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Geospatial-Enabled Smart Bins: Optimizing Waste Management for a Cleaner Environment

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Abstract: ***As technology advances, a greater number of aspects of human existence use it to improve response times to customers by cutting down on latency and speeding up processing. The "smart bins" were one such device. Despite being user-friendly for citizens, it is more useful for organizations, as it uses sensors to generate information on the bin's status, such as if it is full. Our focus is to create a smart bin that is also user-friendly for citizens. With the use of these smart bins, residents can quickly and easily report any issues they are having with the bin to the respected organization. Our objective benefits the organizations as well as the citizens. Our smart bins are equipped with Geospatial technology, so based on citizen complaints about specific bins, an online platform will determine the fastest way to visit every bin in the least amount of time. Using this method, organizations may solve the issue faster and with less personnel. In this way, everyone will become accountable for their locality and the globe will be hygienic.***

Keywords: Smart Bins, Geospatial, Citizens, Organization, Online Platform

I. INTRODUCTION

Sustaining a clean and sustainable environment requires effective waste management. Living in an uncontaminated environment is essential for maintaining good health. To have a tidy and clean atmosphere, there are several factors to consider. Keeping dump yards clean is one such difficulty. Because bad odour, filthy roads, tainted ground water, and soil degradation brought on by dump yards provide the largest challenges to residents of metropolitan areas as shown in figure1.1.

Municipalities in our communities, for example, are working to address this issue by cleaning up the waste from disposal sites and maintaining a hygienic atmosphere. As safety precautions, they are employing both human labour and various types of trash cans for that purpose. Regular patrols by sanitation personnel who visually check the streets and public areas for rubbish accumulation are part of the conventional methods employed by the municipality. To locate regions with a large concentration of trash, they depend on their knowledge and observational abilities. Once the waste has been located, employees use manual collection techniques to physically pick it up and haul it away in containers and sacks.

Figure1. 1 Garbage in metropolitan cities

The town also coordinates recurring cleanup events when volunteers and staff unite to take on larger-scale waste removal. Focus is placed on physically demanding activities like sweeping, raking, and bagging the collected trash during these occasions. After that, the collected garbage is sent to authorized disposal locations for additional processing.

Although these conventional techniques have served as the municipality's mainstay for waste identification and cleanup, they frequently run into problems including limited effectiveness, high labour costs, and significant delays in pinpointing specific issue locations.

My proposal is to bring up geospatial technology and the use of smart bins in our communities to lower risk.

1) *Benefits of utilizing geospatial networks:* These days, any organization's primary goal is to increase output while utilising fewer resources and completing tasks faster. Therefore, labour is the real resource that municipal organizations use to remove the trash. Anybody who want to voice concerns about the issue with the trash at the side of the road must file a complaint by phone or online, but this is a laborious process. So, to resolve all of these challenges, geospatial technology can be applied. Using latitudes and longitudes, this technology will be useful to search the entire planet[8]. The best example of how this technology is useful is Google Maps.
2) *Benefits of using smart bins:* With the aid of smart bins, less manpower will be needed to gather information on the status of the bin (such as full or damaged).[1] Across several nations, smart trash cans are utilized to mitigate issues with traditional trash cans. They automatically separate waste materials based on specific characteristics, and they can sound an alert to reputable organizations when the bin is full and has to be empty[9].

II. LITERATURE SURVEY

Mannem Srinivas et al.[2] had used the IOT sensors for the creation of a smart bin. The 3D printer is used for the entire prototyping phase of the model. The purpose of this experiment is to confirm whether smart bins can be deployed in cities and used to manage trash effectively. The entire testing procedure takes place in an IoT cloud research lab.

S. Murugaanandan et al.[3] had discussed about the problems in handing trash in metropolitan cities and also about the limitations of the model which has been using for the smart way of collection and clearing of waste in smart cities.A smart bin consisting of a set of sensors, detectors, and actuators was put into place. Their model has an added feature that sounds an alarm, informing reputable companies or the local waste management teams about the condition of the bin. With this characteristic, a standard method of trash management in an effective manner was seen throughout their communities.

In the study conducted by T. Mary Jane et al.[4], as documented in their work, the focus was on exploring the potential of the Internet of Things (IoT). The IoT involves connecting everyday objects, ranging from household appliances to trash cans, to the Internet for the purpose of convenient monitoring and control. The primary objective of their investigation was to enhance trash segregation productivity and maintain hygiene in real-time, addressing cleanliness concerns through the implementation of a smart bin system.To achieve this, the researchers employed a T.colour sensor within a cost-effective waste management system. The innovation also integrated the concept of an automated guided vehicle (AGV) to create a path-based robotic garbage collector. Because this particular combination of technology was used in the model's construction, automatic trash management was accomplished effectively and without incurring additional costs.

