Promoting a Clean and Hygienic Environment using IoT

A. Arul Anitha, L. Arockiam

Abstract*: Internet of Things (IoT) based smart devices are the core elements for any smart environment. The sensors and actuators make the life easier when they are connected to one another and to the Internet. The Smart city and 'Swach Bharath Abhiyan' projects introduced by the Government of India tried to promote clean and hygienic Environment. The constant growth of population, industrialization and urbanization increase the unorganized manner of dumping the solid waste in landfills. Smart waste management is the must in all countries due to the voluminous generation of solid waste. In this paper, a methodology for monitoring the dustbins in smart cities, household or organization is proposed. The dustbins are monitored very often to check the garbage level. Whenever the dustbins reach maximum level, alert will be sent to the corresponding authorities with the bin details to dispose the waste. Additionally, the gas sensors in the dustbins detect the bad smell and alert when it reaches the threshold level though the garbage level will not reach the dustbin's maximum capacity. The areas which require emptying the dustbins very often are also identified. Large-scale implementation of the system will promote a clean and hygienic environment.

***Keywords* : Alert, garbage, IoT, smart dustbins**

I. INTRODUCTION

Cleanliness is one of the important issues in the modern society. Solid waste is the sole factor which has negative impacts on the health and hygienic aspects of people and environment. Even though many efforts have been taken to handle the trash efficiently, it is a challenging dispute for all countries. The Internet of Things (IoT) is a boon to solve this ever growing problem. To make a clean atmosphere, IoT based automated process in waste management is necessary [1]. IoT makes the real-world objects to communicate each other and also connect to the global network using various protocols and standards [2].

Whenever there is any need for disposing the trash in the dustbins, the notification will be given to the corresponding authorities. The rising population, continuous growth of industrialization and urbanization have led the country like India towards voluminous generation of garbage and polluted environment. Overflowing landfills due to the unorganized manner of dumping of waste in organizations and cities will bring serious environmental consequences [3]. Waste can be a precious asset when it is properly treated and reused. For the effective management of garbage, households and industries have to manage the waste by regularize the waste monitoring process [4]. This paper suggests a methodology for a simple and easy to use garbage monitoring system which monitors the dustbins of an organization and gives alert notifications to the waste management department to take necessary actions to dispose the waste.

The rest of this paper is organized as follows: Section 2 reviews some related works in smart garbage management. Section 3 highlights the scope and objectives of the projects. Section 4 describes the proposed methodology for garbage management system. Section 5 describes the system implementation details. Section 6 explains the results obtained by the proposed model. Finally, conclusion is given in the section 7 and this section also opens new perspectives related to this research.

II. RELATED WORKS

To understand the International and National issues related to waste management system, the related recent works for waste management system using IoT were studied and analysed. Padma et al [5] recommended a smart waste management system to notify the waste level in the dumpster. This system was composed of a microcontroller and GPRS module. The dumpster's status will be notified regularly using the sensors in the system. The sensor data is also stored in the database for future analysis.

Hassan et al [6] analysed the Solid Waste for Quweisna Industrial Zone of Egypt. According to this paper, every year the Quweisna Industrial Zone generates 170.446 ton of wastes, 32.39 ton wastes are only recovered and 81% of wastes are sent to the local municipality. To transform the zone into a green and clean area, the authors suggested recycling, recovery and reuse strategies.

A modeling study for waste management system was performed by Josiane et al [7] to evaluate the waste collection process of Itajubá, State of Minas Gerais, Brazil. Data were collected via observation, interviews and questionnaires. Simulation and modeling techniques were applied in this research. To improve the waste collection process, some operational ideas were suggested.

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Andreasi et al [8] accomplished a comparative analysis on solid household waste and its impact on environment in seven European countries such as Germany, Denmark, France, UK, Italy, Poland and Greece. The authors considered those countries to represent the whole European Union. The collection, separation, treatment and disposal process as the waste management in this research. All countries need to update their technology periodically to meet the current challenges in the waste management process.

Shilan et al [9] from Iraq developed a smart solid waste monitoring and collection system. Ultrasonic Sensor Arduino Uno and Radio Frequency (RF) transmitter were installed on the top of the waste box for the monitoring task. A message (SMS) will be sent to the mobile phone of the truck driver about the location and ID of the dustbin whenever the waste box is full and needs for disposing the garbage.

An automatic waste segregator system was developed by which Kesthara et al [10] to separate the garbage into metal, dry and wet waste. Moisture and IR sensors were used to distinguish the dry and wet waste. The authors explained only theoretical aspects of the system. A smart waste separator was suggested by Aahash et al [11] in which Ultrasonic and Metal sensors were used to classify the waste into metallic and non-metallic wastes. The system was explained by using a block diagram and there was no experiment in their proposed system.

