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IOT Based Garbage Management System: A Review

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ABSTRACT: One of the major concerns in city areas is a solid waste management that India faces in the case of developed or under development states. With rapid growth, the waste produced also increases and the country is facing huge waste management challenge. Many of the cities are still lacking in the area of waste management, in particular, the collection of garbage within the cities. Uncontrollable use of packaging products is also a key source of developing waste. Because of this, garbage can be overflowed in certain areas. This not only poses a health risk to the surrounding communities, but also produces unpleasant environments for the residents.

According to different literature survey it's observed that maximum garbage bin across roadside are overflowing with trash and is not collected at times. It makes viral infection among the people and spreads the bad smell around the vicinity. This sign in increasing some harmful diseases, hence it requires a smart garbage management system that has the capability of detecting waste material prior to the separation process. To overcome these problems, this paper introduces a garbage management system using Internet of Things (IOT) architecture for the smart waste management. By using this technique, it is then possible to monitor and control in real time to separate out wet, dry and metal garbage and if garbage bin is filled with trash then send an alert to the authorized person using IOT architecture.

At present IOT can be used effectively to manage the solid waste. In this paper discussed about definition of Internet of Things and Key IOT Technologies and lastly the study of various literatures available on Garbage management system using IOT.

KEYWORDS: IOT, Cloud, RFID, Zigbee, 6LOWPAN, GSM, Arduino UNO, Raspberry Pi, Node MCU.

I.INTRODUCTION

The environment should be clean and fresh that leads India for a better life and progress. The wastes formed in India is extremely higher than most of the other developing countries. In the present situation, many times it is observed that the trash bins are placed at open places in the cities are overflowing due to increase in the waste every day. These overflowing garbage bins can produce an unbearable smell and make an unhealthy environment. These are the signs of rapid growth of bacteria and viruses which can affect different types of diseases.

Waste can be solid, liquid, and gaseous and each type has different methods of disposal and management. Waste management deals with all types of waste, containing industrial, biological and household. Waste management is projected to reduce adverse effects of waste on human health, the environment. The primary way of effective waste management is to make sure proper segregation of waste at source. At present situation, the garbage is collected in doorstep in most of the municipal corporation in India. The new Government movements like "*Swachh Bharat Abhiyan*" provides more awareness on garbage separation in India. The aim of this mission is to clean and cover all the rural and urban areas of the country [1]. Garbage separation doing very vital role to keep dry and wet garbage separately so that different processes-composting, reutilizing, shall be applied to different types of garbage. Household garbage can be transformed into biogas and can be consumed in cooking purpose at home. This will decrease the amount of waste produced by each family, which supports in planning, distributed waste management solutions.

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The proposed system shall overcome these problems by informing the status of garbage bins along with helping to keep dry, wet, and metal garbage separately without human intervention. By indicating the notification of garbage filled, the time, money and number of tours of garbage collecting vehicle shall also be reduced. By using Internet of things and cloud computing architecture, it is easy to monitor the status of garbage bins through a web page .The proposed system shall be beneficial for garbage separation in Residential areas, Apartments, Institutions ,Campuses, Industries, Hospitals, Commercial offices etc.

II. INTERNET OF THINGS

Internet of things, mainly deals with sensing, actuating, data gathering, storing and processing by connecting physical and virtual devices to the Internet. Internet of things is the twenty first century phenomenon in which physical consumer products connect to the web and start communicating with each other by means of sensors and actuators.

Initially the term “Internet of Things” was developed by the MIT Auto-ID Centre in 2001.The Internet of Things is the concept of connecting one device to the Internet and to other connected devices. The vision of the Internet of Things is to attach small devices to every single object to make it identifiable by its particular unique IP address. These devices can then independently communicate with each other. Devices and objects with intrinsic sensors are connected to an Internet of Thing platform, which adds information from the various devices and applies analytics to share the most valuable data with applications built to address specific needs [2].

