The Control Of Solid Waste in Smart Cities

SnehaT N [1] , Thrupthi S [2], Vandana C[3] , Yashaswini M C[4]
Students, Dayananda Sagar Academy of Technology & Management, Bengaluru, India Dr. ThiruKrishna JT [5] , Associate Professor , Dayananda Sagar Academy of Tech & MGMT, Bengaluru, India

snehatnsneha@gmail.com[1] , thrupthiachar77@gmail.com[2] ,vvandu699@gmail.com[3]
yashaswinimc2@gmail.com[4], drthirukrishna@dsatm.edu.in [5]

Abstract

Urban sustainability in smart cities depends heavily on solid waste management. In order to assure a sustainable future, smart cities must embrace cutting-edge waste management strategies in response to the increasing development of urban populations and the corresponding increase in trash creation. In smart cities, reducing trash creation, increasing recycling and reuse, and improving garbage disposal methods are the key goals of solid waste management. Smart cities monitor and control garbage collection, sorting, and disposal using a variety of technologies, including IoT sensors, data analytics, and automation. Campaigns for public education and awareness are also essential in encouraging citizens to practise appropriate waste management.Despite the difficulties, smart cities are in a good position to tackle the issue of solid waste management with novel solutions and cutting-edge technology, ultimately creating a more sustainable and livable urban environment.

Keywords—*Solid waste management, Dijkstra's algorithm, shortest path spanning tree, ultrasonic sensor, Arduino UNO, NodeMCU ESP8266.*

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1. INTRODUCTION

Utilizing data and technology to make the waste industry more effective is known as smart waste management. Intelligent trash management using Internet of Things (IoT) technologies attempts to maximize the use of resources, lower operating costs, and improve the sustainability of waste services. In the past, trash was dropped on the ground in open spaces like streets and parking lots without being cleaned up or emptied. Currently, we frequently notice that the trash cans or dust cans in public areas of cities are overflowing as a result of the daily increase in waste production. We suggest building a "Smart Waste Management System" to prevent this because failing so creates unsanitary conditions for people and foul odours in the neighborhood, which spread a number of deadly diseases and human illness.

We provide a trash collection management solution based on giving wastebin intelligence with the help of an IoT prototype equipped with sensors. Large volumes of data can be read, collected, and transmitted by the use of Internet. When these data are analysed using sophisticated and optimized algorithms in a spatiotemporal environment, trash collecting mechanisms can be managed dynamically. Run simulations for a variety of scenarios to investigate the benefits of such a system over a traditional system. The latest technological advancements must be included into waste management strategies that are customized for smart cities. Municipalities, which are in charge of managing waste in cities, have a variety of needs, which makes this component of trash management for smart cities the most crucial. For sustainable municipal trash management, new technologies provide appropriate and efficient waste management solutions.

As previously defined, municipalities primary demand is to have effective garbage container tracking. Asset management
is the effective and useful response to this requirement. With the use of smart sensors included inside smart trash cans, one can easily locate the trash bins. IoT technology-enabled smart sensors will provide users access to real-time asset data. Second, garbage trucks in smart cities must travel the shortest distance possible. One of the major difficulties facing municipal corporations worldwide today is trash management, from creation to disposal. Due to the daily growth in garbage, dust bins scattered around cities and mounted in open areas are

overflowing, putting the public in an unclean situation. To prevent this, we put forth a wireless solid waste management system for smart cities that enables municipal corporations to remotely check dustbin status over a web server and maintain cities clean by minimizing the cost and time needed for it. When the trashcan reaches its maximum level, a gsm module mounted at the dustbin sends an SMS to the waste management department, which enables
the department to deploy a waste collection vehicle to the correct location to collect garbage. The project's objective is to increase the usefulness of the IoT-based solid waste collection and management system for smart cities.

Things (IoT) paradigm is essential for enhancing applications
for smart cities. Solid waste management, which has a detrimental effect on the environment and the health of our society, is one of the most important problems connected to smart city applications. Beginning with trash generated by municipal inhabitants and disposed of in garbage cans at the
source, the conventional waste management strategy.

2. RELATED WORKS

According to Kristoffersen et al. (2020), individuals who use digital technologies (DTS) [1] are important organizers of recycling and reuse. There isn't any structured advice on how to use DTs to properly grasp how circular solutions might increase productivity and resource efficiency. The system can be useful for identifying the discrepancy between actual and expected requirements as well as the new objectives required to close it. It can also be used to establish a similar language for coordinating operations between various fields of study, such as information systems and the circular economy research method. The creation, extraction, analysis, and exchange of data from DTs can help with the circular economy's intelligent resource management. An organization's ability to embrace and apply the circular economy on a large scale depends on.

