Smart Waste Management System: A Survey

Brinda Patel[1], Rikin Thakkar[2], Satvik Khara[3]
[1]*Department of Computer Engineering Silver Oak College of Engineering Technology, Ahmedabad, Gujarat, India*
[2]*Assistant Professor, Department of Computer Engineering Silver Oak College of Engineering Technology, Ahmedabad, Gujarat, India*
[3]*Professor, Department of Computer Engineering Silver Oak College of Engineering Technology, Ahmedabad, Gujarat, India*

***Abstract*- The waste management is a major problem now days. Waste bins checking procedure for waste collection is one of the major troublesome tasks. The typical technique by which, a man needs to wander through the distinctive spots and check the spots for waste accumulation. This is to some degree complex and time consuming process. Presently, waste management system is not as effective as it ought to have been taken over the progressions in the advances and technologies that emerged in the current years. Smart Waste Management System is to implement a smarter way of conventional waste management using smart sensors to gather fill-level data, presence of garbage around the dustbin and stinking condition from containers and garbage bins, and send it to servers in real time.**

Index Terms- smart, waste management, sensors, cloud, IOT.

I. INTRODUCTION

Management of waste is a big challenging problem in urban areas for most of the countries throughout the world and is seen in most of the developing countries then in the developed countries. An efficient management of waste is a requirement of maintaining a clean and green environment as there is an increase in all kind of wastes thrown by many places like industrial, agricultural, home waste, etc. Waste collection and recycling is done through various technologies. Collection of information is big and cumbersome. The current growth in nation with large residential area and a demand for modernization in the city creates a challenging task for waste management people. The complexity of BBMP or municipal authorities is mainly on problems related to the collection the waste from different locations, transporting them for degradation and processing of residential solid waste today the garbage collection is manual which takes a lot of efforts and is time consuming.

The organic waste from vegetables and fruits market is biodegradable quickly and releases bad odor. Rats, flies and other pests are attracted due to discharge of organic waste. These cause diseases such as typhoid and cholera, and can also cause diarrhea, eye problems, skin diseases etc. Due to improper disposal of waste in the environment many diseases are attracted due to the presence of many insects like flies, mosquitoes[1].

Waste management is a consistently developing issue at local and global levels. Normally, human and animal activities emerge has solid wastes and are futile and undesirable. The residential waste items are gathered through waste bins at a typical place at a specific spot for a road/area. Waste bins checking procedure for waste collection is one of the major troublesome tasks. The typical technique by which, a man needs to wander through the distinctive spots and check the spots for waste accumulation. This is to some degree complex and time consuming process. Presently, waste management system is not as effective as it ought to have been taken over the progressions in the advances and technologies that emerged in the current years. There is no surety about the administration/clearing of wastes at all the spots. To conquer this issue another approach, proposed automated waste management system [2].

With the advancement of technologies in many areas, a concept called “smart” is evolved over a period of last few decades across the world and became popular in India now in 21st century. As a part of “smart city” concept, “smart waste management” is emerged as one of the major area which needs to be

developed and implemented utilizing various technologies those is available.

In the approach of the smart cities mission, the objective is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment with the application of smart solutions". Smart cities don't only mean smart buildings and smart parking areas but "smarter waste management system" is also a major issue to be addressed in developing a smart city. The SMART WASTE MANAGEMENT SYSTEM which is proposed here in uses smart sensors to gather fill-level data from containers and garbage bins, and send it to an authorized number in real time [4].

