

IoT BASED SMART WASTE MANAGEMENT IN SMART CITY

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Abstract: Waste management is the nothing but a managing the waste that is generation, collection, transportation. The issue with the waste management is the overflow of waste before start of the next cleaning process and produce various problems such as bacteria, insects from garbage, contaminates surface water, air pollution and respiratory disease. This method overcomes these problems, and the design is about separating the waste into plastic, aluminum, glass and also monitoring the volume of the waste in the bin using sensors. Each level of the bin is shown on the web page, if the bin is full then an alert message will be show on the web page and also sent to the worker. The position of the bin is identified by using GPS. After the waste is takeoff, the level of the bin is shown as empty and all the sensor values are stored in cloud.

Keywords: Cloud, GPS, IoT, Raspberry pi, Segregation, Sensors

1. Introduction

Waste management is one of the major issues in the developed and developing countries. India is facing major environmental challenges associated with waste generation, waste collection, waste transportation and waste recycling. The highest amount of waste is generated in the United States, Switzerland e.t.c., A smart city is nothing but a vision to integrate Information and communication technology along with Internet of Things in a such way to manage city assets. 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[1]. The city's assets include, among others, the local departments, information systems, libraries, schools, hospitals, waste management systems, transportation systems, etc. The waste management in India has surfaced or continued to be a severe problem not only because of environmental and aesthetic concerns but also because of the enormous quantities generated every day. Approximately world waste production is expected to be 27 billion tons per year by 2050, one-third of waste

will come from Asia, Currently India's population is 1.34 billion and urban population is 32.5 percent (census 2018) and the amount of waste generated in India is 62 million tons every day. However, waste generation is not an issue but the fact is that more than 45 million tonnes annually, out of which only 11.9 million, that is 22-28 percent is treated, while about 31 million tonnes of waste is left untreated and dumped at the landfill sites by municipal authorities every day in an unhygienic manner and it leads to health issues and environmental degradation[2]. Waste is nothing but any material in which something valuable is not being used or is not usable and represents no economic value to its owner. The generation and disposal of waste in large quantities have created a greater concern over time for the world which is adversely affecting the human lives and environmental conditions [3]. Segregation plays a important role in proper disposal of waste. Generally the waste is separated as bio degradable and non bio degradable, waste can be separated as plastic, paper, wet waste, etc. automatically and placed in the particular bin. The problem is with servo motor whose magnet can be demagnetized [4]. One of the issues with waste management is a overflow, to solve this problem we use the pso algorithm. The particle swarm optimization (pso) algorithm gives information of percentage level of waste in the bin, better path and this can be done by Zigbee and GSM/GPRS technology. The drawbacks are Zigbee technology is not secured and replacement cost will be more when it is damaged [5]. Now a day's internet of things plays an important role in most of the applications in smart city and some of them are air quality by using pollution sensor we can detect how much pollution is in air and also its sensor data is publicly shown to citizens. Waste management using IoT can solve overflow problem, this will continuously monitors the waste and if it reaches the threshold value then it intimates to municipal authority. This is another method to solve overflow problem [6]. The genetic algorithm is used to provide optimized route for waste collection but there are few drawbacks, they are it is a unguided mutation and slow process [8].The smart dustbin is waste collecting bin which can store greater amount of waste i.e., if it reaches the threshold level then it compress the waste and in the

same it can compress three times [9]. The main aim of this project is the awareness of a compact, low cost and comprehensible segregation system for urban households to make more efficient about the waste management process, so that the waste is segregated in basic streams and then waste could be reused or recycled. If the growth of the country increases then the waste also increases so that the segregation of waste is important for proper disposal of the vast amount of garbage modern society produces in an environmentally sensible mode. The benefits of doing segregation is to give higher quality of the material is retained for recycling which means that more value could be recovered from the waste. We propose an IOT based smart waste management and collection system on the basis of segregation and level of wastes present in the waste bins. The waste is segregated using sensors and the data which means the level of the waste is obtained through sensors is transmitted over the Internet to a server for storage and processing mechanisms. It is used for monitoring the daily selection of waste bins, based on which the routes to pick several of the waste bins from different locations are decided. Every day, the workers receive the updated optimized routes in their navigational devices. Each level of the bin is measured using sensor, if the level of the waste reaches the threshold level then the message and location of the bin are sent to the worker.