Similarly, the other important term is Cloud computing, it is the model for enabling convenient, on demand network access to a shared pool of configurable computing resources. It provides a high level generalization (abstraction) of computation and storage model [3].

III.KEY IOT TECHNOLOGIES

- **Device Intelligence**:An important consideration relates to on-board intelligence. In order for the IOT to become a realism, the objects should be able to intelligently sense and interact with the surroundings, possibly store some passive or acquired data, and communicate with the world around them. Object-to-gateway device communication, or even direct object to-object communication, is desired. These intelligent abilities are essential to support the universal networking to provide seamlessly interconnection between humans and objects.

- **Communication Capabilities:**As noticed it is highly desired for objects to support ubiquitous end-to-end communications. To attain ubiquitous connectivity human-to-object and object-to object communications, networking proficiencies will need to be implemented in the objects (“things”). In particular, IP is reflected to be a key capability for IOT objects, likewise, the entire TCP/IP Internet Suite is generally desirable. Self-configuring capabilities, especially how an IOT device can create its connectivity automatically without human intervention, are also of interest. IPv6 auto-configuration and particularly the scope-based IPv6 addressing features.

- **Mobility Support:**Mobility-enabled architectures, and protocols are necessary for the object. It is key to provide ubiquitous and seamless communication among objects while tracing the location of objects. Mobile IPv6 (MIPv6) compromises several capabilities that can address this requirement.

- **Device Power:**The power constraint is driven by the need to operate for extended periods of time from small batteries or from energy-searcher mechanisms. In general, wireless technologies need significant amounts of power; therefore, the need for low energy (LE) wireless technologies. Batteries are critical to all sorts of products counting laptops, pads, smart phones, and IOT objects.

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- **Sensor Technology**:A sensor network is an infrastructure including sensing computing, and communication elements that give the manager the ability to instrument, observe, and react to events. Sensors facilitate the instrumenting and controlling of factories, offices, homes, cities, vehicles, especially as commercial off-the-shelf technology becomes available.

- **RFID Technology:**RFIDs are electronic devices associated along with things that transmit their identity (usually a serial number) via radio links. The RFID space is large and well documented.RFID tags are devices that typically have a read-only chip that stores a unique number but has no processing competence. RFID tags have broad uses, including the rapid collection of data in commercial environment and also used in industrial environments. The technology can also be used for identification of people or belongings.

- **Satellite Technology:**Due to its global range and the capability to support flexibility in all geographical environments, satellite communications can play a precarious role in many broadly distributed M2M applications.

IV. LITERATURE REVIEW

P. Reis et al. developed the iEcoSys system (Intelligent Ecologic System). It is a technical tool that identifies the waste produced individually, using RFID tags embedded in garbage bags – the iBags. When put down waste, the recycling center identifies and weighs every bag and the composed data is sent to a server system using ZigBee communication standard [4]. V. Wilson et al. announces an automatic system called SWACH (Smart Waste Collecting Hopper) that helps to collect garbage without human interference. SWACH has a web portal introduced on a server using which the user can identify the time of garbage collection. The system peripherals are executed using Arduino that senses the environment and provides essential actuation. SWACH wirelessly communicates to the server to obtain the direction-finding information, using Raspberry Pi, thus porting the complete application on IOT. It is also equipped with the proficiency of detecting and avoiding obstacles that barrier its path [5].

A. Bharadwaj et al. providing a complete IOT enabled system, the process of tracing, gathering, and managing the solid waste can be simply automated and monitored efficiently. By the use of sensors, we collect data from the rubbish bins and send them to a gateway using LORA technology. The information from many garbage bins are collected by the gateway and sent to the cloud over the Internet via the MQTT (Message Queue Telemetry Transport) protocol. The main advantage of the planned system is the usage of LORA technology for data communication that facilitates long distance data transmission using low power consumption as compared to Wi-Fi, Bluetooth or Zigbee [6].