A garbage segregator system was implemented by Balagugan et al [12] to classify the waste at household level. PIC16F877 microcontroller was used in this segregator to control the entire process. An IR (Infrared) sensor, a moisture sensor and a metal sensor were used to detect and identify various types of waste respectively. The authors used Proteus tool to simulate their research idea to categorize the metallic and non-metallic waste efficiently. There is no real garbage segregation in their work.

To identify the metallic waste, parallel resonant impedance sensing mechanism was used by Amrutha et al [13] in an automatic garbage management system. This system can categorize one waste at a time and also it cannot segregate ceramic into dry waste. Mahajan et al [14] suggested a waste management system for municipality. In this work, to monitor the garbage level, the public dustbins would be provided with embedded device. Load sensors were used to increase the efficiency of the level of garbage whereas moisture sensor was used to segregate the wastes.

III. OBJECTIVES AND SCOPE

The primary aim of this project is to promote a clean and hygienic environment by developing and automating a cheap, easy to use garbage management system to monitor and to treat the trash at household or institutions. The sub objectives of this system are:

- To monitor the dustbins periodically.
- To give the alert to the person in-charge whenever the dustbins are full or the gas level in bins increased.
- To automate the waste management process efficiently.
- To complain the administrator of the system whenever the waste management process is not done properly.

The scope of the project is defined that it can be implemented only in household, organizations and cities where technology like internet connectivity and other technology are available. Remote areas are out of the bound as technical feasibility is not possible. Skilled and trained people are required to control, monitor and manage the whole system.

IV. PROPOSED METHODOLOGY

This project deals with the waste management systems in household or institution level through which it can promote clean city. The Methodology followed in this smart waste management project is explained by using the Fig.1.

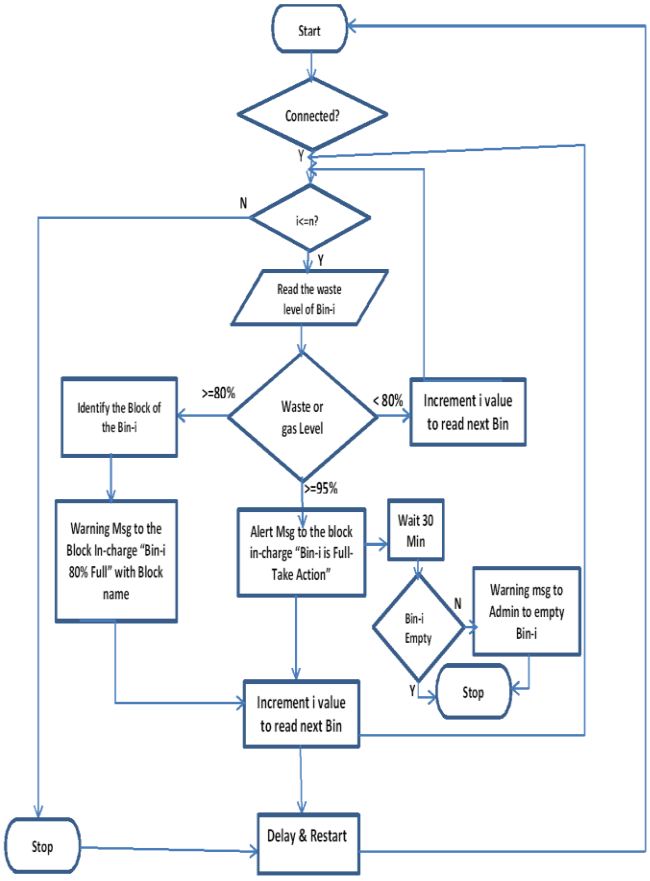

Fig.1. Flow Diagram for Garbage Management System

As it is given in the flow diagram, the dustbins in the particular area are monitored periodically. First, the connectivity is checked and the problems are rectified. Then the garbage level and bad smell level of all the dustbins are monitored, if it exceeds the threshold level, then the block in-charge who manages the particular area will be notified to take necessary actions with the block name and bin-id of the dustbin. Whenever the block in-charge receives notification, the message will be automatically forwarded to the personnel who are responsible for emptying the smart bin. After waiting for 30 minutes, again the status of the smart bin is monitored.