2. Proposed System

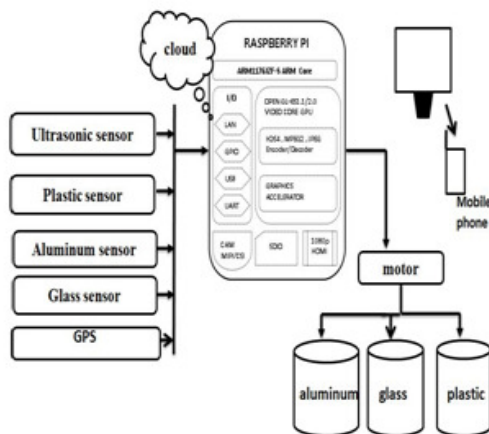


Figure 1. Proposed System Block Diagram

The proposed system block diagram of a smart waste management using cloud IoT based raspberry Pi is shown Fig 1. This system maintains a separation of waste as aluminum, plastic, glass using sensors. The glass sensor is used for glass waste detection, plastic sensor for plastic waste detection, an aluminum sensor for aluminum waste detection and for level detection ultrasonic sensor is used. Dc motor is used for moving

and to place a waste in appropriate bin and GPS is used to find the location of the bin. Using ultrasonic sensor we get the volume of the waste present in the bin. If the waste in the bin is full then the system generate an alert message through raspberry pi and sends the notification and place of the bin to the garbage collecting person to collect the garbage. The garbage collector collects the waste and empties the bin. After the bin is clear, the level of the waste is shown as zero on website. All the sensors values are stored in cloud.

The process after the waste is segregated is shown in flowchart. The flowchart start the monitoring of the bin, if the waste in the bin reaches greater than 90 then municipal authority sends the message to the worker if not continues the monitoring. After takeoff the waste the bin level is displayed as zero in the web page and stop.

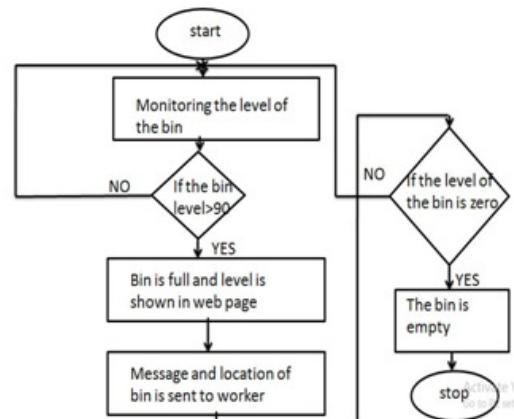


Figure 2. Flow Chart of Waste Monitoring

A. Unoptimised Route

The unoptimised method is traditional method which means the collecting truck comes to each and every place of bin without knowing whether it is filled or not. Using this method there are few drawbacks are waste of time, money, energy e.t.c., To save these there is another route i.e., optimized route.

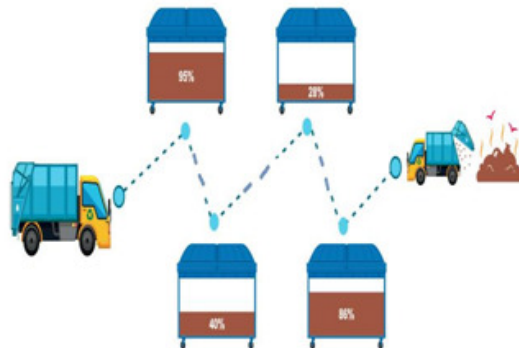


Figure 3. Unoptimised Route

B. Optimized Route

The optimized route is one of the best routing method. In optimized route waste collecting truck is goes to the particular bin which is filled, not to every bin. The advantages are reducing fuel usage, cost is reduced, and energy is reduced.