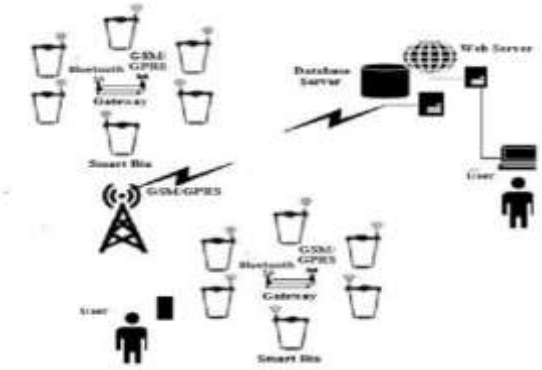

Figure 1 Smart Waste Management Environment [5]

The purpose of our work is to introduce a smart and intelligent waste management system that is able to handle the process dynamically and cost effectively. In our approach weight and volume of waste thrown in the waste bins are collected by economical sensors and then sent to cloud server using a micro-controller and GPRS. This data is used to find the waste collection schedule to maximize the collection. Location of vehicles and waste bins are used to find the shortest possible collection route for each truck which is implemented by Ant Colony Optimization (ACO) technique. The system is adaptable to dynamic changes i.e. routes blocked during waste collection process. The whole process can be monitored centrally and thus provide a high-quality service to the citizens of a smart city [8]. Our proposed smart waste-bin system can be adapted into general waste-bin and it consists of the sensing units, a Bluetooth and GSM Module for data transmission, and a mobile application and web-based monitoring for interfacing and communication with the waste department for waste management[8].

II. BACKGROUND THEORY

A. Cloud Computing

NIST describes cloud computing as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction"[6].

Cloud is store on Internet servers instead of on your computer. It's like having an extra hard drive one that you can access anywhere and anytime you're connected to the Internet which provides services for computing. And when we are using this cloud for the computation means we are taking input and process it and give it back to the client that is known as the Cloud Computing. Cloud computing is the model in information technology which deals with the transferring the data over the internet or the sharing the information, resource, software to the computer or any other device that you are using. Cloud computing is the use of computing resources that are delivered as a service or an application over a network. Cloud computing is provided by many services such as Amazon Web Service, Microsoft Azure, Google Cloud Platform [19].

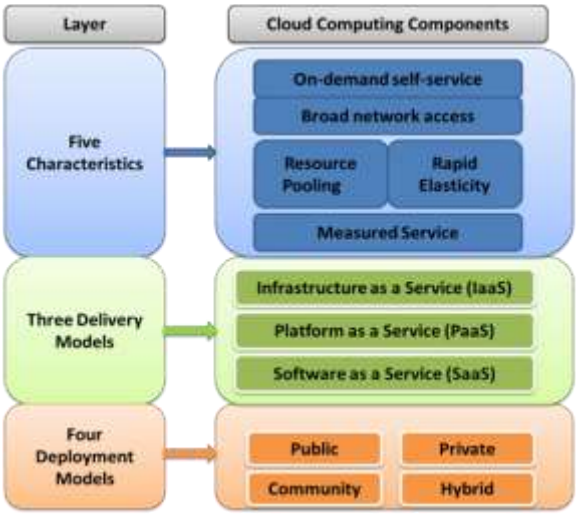

Figure 2 Cloud Environment Architecture

The three key cloud delivery models are infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS). In IaaS, the user can benefit from networking infrastructure facilities, data storage and computing services. In other words, it is the delivery of

computer infrastructure as a service. An example of IaaS is the Amazon web service. In PaaS, the user runs custom applications using the service provider's resources. It is the delivery of a computing platform and solution as a service. An example of PaaS is GoogleApps.

An example of SaaS is the Salesforce.com CRM application. This model represents the second layer in the cloud environment architecture. Cloud deployment models include public, private, community, and hybrid clouds. A cloud environment that is accessible for multi-tenants and is available to the public is called a public cloud. A private cloud is available for a particular group, while a community cloud is modified for a specific group of customers. Hybrid cloud infrastructure is a composition of two or more clouds (private, community, or public cloud). This model represents the third layer in the cloud environment architecture[7].

B. Cloud Computing in Smart Waste Management System

Cloud based server- This is a connected Web entity that receives, stores, displays and analyses the information provided by the various wireless sensing nodes in real time. It also notifies the workers for suitable action[11].