If the trash is not treated then the warning message will be sent to the cleanliness administrator of the system. After monitoring all the dustbins likewise, some delay will be given and again the system will restart its operation. The pseudo

code for the functionalities of the smart garbage management system is given below:

Pseudo Code for Smart Garbage Management System

Input: garbage_level, gas_level, Bin_id
Output: Alert Message with Bin_id

```
1: Start
2: Initialize no_of_dustbins, garbage_threshold,
    gas_threshold, delay
3: if (devices_not_connected==true) then
4:   rectify the Connectivity issues
5: else
6:  for i=1 to no_dustbins do
7:       get the garabge_level of Bin_i
          // get the value from Ultrasonic Sensor
8:       get the gas_level of Bin_i
          // get the value from gas Sensor
9:       if (garbage_level> =garbage_threshold  or
           gas_level>=gas_threshold) then
10:         get the Block name of the Bin_i
11.          send alert to Block In-charge with Bin-Id
12.         // wait for 30 min. and check the status
13.       if (Bin_i not empty)
14.          send the warning to Admin.
12:      else
13:  end for
14: wait for the delay go to step 3
       //after some delay restart the process
15. Stop
```

This pseudo code clearly explains various functionalities of Smart Garbage Monitoring System. Careful deployment of the system in a large scale will promote clean environment..

V. SYSTEM IMPLEMENTATION

The project was developed by keeping in mind of the need for smart garbage management system in St. Joseph's College (Autonomous), Tiruchirappalli, Tamilnadu, India. The college campus is divided into number blocks based on the location. Each block is given a unique name and is under the control of a block in-charge and maintained by a small group of personnel. There are 'n' numbers of dustbins in each block. Each dustbin has a unique ID along with the block name for the smooth functioning of the system.

The dustbins are attached with HC04 ultrasonic sensor, MQ2 gas sensor and SG90 TowerPro Servo Motor. The Ultrasonic sensor is used to indicate the garbage level in the dustbin; MQ2 will send the presence of bad smell and level of gases and servomotor is used for the automatic movement of the dustbin's lid. The entire system is under the direct control of the Cleanliness Administrator. The system design for implementing the project is explained in Fig. 2.

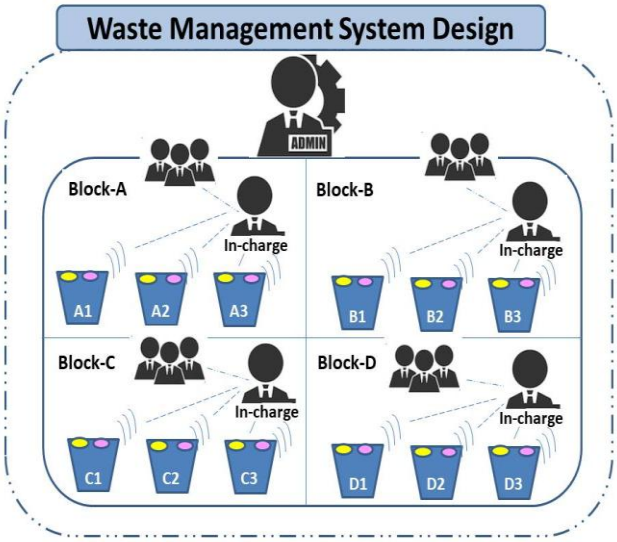

Fig.2. Waste Management System Design

When the garbage level exceeds the threshold, the ultrasonic sensor will send an alert to the block in-charge along with the bin-id. Once the message is received, automatically a message is sent to the mobile of personnel who is responsible for emptying the dustbin. The system will monitor the current status and wait some time (30 minutes), if the dust bin is emptied during the waiting period, the warning message is sent to the corresponding block in-charge and also the administrator to take immediate action. The smartbins used in this project is given in the Fig. 3.

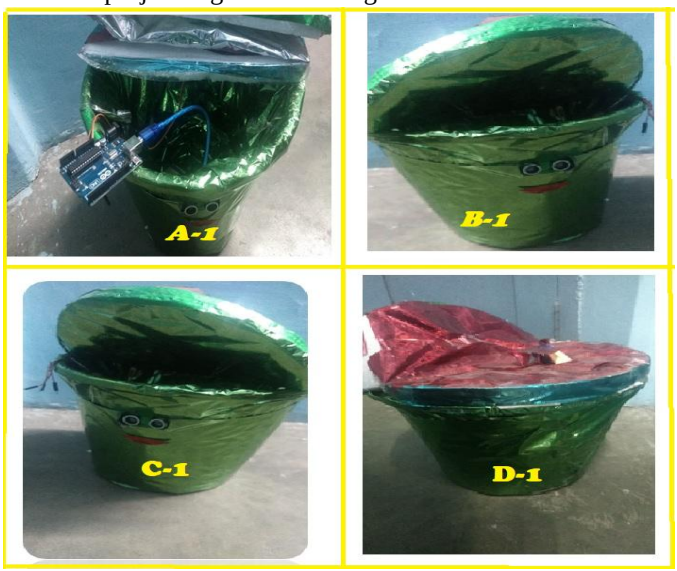

Fig.3. Dustbins used for this project

VI. RESULT AND DISCUSSION

The bins are placed in different locations. They sent the garbage level in the dustbins and gas level periodically to the block in-charge and administrator of the cleanliness department. The the output generated by the serial monitor is given in Fig. 4.