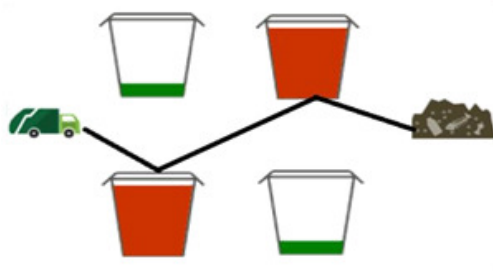


Figure 4. Optimized Route

C. IoT

The internet of things (IoT) is a system of reticulated computing devices which has an ability to transfer data without requiring human to human and human to computer interaction. The thing in IoT defined as a human with a heart monitor or an automobile with built-in-sensors. Internet of things also called as internet of everything because it consists of web enabled devices which collects, send, acts on acquire data which is taken from surrounding environments using embedded sensors, processors, communication hardware. The communication between the connected devices or smart devices to other related devices is called machine-to-machine (M2M) communication, and act on the information they get from one another. IoT plays an important role to make cities greener and more efficient. IoT platforms can improved process efficiency, asset utilization and productivity and help organizations to reduce cost . The opportunities for people, businesses and industries have increased due to the growth and consolidation of data, processes and things on the internet making such connection more relevant and important.

1) Application:

- Smart Home
- Wearable
- Connected Cars
- Industrial Internet
- Smart Cities

3. Hardware Components

A. Raspberry Pi

Raspberry Pi has different models in that third generation model is Raspberry pi model B. This powerful credit card sized single board computer which is used in many applications and replaces the original

Raspberry pi into different models. Raspberry pi is similar to PC which can do many things that desktop PC does like system software, word processing, internet browsing, and playing games. The processing speed of Raspberry Pi model B is ten times more than the previous models and additionally it has Bluetooth and Wi-Fi.

1) Features:

- Broadcom BCM2837 is roughly 50 percent faster than pi2.
- Bluetooth and Wi-Fi
- Full HDMI
- Micro SD Card
- Linux Operating System
- USB Connector

2) Benefits:

- Cost is Low
- Processing Speed is High
- Added Connectivity

3) Applications:

- Home Automation
- Controlling robots
- Gaming
- IoT Applications

B. Ultrasonic sensor

The ultrasonic sensor is a device which is used to measure distance to an object by sending sound waves. The ultrasonic sensor passes out some sound waves and then calculates the distance how long it takes for the echo of the sound to reflect back. The sensor transmits ultrasonic waves through the front opening and another receives them, because it has two openings in its front. The distance calculated manually using a formula, $DISTANCE = (SPEED * TIME) / 2$ One of the ultrasonic modules is HC-SR04 and its range is 2cm-400cm non-contact measurement function.

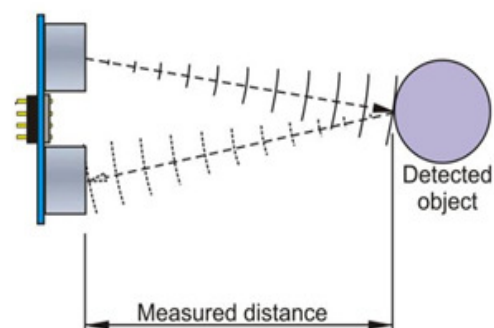


Figure 5. Ultrasonic Sensor

1) **Pins of Sensor:**

- 5v Supply
- Trigger Pulse Input
- Echo Pulse Input
- 0v Ground

Table 1. Electrical Parameters

Working Voltage	DC 5v
Working Current	15mA
Working Frequency	40Hz
Max. Range	4m
Min. Range	2cm
Measuring Angle	15 degrees
Trigger Input Signal	10us TTL pulse
Echo Output Signal	Input TTL Lever Signal and the range in proportion
Dimensions	45*20*15 mm

C. GPS

GPS or Global Positioning System is a satellite navigation system that sends precise details of their position in space back to earth. The signals are obtained by GPS receivers which are nothing but navigation devices and are used to calculate the exact position, speed and time at the vehicles location. They can be used to map are used in military applications and by emergency crews to locate people in need of assistance. Farming (GPS help farmers to harvest their fields, and navigate airplanes on the ground or in the air. GPS works in different applications such military (soldiers can find objectives in the dark and unknown regions with the help of GPS.), Aviation (GPS provides the real time aircraft position of pilots or passengers and map of each flights progress), marine (GPS provides fastest and most accurate method for mariners to navigate, measure speed and determine location), civilians (used by navigators for orientation and precise velocity measurements.). If the person has GPS receiver then they can use GPS technology.

4. Simulation Results

In the simulation part Arudino Uno, ultrasonic sensor, three bins, motor and switches are taken. Process starts with con-necting components before the execution start. Next program has to upload in the Arudino and ultrasonic. After uploading run the program. The simulation operation is when the waste is placed in the bin the sensor will sense the waste and with the use of motor waste is placed in the bin. The motor operates as if the sensor sense particular waste then the motor is moves backward and forward and waste is placed in the

particular bin. The ultrasonic sensor senses the level of the bin and this sensor will continuously monitor the level of the bin. The results give how much of waste is filled in the bin and that is shown in below figures.