Volume of waste thrown in the waste bins are collected by economical sensors and then sent to cloud server using a micro-controller and GPRS. This data is used to find the waste collection schedule to maximize the collection. Location of vehicles and waste bins are used to find the shortest possible collection route for each truck[8].

Figure 3 Smart Waste Management System Connected with Cloud [8]

C. IOT

Internet of Things is a connection of devices. Devices connected to network, transfer data and communicate each other provided with a Unique Identifier (UID), with or without interaction from human to human/human to computer. Automation of human life is goal of an IoT. It's an ever growing Technology connecting sensors; object extends to computing capability and also allowing devices to generate, exchange and data consumption.

IOT is an evolving concept with an increasing range of applications leading to development of new technologies and methods for the improvement of IOT environment. Here the things are connected and controlled by the Internet[18].

D. IOT includes following six elements [18]:

- IOT identification: IOT identification is required to match the name and the services as per the need. Identification includes addressing the IOT objects, which consists of two things: Object ID and its address. Identification method is not unique one, for unique identification of the objects address is required.
- IOT Sensing: Sensing is required to collect the relevant information from the network of related objects and to send it back to the server or cloud. Smart sensors, actuators or wearable sensing devices can be the IOT sensors.
- IOT Communication: To deliver specific smart services we need to connect heterogeneous objects together. This feature is provided by the IOT communication technology in the presence of lossy and noisy communication links, the nodes of IOT can be operated using low power.
- IOT Computation: The computational competence of the IOT is processing units and software applications.
- IOT Semantics: Semantic in the IOT refers to extraction of knowledge wisely by different systems to provide the required services.
- IOT Services: Identity related services, information aggregation services, collaborative-aware services, Ubiquitous services are the main IOT services.

IOT includes three main system level characteristics [18]:

- Anything Communicates: Smart things have the capability of wireless communication between them and from adhoc networks of interconnected objects.

- Anything identifies: Smart objects are recognized by digital name.
- Anything Interacts: Smart objects can interact with any local environment/objects via sensing and actuation capabilities.

E. IOT in Smart Waste Management System

To make the cities greener, safer, and more efficient, Internet of Things (IoT) can play an important role. Improvement in safety and quality of life can be achieved by connecting devices, vehicles and infrastructure all around in a city. Best technological solutions can be achieved in smart cities by making different stakeholders to work together [10].

IoT internet of things based smart waste management system which allows waste management authorities to continuously monitor status of dust bins placed at different locations and as per the status take appropriate actions to collect it immediately and efficiently[17].

F. Sensors:

New solutions for managing waste have emerged due to the rise of Smart Cities and Internet of Things. These solutions can also be applied in rural environments, but they require the deployment of a low cost and low consumption sensor network which can be used by different applications.

Different types of sensors used in Smart Waste Management System are:

- Ultrasonic Sensor
- IR Sensor
- Weight Sensor
- Temperature Sensor
- Humidity Sensor
- Smoke Sensor

Ultrasonic sensor: Ultrasonic sensor used for garbage volume sensing in bins due to its low cost and good accuracy. It comprises ultrasonic transmitters, receiver and a control circuit, powered by a 5V supply. A high-level voltage signal is applied for 10 microseconds at the input pin of sensor which generates eight 40 kHz burst pulses which hit the target object and return. The module detects the returned pulses. The fill volume is inversely related to the time delay elapsed between transmitted ultrasonic burst and received echo signal[11].

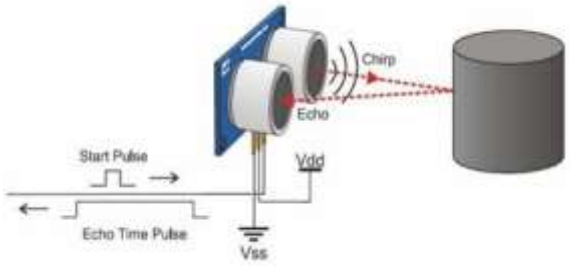

Figure 4 Sketch of working principle of the Ultrasonic Sensor [11]

IR Sensor: An infrared sensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. infrared proximity sensor made by Sharp. Part # GP2Y0A02YK0F has an analog output that varies from 2.8V at 15cm to 0.4V at 150cm with a supply voltage between 4.5 and 5.5VDC. The sensor has a Japanese Solder less Terminal (JST) Connector.

