AN IOT BASED WASTE MANAGEMENT SYSTEM FOR SMART CITIES

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Abstract : There is a huge increase in the waste production in the last few decades. This increase in waste generation causes many issues in the environment. The key for solving this issue is waste management. Efficient waste management methods should be used to reduce this problem. These days government is trying to build smart cities and smart waste management is one of the applications of smart cities. Emerging technologies like IOT is mainly of two parts-first collecting information about status of the bin by monitoring. Second is dynamic scheduling and routing for collection of waste from bins using waste disposal trucks. In will be monitored by equipping the bin with embedded devices. The information about the level of the bin is sent to the waste disposal truck along with the location of the bin and truck drivers collect the waste from the bins.

IndexTerms **- sensors, microcontroller, gateway, MQTT, Dijkstra algorithm, GSM modem, shortest path, RFID, big belly, BURBA.**

I. INTRODUCTION

Due to rapid growth of population, the amount of garbage generation is increasing everyday in the society. So, waste management is important to avoid the problems and also diseases caused by the garbage. Efficient waste collection is very important application of the smart cities. The use of emerging technology like IoT helps to improve the waste management systems. IoT can change in the way of waste collection as more information can be known about the bins using sensors. In this paper, we present an efficient method for waste management which uses the emerging technology, IoT. In our system, we use a microcontroller, ultrasonic sensor, load cell, GSM and GPS module. Status of the bin is monitored using ultrasonic sensor and load cell. Load cell calculates the weight and ultrasonic sensor measures the level of the bin. If the bin is full, then the status of the bin along with its location is sent to the waste disposal truck driver. Waste disposal truck driver tracks that location and collect the garbage from the filled bins. In this paper, we also discussed about some of the existing systems for efficient waste collection using IoT. There are also several benefits of smart waste management. Smart waste management reduces unnecessarily visiting every bin by sending location of the bins which are filled.

II. RELATED WORK

Abhay Shankar Bharadwaj et al [1] proposed IoT based architectural solution for waste management for collecting and managing the solid waste. Sensors are used to collect the data from the smart bins and send them to a gateway using LoRa technology. Sensors used are MQ135 gas sensor to detect the harmful gases, two IR sensors for detecting amount of garbage in the bin, PIR sensor foe detecting the presence of the users near the bin and a load cell with HX711 amplifier for calculating the weight of the garbage in the bin. DHT22 sensor is also used to monitor the temperature and humidity of the surroundings and to detect the sound levels sound sensor is used. These sensors are connected through ATmega328 microcontroller. SimTech SX1276 LoRa module is used to send the data to the gateway. Gateway receives the data from the bin by running a local MQTT broker and gateway sends the data to the cloud by using MQTT Bridge over TCP/IP. Web application can be used by the authorities to monitor the entire process. The waste disposal vehicle driver should log in to the application to know about the scheduled bins and best route to collect the garbage.

Saurabh Dugdhe et al [2]proposed a system that provides efficient and optimized routes to collect the maximum waste within less cost by inspiring from the Swachh Bharath Abhiyan to clean the streets, roads and infrastructure of the country by the Indian government. For designing this bins microcontroller is used of the type Open-source hardware which is Arduino based. This microcontroller is interfaced with ultrasonic ranging module HC-SR04 that provides non-contact measurement function up to 2cm to 400cm and the ranging accuracy can reach to 3mm. This microcontroller is also interfaced with MQ4 gas sensor for detecting the harmful gases. These sensors generate data which will be received by the workstation. Workstation will consider the bins which will be filled more than 80% or in the presence of harmful gases. The shortest path will be computed in the workstation and

the trucks will be scheduled. Shortest path is calculated using Dijkstra Algorithm where it will consider the bins as the node's ant takes the input as the graph of the city.

P Haribabu et al [3] proposed a system using mobile application. Heremobile application is associated with the smart trash bin. The main of this system is to reduce human resources. Smart waste bin is built using Arduino board platform. Arduino board is interfaced with GSM modem and Ultrasonic sensor HC-SR04. Some buzzers and LED displays are also used to display the level of the waste in the bin. Ultrasonic sensor measures the distance using Ultrasonic waves. In this system GSM modem is used to send messages. To connect easily to other devices, a GSM/GPRS modem is used with standard communication interfaces like RS-232 which is a serial port and USB is also used. Three LEDs are used which indicates three different levels of waste in the bin. Green light indicates that the bin is empty and red light indicates that the bin is full. Buzzer beeps for three times if the bin is full so that no more disposal is made into the bin. Users get a message to dispose bin when the bin is full. GSM modem is used to send this message and this message can be sent to multiple people during same time.