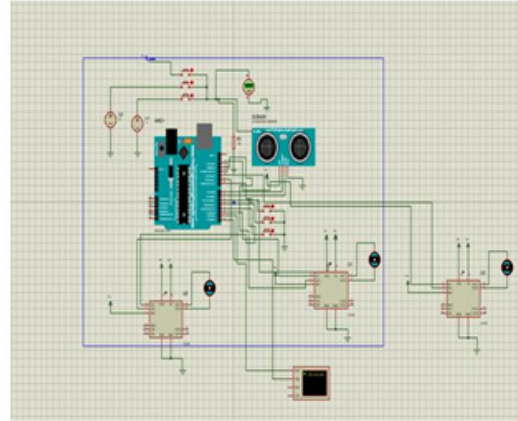


Figure 6. Simulation Circuit

Table 2. Motor Operation

Motor	If Plastic is Detected	If Aluminum is Detected	If Glass is Detected
Motor1	Active	Not Active	Not Active
Motor2	Not Active	Active	Not Active
Motor3	Not Active	Not Active	Active

The table II is for motor operation, if plastic is detected then the motor1 is active, if the aluminum is detected then motor2 is operated, if the glass is detected then motor3 is active. Based on the motor activation the waste is placed in particular bin.

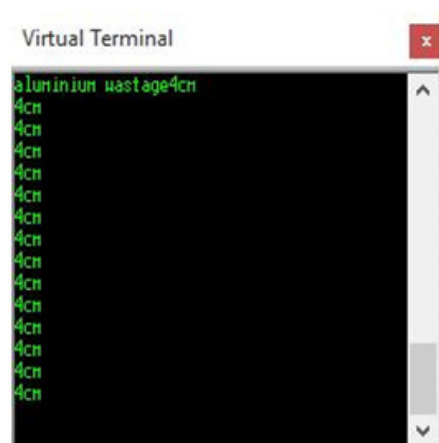


Figure 7. Level of Aluminum Bin

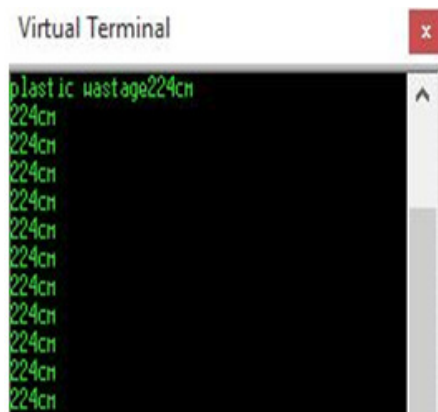


Figure 8. Level of Plastic Bin

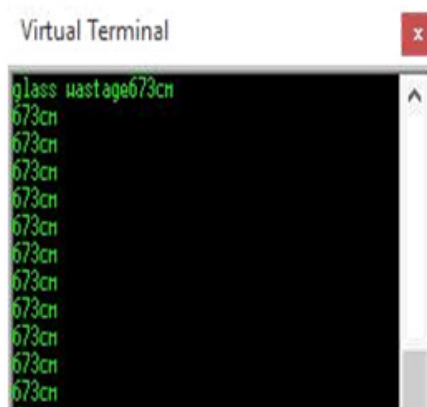


Figure 9. Level of Glass Bin

The figure 7 shows the simulation output for the waste level of the aluminum bin. The figure 8 shows the simulation output for the waste level of the plastic bin. The figure 9 shows the simulation output for the waste level of glass bin.

5. Conclusion

The IoT based smart waste management in smart city is carried out with simulation. The segregation of waste is done using sensors and measuring the level of each bin is done with the ultrasonic sensor. The IOT continuously monitors each bin, and the levels of the bin are transferred to web page through IoT. If the level of the bin reaches its threshold level, then the message and location sent to the worker, after the waste is takeoff then the bin level is shown as zero in web page. Thus, the waste bins will be cleared as and when filled, giving way to cleaner and greener city, better infrastructure and increased hygiene.

In future work Image sensing can be used to segregate materials through Image processing technology and also advanced processing techniques can be incorporated once the waste has been segregated.

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