Nesreen Alsbou et al.[5] had developed a model of smart bin which is beneficial for the users and organizations in terms of cost and usage. A feature of intimation of the overflows of the bin to the respected organizations are been used in this economic friendly bin.It consisted of a main garbage can with a waste-level-detecting ultrasonic sensor on the lid. The mechanism alerted the waste management provider for collection when it reached its maximum capacity. The main bin had a crusher to compress waste and stop overflow in order to meet imminent full capacity. Furthermore, surplus garbage was held until collection in an additional bin that was installed and expanded. The comprehensive system operated entirely on energy harnessed from solar panels seamlessly integrated into the lid of the main bin. This kind of technology will improve the model's performance without affecting how much electricity is used. To the greatest extent possible, the model's performance and use can be enhanced by using the solar panels. The operation of any alert raising in the smart trashcan does not require an electricity wire system, and the environment will be spared from pollution brought on by electrical resources.

A.P.S Kumar et al.[6] had used the IoT technology (Internet Of Things) for the creation of smart cities using smart bins for automatic trash collection. As the IoT devices can transmit the data to the respected authorities according to the program being installed in the device. By this way the authorities can receive the data in the allotted time series. So, in this study the smart bins are connected to the trash collecting vehicles and the dynamic updating of the route is being used to traverse all the bins in the locality. By using this type of feature of dynamic updating of routes, the time required for the traversing will be decreased.This innovative strategy showcased the potential of IoT in optimizing waste management processes within urban settings.

Digital twins, which enable the development of virtual copies of actual items and systems for real-time monitoring and analysis, quickly became a fundamental component in the construction of smarter cities. The growth of fake goods has been a major worry in the worldwide market, particularly in smart cities. M.Saad et al. [7] employed a 5-dimensional digital twin model approach to investigate and summarise commonly used enabling technologies and techniques for digital twin applications in solving this issue.

III. PROPOSED METHODOLOGY

The steps involved in my methodology are:

1) Higher organizations like the ministry of housing and urban affairs should gather geospatial data from the agencies.
2) The higher authorities need to conduct "garbage detection" in certain areas.
3) Organizations should then communicate with the regional municipal bodies.
4) Local organizations should now set up "SMART BINS" at the necessary places.
5) Local organizations will take measures after receiving comments from the public.

Total algorithm are shown in figure1.3.

A. Garbage detection using machine learning(CNN)

We have used Convolutional Neural Network (CNN) algorithm for the purpose of detection of garbage in geospatial images. A customized data set of 1000 samples had been created by us for training the model. Steps followed in this process are:

1) Data set is created and the images are preprocessed by using the techniques such as flipping, rotation, etc.
2) The data set is splitted in the terms of percentages as 70% as training set for model, 15% as validation set and 15% as testing set.
3) Using the training samples, the CNN model had been trained.
4) The model is created in a way that it is capable of detecting the presence of garbage in the image by converting the image into gray scale and by applying the filters.
5) After the training process is completed, with the help of testing samples the model is examined on the unseen images.
6) By increasing the number of epochs upto required limit, the accuracy of the model had been increased.
7) When an unseen image had been give to the model, the result produced by model is as shown in fig 1.2.

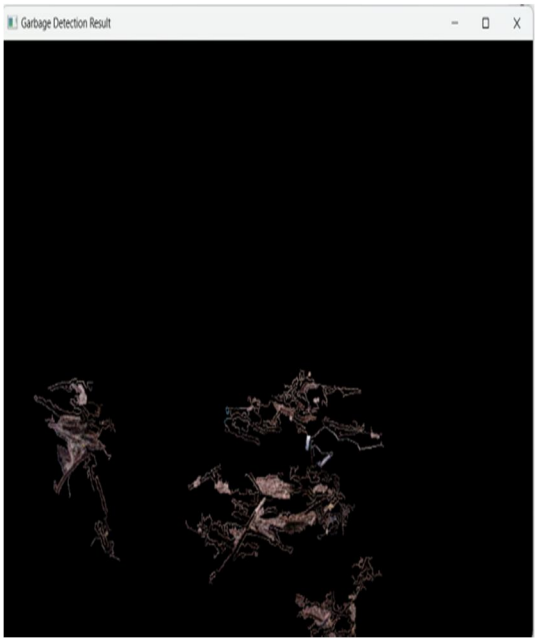

Figure1.2. Outcome produced by the CNN model

We have chosen the geospatial images in this idea, because on the geospatial images there will be latitudes and longitudes on the images and this latitudes and longitudes will be very much useful for identifying the location in the world where the problem(garbage) is being existed.