Mohd Helmy Abd Wahab et al [4] proposed a conceptual approach of smart waste management by integrating web-based system. They proposed a smartrecycle bin application that automatically calculates the waste and convert the weight into point and stored into a card. RFID based system is used to track the smart bins. This system has at least one automated door for receiving the disposed objects. A sensor is used to detect the disposed object into the bin. Target device having a reader is installed on the recycle bin. A microcontroller is used for regulating the recycle bin by establishing connection between the door, sensor and the reader. A base station is having a server is connected to the microcontroller and data is stored in database which is received by the microcontroller. A calculator module is used to calculate the amount of points obtained by the user from their disposal activity. Microcontroller is integrated with a RFID based 3R card and the users owing 3R card should register and create an account on the online system. Data related to recycle bin and the points of the users are provided in the online system.

Jetendra Joshi et al [5] proposed a solution for smart bin in a network of dustbins using IoT and wireless sensor networks. In this system bins are equipped with different sensors like ultrasonic sensor to measure the level of the waste in the bin which is attached to its GPIO pin. Here a network of bins equipped with sensors sends data to a sink node. There are multiple sink nodes which further send data to the gateway node through the means of web service which uploads the data to the cloud. The application layer protocol MQTT is used for uploading the data to the cloud and learning techniques to predict level of garbage using sensor data. The data after doing predictive analysis along with the current status of the bins is sent to the client app. scheduling of the bin to pick up the waste from the bin is generated based on the obtained data in the app. The client app is used to ease the task of disposing the wastein the bin and also to find the shortest route for collecting the waste from the bins which are filled.

Jeannette Chin et al [6] proposed high-tech refuse-bins which are called as ReDBin, where the ReDBinis compared with two other approaches called as Big Belly and BURBA. The basic system proposed in this paper is to deal with five issues. They are network and sensors connectivity, sensing, security, mobility, and data management. ReDBin consists of network sensors for holing and sorting different types of waste. ReDBin has a special feature of self-managing which is in-built and capable of performing self-diagnostics and authorities were informed about the bin whenever bin needs emptying or servicing. It also has a built-in security system and it can be accessed remotely. A management system is hosted by authority to for sending and receiving data from the ReDBins and it works with IPv6 enabled Personal Area Network. Best path is calculated using shortest path algorithm for emptying bin and path is calculated by considering weather conditions and local traffic to maximize the collection of the waste from the bin and to minimize the journey.

III. ARCHITECTURE

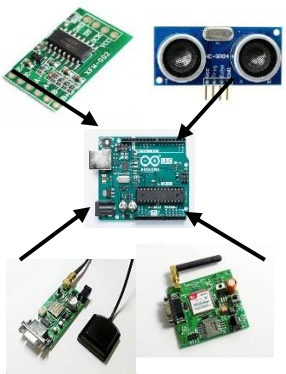

Figure 1. Monitoring status of the bin

IoT based architecture for waste management has mainly two parts. First one monitoring the status of the bin using sensors and second one is dynamic scheduling and routing algorithm for garbage collection from the bins which are filled.

Figure 1 describes about the sensors and modules connected to the microcontroller. HX711 Load cell is used to calculate the weight of the garbage in the bin. Ultrasonic sensor is used to calculate the level of garbage in the bin. GSM module is used to send the message when the bin is full and GPS module is used to send location of the bin. These components are connected to microcontroller.

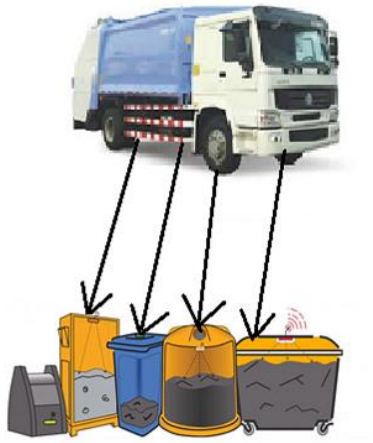

Figure 2. Collecting waste from the filled bins

Figure 2 describes about the waste disposal truck visiting the bins for garbage collection. Waste disposal truck driver gets message of the location of the bins which are filled. Dynamic scheduling and routing algorithm are used to calculate shortest path to visit the waste bin.

IV. CHALLENGES, ISSUES AND BENEFITS

a. Challenges of waste management

- Waste collection methods should ecofriendly and should be in such a way that those methods should not effect environment.
- Waste collection methods should utilize the raw materials very efficiently and resource management should be efficient.

b. Issues with present waste collection methods

- There is no proper planning for the waste collection.
- Lack of awareness among the population about increase in waste production.
- Lack of usable landfills for disposing and recycling the waste collected.
- Lack of awareness among people about smart waste management.

c. Benefits of smart waste management

- Efficient waste collection method and low cost method.
- Harmful gases can be detected easily.
- Reduces unnecessary visiting of every bin. As we can know status of the bin, we can visit only the bin which is full and can empty that bin.
- Reduces man power.
- Waste disposal truck driver will be knowing the location of the bin. This makes easy to empty bin which is full.

V. CONCLUSION

Waste generation is increasing due to increase in population. To manage this waste efficient waste collection methods can be used using different emerging technology. This paper gives you brief description about different methods for waste management given in different papers. This paper provides one effective methods of waste management using IoT. By this method we can

know how sensors are used to collect data from the smart bins and also calculation of best path for emptying the bin when the bin is full.

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