E. Ramya et al. proposed a smart trash bin, if it fills the trash bin it will send the notification to authorized person by GSM then the garbage is dumped into waste land. In this GSM will do the vital role to send an SMS to authorized persons [7].Dr. N Satish Kumar et al. designed a system that it avoids the overspill of the garbage bin by sending alerts using a microcontroller linked to a web server using IOT. It also offers the verification process after cleaning the dustbin. The status of the garbage bins is calculated by evaluating the distance of the nearby obstacle using an ultrasonic sensor. Arduino UNO R3 is being used as the microcontroller to read the data from the ultrasonic sensor. It is programmed to send a notification to the Thing Speak web server if the garbage reaches a certain distance. An RFID reader is interfaced with the Arduino for the verification process. When an RFID tag (ID card of the cleaner) interrupts the RFID reader, the ultrasonic sensor checks the status of the trash bin and leads it to the web server. By using An Android app to view the alerts and status of garbage bin at the server end [8].

A. Mohan et al. offers a waste collection mechanism using an IOT use ultrasonic sensor to find the level of the garbage in the bin Weight sensor supports to differentiate light waste like paper and heavy wastes. Some garbage produces an insufferable smell, hence MQ Gas sensor is used to find the smell. These sensors are devoted to the Arduino UNO microcontroller which sends the information to a Raspberry Pi. The sensor values are constantly observed, when it

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touches the threshold value(s), Raspberry Pi sends the data to the Thing Speak IOT cloud boards. A message is sent to the municipality server and then a garbage clean-up is authorized for the corresponding garbage can [9].

Mohd. Talha et al. introduces a system that centrally observers the temperature, humidity, smoke, fire detection and garbage fill level in garbage bins by using wireless sensing nodes placed at distant locations in the city. The communication from the device node to the central station is done by using TCP/IP protocol using present GSM/GPRS wireless infrastructure within the town. The Arduino Mega establishes a GPRS link with the mobile network then, it samples the smoke sensor, humidity and temperature sensor and ultrasonic sensor signals, forms packets and transmits wirelessly to the Thing Speak server using GPRS connectivity. A message is sent to the worker in authority for cleaning/emergency action. The workers may also monitor the bin in real time using Android app installed on their smartphones. The trash collector vehicle schedules its pick-up / emergency action route accordingly [10]. S. Ghadage et al. provides a comprehensive survey of enabling technologies that use ultrasonic sensors to sense the level of trash in the bin, flame sensor to detect the fire and moisture sensor to separate out wet and dry garbage. By using global system for mobile (GSM) the concerned persons shall be acknowledged through SMS. The officers shall monitor the status of rubbish bins through a web page. As enormous data is to be transmitted and processed rapidly Raspberry Pi3 is favoured as controlling board [11].

S. Karthikeyan et al. offered architecture consists of three modules such as Data acquisition, Data processing and Notification that easy to determine filled status of the waste bin. The data acquisition module located in the waste bin keeps informed the server via ZigBee coordinator, whenever the level of the waste ranges the threshold. MQTT is a lightweight protocol and it offers the communication link among coordinator and the server. The data are informed to the garbage collection unit through Telegram messaging application. Optimum path for collecting the filled waste bin is determined in the server using Haversine formula and travelling salesman algorithm [12]. Pallavi K N et al. reviews the literature survey numerous works carried out on solid waste management using Internet of Things has been deliberated. The literature review has specified solutions to the problems such as sensing the data, analysing the data, collecting data, processing the collected data and getting output results of actual handling of solid waste. Using IOT one can track garbage/bin location, load, missing/stolen bins, the level of the trash in garbage bins and to suggest the shortest path for fast collection of solid waste without or minimum human interference [13].

B. Bharadwaj et al. focuses on the actual approach on dry and wet waste collection using Embedded System. The proposed system is designed for Apartments, Hospitals, Commercial complex. The main slogan of the application called as **"**Swachh Bharat Abhiyaan" which initiates gathering of dry and wet waste distinctly which is located end side of the conveyor belt on which the dry waste collected trash bins are located left side and wet waste collected bins on right side. The system will get the input through the garbage collecting human being via switches and sends signal to the Micro controller unit with RF technology and that creates the H-bridge to rotate conveyor belt. When the belt starts rotating clockwise the trash bins cover is automatically closed, instantaneously the waste is dumped into the underground garbage container placed on the ground floor. At this point IOT module is used to control and monitor the waste and the data will be sent to the particular society and the common man. The mobile app shows the collection of waste and the specific date and time of arrival the vehicle [14].