For cities with a range of issues, such as poor garbage management, Gondal et al. [2] (2021] looked into the Multilayer Convolutional Neural Network (ML-CNN). directly associated with the population density. Municipalities and city administrations rely on pricy, inefficient, and labor-intensive waste sorting methods. Improved waste recycling calls for automatic waste classification and management in developed locations. By lowering the need to purchase new raw materials, improved garbage recycling can reduce the amount of waste that needs to be disposed of. Image segmentation was used in real-time tests. When an item is placed in its designated basket, the model determines its class and activates the appropriate hammer to remove it.

Applied a detection strategy and discovered a more efficient way to recycle and dispose of waste. By Kumar et al.[3] (2021b), the YOLOv3 Algorithm (YOLOV3) was demonstrated to result in ecological discord. According to the experimental results, the suggested YOLOv3 technique provides a reasonable level of generalizability for all waste classes with a range of waste components. According to the results, the suggested work successfully separates trash into biodegradable and non-biodegradable categories. Given the reduction in detection time and the extraordinarily high prediction probability, further study is still possible.

Forecast likelihood and outcomes optimization for different waste products in the real world can be the subject of future study and results optimization. The definition of dynamic routes in relation to the trash assortment issue was covered by Ramos et al. [4]. Despite taking into account the availability of the time period data, this work examined a reduced form of the problem, which is a small-scale optimization problem that is solved every day using only the sixty-eight trash cans. The number of available cars and the percentage of overflowing bins don't appear to be taken into account.

Sharma et al. [5] 2020 looked at the barriers to Internet of Things (IoT) adoption for waste management in smart cities. In the current investigation, hybrid Multi-Criteria Decision-Making (MCDM) strategies were employed. This study can aid decision-makers, participants, and The government has a greater understanding of how waste management practices are being impacted by the Internet of Things. They may be better positioned to address these obstacles for a more effective IoT adoption in smart city waste management efforts. Our analysis uncovered a few modest IoT adoption roadblocks. Waste management in smart cities can be divided into services, and stakeholders will be more successful if they do this well.

The Multi-Layer LoRaWAN Infrastructure for Smart Waste Management was launched by Baldo et al.[6] in 2021. Long Range Wide Area Network (LoRaWAN) has gained notoriety as a crucial enabling technology for the creation of IoT architecture in recent years. In contrast, the design of a LoRaWAN infrastructure described in this article combines various service typologies inside one of the most significant subsystems of the smart city ecosystem on a single network.

Gomes [7] suggested developing a smart trash can. The ultrasonic range finder in this variant is useful for sending data to the server. The power source's capacity is 3620 mAh, while the system's current consumption is 47.48mA. The model has a low power consumption and communicates using the IEEE 802.14.5 standard protocol, as demonstrated in [1].
the frequency band with a 50-meter maximum transmission distance. In this system, the power consumption is measured.

3. PROPOSED WORK

In this work we have installed sensors in waste bins to collect the real time data and route optimization to get optimal route for garbage collection trucks. The architecture is shown in below fig1.The work process starts by collecting data from the garbage bins. Unique id is provided for every bins. The data is stored in server and then used to find shortest or optimal routes and send to truck drivers.
Our model consists of two phases. They are

i. Collecting data from the trash bins
ii. Finding best optimal route for trash collection

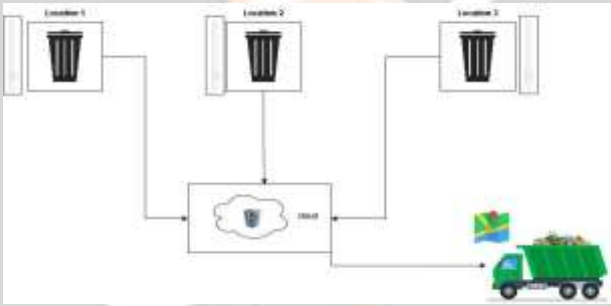

Fig 3.1. Architecture of proposed work.

i. Collecting data from the trash bins

In this phase we focus on collecting the data from the installed sensors in the trash bin. We have used ultrasonic sensors for detecting the bin level. When the trash bin is empty the led turns green and when the trash bin is filled then led turns red. After this the notification is sent to the truck drivers through email.

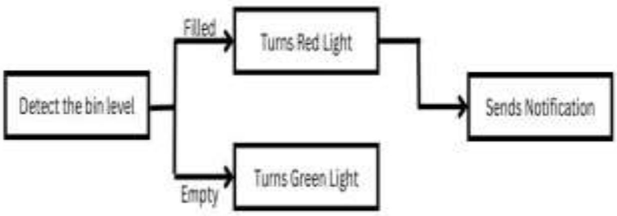

Fig 3.2. Collecting data from the trash bin.

ii. Finding best optimal route for trash collection

The data sent to truck drivers used for optimal route. To find the best optimal route we have used Google API where Dijikstra's Algorithm is used. Dijikstra algorithm helps to navigate the shortest distance and path to reach the trash bins. By this we can save time and fuel.