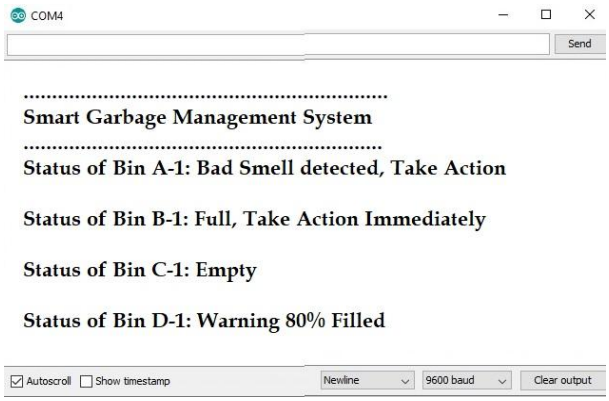

Fig.4. Output of the System in Serial Monitor

The various alert messages sent by the system according to the status of the trash bins are shown in the Table-I.

Table-I: Conditions and Corresponding Messages

S.NO.	CONDITION	MESSAGE	TO WHOM
1.	Garbage level = 0%	Bin is empty	Block in-charge
2.	Garbage level reaches 80%	Warning… 80% Filled	Block in-charge, Staff
3.	Garbage level >=95%	Bin is full. Take Action	Block in-charge, Staff, Admin
4.	30 Minutes after filled	Complaint	Admin
5.	Gas Level < 300	Nil	Nil
6.	Gas Level>=300	Bad Smell detected… Take Action	Block in-charge, Staff, Admin

The conditions and status of the dustbins are monitored. According to the current status of the bins like gaslevel and garbage level of the particular smartbins, actions are taken place. The notifications sent by the smartbins to the authorities are shown in Fig.5.

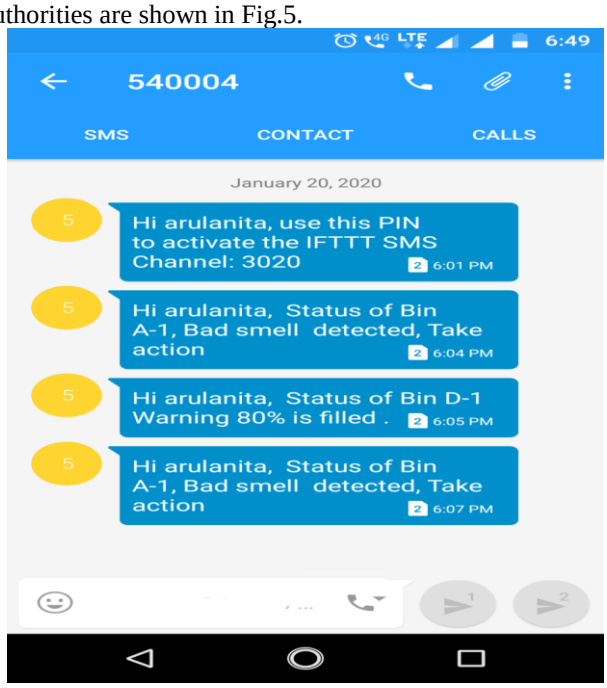

Fig.5. Notification to authorities

Actions are taken place as per the alert messages sent by the system. The located areas of the dustbins and their frequency level to empty the dustbins are listed below in Table II.

Table-II: Dustbin's area and Frequency

S.No.	Dustbin's area	Frequency
1.	Canteen	High
2.	Toilets	High
3.	Hostels	High
4.	Administrative Block	Medium
5.	Staff Room	Medium
6.	Classrooms	Low
7.	Library	Low

The above table shows the dustbins in canteen, toilets and hostel fill very often and require emptying them frequently. The garbage collection in classrooms and library are low. It is suggested to place more dustbins in the areas where the frequency is high. The system involves number of sensors and other hardware components. Implementing the system on a broad level will require lot of technical and financial investment.

VII. CONCLUSION

The project was designed to improve the waste management at an organization level. The technical aspects and constraints related to the project have been analyzed before developing the project. Large-scale implementation of the project will reduce the service cost associated with the Waste Management System significantly. It is recommended to include surveillance camera to monitor the improper usage of the garbage bins. In future, the project can be enhanced by implementing data security and device security at the edge level. The stored sensor data can also be analyzed for decision making.

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