Smoke Sensor: MQ2 Gas Sensor module is used in this work for detecting flammable gases H2, LPG, CH4, CO, Alcohol, Smoke or Propane. This sensor uses SnO2, which has lower conductivity in clean air. When the targeted flammable gas is present, the sensor's conductivity gets higher as the gas concentration rises. This change of conductivity may be converted to corresponding voltage output signal of gas concentration through a simple circuit. The sensor has large measurement range (300-10,000 ppm), high sensitivity, fast response time

Humidity sensor: sensor used in this work detects water vapour by measuring the electrical resistance between its two electrodes. The humidity-sensing component consisting of a moisture holding substrate with electrodes is applied to the surface. When water vapour is absorbed by the substrate, ions are released by the substrate, which increases the conductivity between the electrodes. The change in resistance between the two electrodes is proportional to the relative humidity. Higher relative humidity decreases the resistance between the electrodes.

Temperature Sensor: Temperature sensor measures temperature with a surface mounted NTC (negative temperature coefficient) temperature sensor (thermistor) built into the unit. The measurement ranges of the sensor are 20-90% RH and 0-50°C

temperature with sensitivities of +-5% RH and +-2°C temperature.

Weight Sensor: A load cell is a sensor or a transducer that converts a load or force acting on it into an electronic signal. This electronic signal can be a voltage change, current change or frequency change depending on the type of load cell and circuitry used. Resistive load cells work on the principle of piezo-resistivity. Intervals dustbin will be squashed. Once these smart bins are implemented on a large scale, by replacing our traditional bins present today, waste can be managed efficiently as it avoids unnecessary lumping of wastes on roadside. Breeding of insects and mosquitoes can create nuisance around promoting unclean environment. This may even cause dreadful diseases. Abbreviations and Acronyms.

In [14], paper is proposed IOT based smart waste clean management system which checks the waste level over the dustbins by using Sensor systems. Once it detected immediately this system altered to concern authorized through GSM/GPRS. For this system used Microcontroller as an interface between the sensor system and GSM/GPRS system. To monitor and integrate an android application is developed for the desired information which is related to the various level of waste in different locations. This is ensued the greenish in the environment and support for swachh bharat for cleanness.

In [16], paper presented the smart waste-bin that can manage the waste in a smart city project. The system consists of sensors to measure the weight of waste and the level of waste inside the bin. The system also adapt with network environment, to manage all information from waste management. As the result we proposed a prototype of smart waste-bin that suitable for many kind of conventional waste- bin.

III. LITERATURE SURVEY

In [1] paper, the completeness of waste in the dustbins is checked with the help of Sensors used in the system, and information is sent to the required control room through GSM/GPRS system. Renesas Microcontroller is used to communicate the sensor system with GSM system. An android application is been designed to monitor the information related to the waste for different selected locations. Through this the collection of garbage can be made efficiently.

In [12] paper they have developed a low cost, low power waste management system which will be applicable in regions which are not economically sound. This system enables us to collect the trash as and when the can is full or when the trash inside is decomposed compared to daily collection. This has been designed using an Arduino Uno board incorporating additional modules such as a GSM module to send messages.

In [11], the proposed system centrally monitors the temperature, humidity, flammable gases concentrations (or smoke), fire detection and garbage fill volume in waste bins with the help of wireless sensing nodes placed at remote locations in the city. The communication from the sensor node to the central station is done using TCP/IP protocol via existing GSM/GPRS wireless infrastructure in the city. At the cloud server, the data is monitored, analyzed and stored and notification to the service providers is sent for suitable action for fire prevention and waste bin overflow. The experimental results show that the proposed system is a cost-effective and efficient solution for waste management in modern urban scenario.