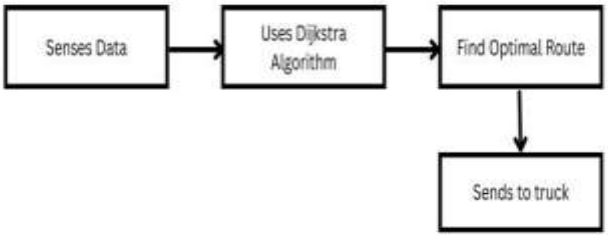

Fig 3.3. Finding best optimal route for trash collection.

3.1 HARDWARE COMPONENTS

A. Ultrasonic Sensors

Fig 3.1.1. Ultrasonic Sensors.

Ultrasonic Sensors used in smart trash bins to detect the level of trash bin where bin is full or empty. The ultrasonic sensor transmits sound waves. These waves get reflected whenever an object comes into the vicinity of the sensor. This generates an electrical signal which is used find the bin level.

B. NodeMCU ESP8266

Fig 3.1.2. NodeMCU ESP8266.

A cheap open source IoT platform is NodeMCU.Hardware based on the ESP-12 module and firmware running on Espressif Systems' ESP8266 Wi-Fi SoC were initially supplied.NodeMCU is used to read data from the sensors, process it and send the data to cloud. Also With the help of the Wi-Fi connectivity, NodeMCU can be used to remotely control the bin operations such as opening and closing of the lid or starting and stopping of the bin's motor.

C. Arduino UNO

Fig 3.1.3. Arduino UNO.

The Arduino Uno is an open-source microcontroller board created by Arduino.cc and first made available in 2010. It is based on the Microchip ATmega328P microprocessor. A variety of expansion shields and other circuits can be interfaced with the board's sets of digital and analogue input/output (I/O) pins.Arduino uno is used as an object detection sensor. It is used to measure the distance of the object from the sensor.

4. RESULT ANALYSIS

Fig 4.1. Proposed System.

An interior site was used to develop and test an IoT-based solid waste management system. The completed prototype for the suggested system is shown in Figure 4.1.

Fig 4.2. Status of Bin Level.

In the proposed system, when the trash cans are empty then the green led light get triggered. In the similar way when trash cans are filled the red led light get triggered and give an alert notification to truck drivers through email to collect the waste from the trash cans.

Fig 4.3. Email Notification.

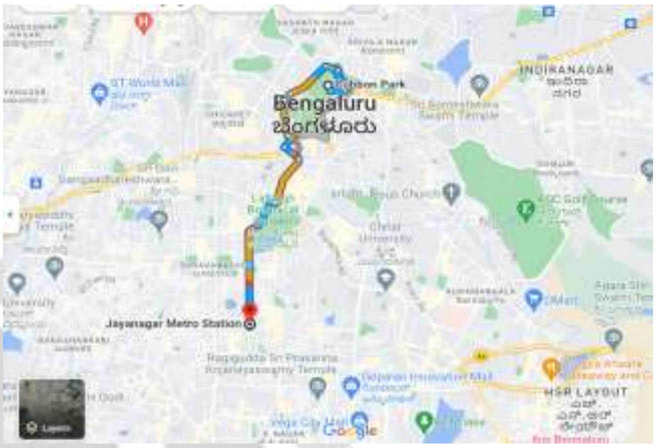

Fig 4.4. Optimal Route.

Email notification sent to truck driver when the bin is filled. In the suggested system, trash cans are fitted with inexpensive embedded systems to monitor the level of trash inside. Sensing data is transmitted over the internet, enabling truck drivers to determine which bins are full and where, as well as to find the fastest route to those bins.

5. CONCLUSION

In recent years, the garbage collection has been handled in a pretty stale manner. Additionally made possible by the spread of sensors and actuators are dynamic models. We have recommended a more effective with stated characteristics like resource optimization, cost reduction, and time management, trash management system based on Internet of Things idea has intelligent administration of all rubbish bins situated throughout city. The suggested system also gives the garbage truck driver the ability to observe the path from his current location to the location of the fully loaded waste bin.In the suggested approach, trash cans are fitted with inexpensive embedded systems to monitor the level of trash within the bin. Sensitive data is transmitted online to assist truck drivers in find out which bin is full where it is, and the driver may choose the shortest route to that specific bin.

Additionally, unlike the present waste management system, drivers may actively participate in the entire system. In order to quickly locate the most effective route to the intended bin, we used the Google Map API.

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