.12: Existing Dustbin

V. CONCLUSION

This system is much helpful for citizens and Municipal Corporation to manage waste and monitor the dustbin time to time. Smart system provides the filling status of dustbin using message and it will save time, fuel and money of Municipal Corporation. As there was a problem of checking real time status of dustbin so it will be cleaned timely. So, in this project this problem is solved and proper database is managed online. In this way the municipal corporation shall work efficiently. There is one complaint desk for the citizens where they can send their complaint.

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