In [13], propose a system through a mobile application associated with a Smart Trash Bin .The main aim of this application is to reduce human resources and efforts along with the enhancements of a smart city vision. At regular

IV. CONCLUSION

Smart waste management systems will go a long way in making our daily lives much healthier and toxic free. Also, it can contribute to reducing fuel consumption of the garbage trucks by going for collection to particular areas only when the considerable amount of the cans is present in that particular geographic location that needs to be collected. Since its requirement for funds is less, this system can become readily available in all countries that aren't looking forward to investing much in their waste department.

REFERENCES

[1] Aditya Jain and Ranu Bagherwal, "Design and Implementation of a Smart Solid Waste Monitoring and Collection system Based on Internet of Things", IEEE-2017, 8th ICCCNT 2017, July 3 -5, 2017, IIT Delhi, India.

[2] Prof. B. S. Malapur and Vani R. Pattanshetti, "IOT based Waste Management:An application to Smart City", International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS-2017), 2017 IEEE.

[3] Pooja V. Garach and Rikin Thakkar, "A survey on FOG computing for Smart waste management system ", 2017 International Conference on Intelligent Communication and Computational Techniques (ICCT) Manipal University Jaipur, Dec 22-23, 2017.

[4] Shyamala S.C, Kunjan Sindhe, Vishwanth Muddy and Chitra C N, "Smart waste management system", International Journal of Scientific Development and Research (IJSDR), September 2016.

[5] Aksan Surya Wijaya, Zahir Zainuddin and Muhammad Niswar, "Design a Smart Waste Bin for Smart Waste Management", 2017 5th International Conference on Instrumentation, Control, and Automation (ICA) Yogyakarta, Indonesia, August 9-11, 2017 IEEE.

[6] Peter Mell and Tim GranceM. Young, "The NIST Definition of Cloud Computing", Version 15, 10-7-09.

[7] Mohammed A. AlZain , Eric Pardede , Ben Soh , James A. Thom, "Cloud Computing Security: From Single to Multi-Clouds", 2012 45th Hawaii International Conference on System Sciences

[8] Sadia Sharmin and Sikder Tahsin Al-Amin, "A Cloud-based Dynamic Waste Management System for Smart Cities", ACM DEV "16 November 17-22, 2016, Nairobi, Kenya.

[9] Gopal Kirshna Shyam, Sunilkumar S. Manvi and Priyanka Bharti, "Smart Waste Management using Internet of Things(IoT)", 2017 IEEE.

[10] Mohd. Talha, Amar Upadhyay, Raaziyah Shamim and M. Salim Beg, "A Cloud integrated wireless garbage management system for Smart Cities", 2017 IEEE.

[11] Balamurugan S, Abhishek Ajith, Snehal Ratnakaran, S. Balaji and R. Marimuthu, "Design of Smart Waste Management System", IEEE 2017.

[12] P Haribabu, Sankit R Kassa, J Nagaraju, and R Karthik, N Shirisha, M Anila, " Implementation of an Smart Waste Management system

[13] using IoT", Proceedings of the International Conference on Intelligent Sustainable Systems (ICISS 2017),IEEE.

[14] S. Vinoth Kumar1, T. Senthil Kumaran, A. Krishna Kumar and Mahantesh Mathapati, "Smart Garbage Monitoring and Clearance System using Internet of Things", 2017 IEEE International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM).

[15] Krishna Nirde, Prashant S. Mulay, Uttam M.Chaskar, "IoT based solid waste management system for smart city", International Conference on Intelligent Computing and Control Systems ICICCS 2017, 017 IEEE.

[16] Pallavi K N , Dr. Ravi Kumar V , Chaithra B M , "Smart Waste Management using Internet of Things: A Survey",I nternational conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC 2017),IEEE.

[17] Mr. Amit Gyandev Prajapati, Mr. Shankarlal Jayantilal Sharma, Mr. Vishal Sahebrao Badgujar, "All About Cloud: A Systematic Survey".