S. Murugaanandam et al. proposed the method for outdoor trash bins in which Sensor node is installed in every Smart-bin with a power supply unit is secure to the bin. The Sensor node senses dust bin fullness, inform the readings and Sensor statuses with the help of Ethernet modem from Arduino UNO. It also has a function to lock the dust bin door using motors when it is full and at rainy period. Ultrasonic Sensor is used to check the status of the dust bin and similarly update the status of the dust bin and sends this information to its nearby corporate office. An operative HTML based webpage being used to get the status in the office. An IR Sensor is designed for detecting objects. These Sensors are attached to the SPI Interface of the Arduino, also a buzzer is added with relays. The buzzer is being used as an alarm in case people throw wastes nearby the dustbin. The Arduino UNO contains of an Ethernet module, which is used for server client communication [15].

P. Nehete et al. introduced the smart dustbin in which IR sensor being used to detect levels of the garbage filled in the dustbin, water sensor is used to detect the wet garbage in the bin. The LCD is used to display status of the dustbin that

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is low, middle, high, empty or overflow by this technique we can monitor dustbin from the wet garbage. When garbage filled over the 70% of the dustbin level, GSM modem sends registered message to the specific mobile number which is mentioned in the system which is known as code for the system. Buzzer will create sound not merely when water sensor detects wet garbage but also when garbage overflow simultaneously when garbage overflows then message will be received by garbage collector person [16]. S. Ray et al. enables dynamic solution designed for Optimizing Routine Collection Efficiency in IOT based Garbage bin. Cloud Computing, have an advantage, it is more capable, by storing data for analytics. By accessing the available Wi-Fi the device can access the internet. Sensors can notice how much of the trash bin is full. The device can send HTTP request to the Web API, as required, with the Web APIs, trash bins can be configured and data about each trash bin can be stored. The Web API report to the headquarters if a trash bin is full. It stores the time a trash bin is the either filled or cleaned. Machine learning from this data improves the time of routine clean ups and suggests places where another trash bin should be installed so that a single trash bin is not being overflowed. The proposed key tries to balance the frequency of trash bins getting filled, so as to optimize clean-ups. We use K means clustering on the fill times of each trash bin. The value of 'k' is changeable, depending on how many routine clean-ups the management of the institution required [17].

E. Al-Masri et al. designed recycle.io to determine in real-time the types of source material violations prior to the garbage collection. As follows, garbage management systems can identify sources of violations and cure this by taking awareness to the public or issuing fines to prevent violations taking place. Recycle.io is designed of a number of smart recycling bins (SRB) and smart organic bins (SOB). Each of these bins is fitted out with a Raspberry Pi that contains a camera module and an ultrasonic sensor. The information collected by the smart bins' camera module and sensors is guided to an analytics unit. The analytics unit surveys captures images of disposed substances and is able to process them to detect probable violations [18].S. Memon et al. design of the projected system, where garbage bin is fitted out with ultrasonic sensor and that sensor is connected to We MOS D1 mini which is like on Arduino board having built in Wi-Fi capabilities to transfer sensor data to the garbage monitoring system. Conferring to monitor data, garbage collection truck can be informed to collect garbage from that specific garbage bin [19].

V.CONCLUSION

In this paper, during a literature survey various different works which are carried out on the garbage management system has been discussed. It is very important to understand that the literature review has given solutions to the problems such as sensing the data, collecting the data, processing collected data and getting output for effective handling of garbage. Using IOT anyone can track the trash bin location, load, missing or stolen bins, the level of the trash in garbage bins and to recommend the shortest track for rapid collection of waste without or minimum human Intervention.

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