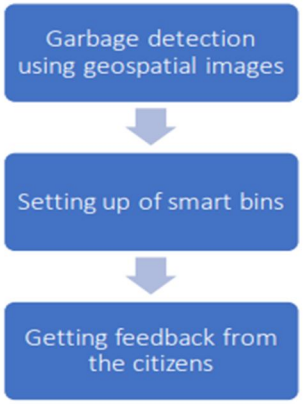

Figure1.3.1. Two work flows of Proposed methodology of smart way for waste management

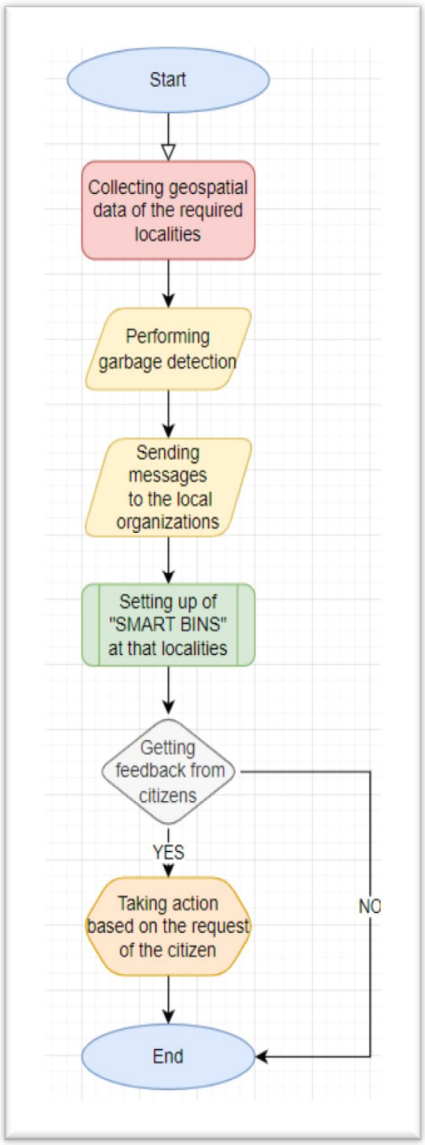

Figure1.3.2. Two work flows of Proposed methodology of smart way for waste management

B. Characteristics Of Smart Bins

Unique features in the smart bins are:

1) Ultrasonic and infrared sensors are employed in smart bins to sound an alert when the bin is full and send a message to the nearby municipal organization informing them of the bin's status.

2) By scanning a built-in QR code that is printed on the smart bin, residents of that area may file a complaint with the local municipal organization and describe the issue they are having with the bin and ask for a quick resolution.

3) Residents in the area may file complaints with the appropriate organization about the smart bins that have been placed there, saving time and effort.

IV. RESULTS

The view of the smartbin equipped with QRcode will be as shown in figure1.4.

Figure1.4. Inbuilt QRcode on the smart bins

Result of scanning QRcode is shown in figure1.5.

It produces a Google form containing information about the location of bin, a drop-down menu for selecting the problem facing by the citizen and remarks.

Anyone wishing to file a complaint should fill out the lengthy text field the website provides. However, communication with the appropriate authorities takes a long time, and organizations should read the entire text message to comprehend the victim's situation. Therefore, if the individual is given a Google form, the process will be simple and time-saving for both the client and the company.When submitting a complaint via the Google Form, users will have fewer alternatives to choose from. Thus, someone with limited time to file a complaint can also conveniently discuss their issue via the form. A drop-down menu with only essential options is presented in the Google Form for users to choose from. Each bin has an individual bin number. So, if the individual wants to indicate the bin in which they are having problems, they can do so by entering the bin number. Additionally, tracking down the problem's location will assist the organization eliminate it more quickly.

The alternatives in the drop-down menu will not be sufficient if the individual want to express the exact issue that the bin is having. Therefore, the form also has a text section for that purpose. The text field does not need to be filled in. Thus, the space will only be used by those that require it.

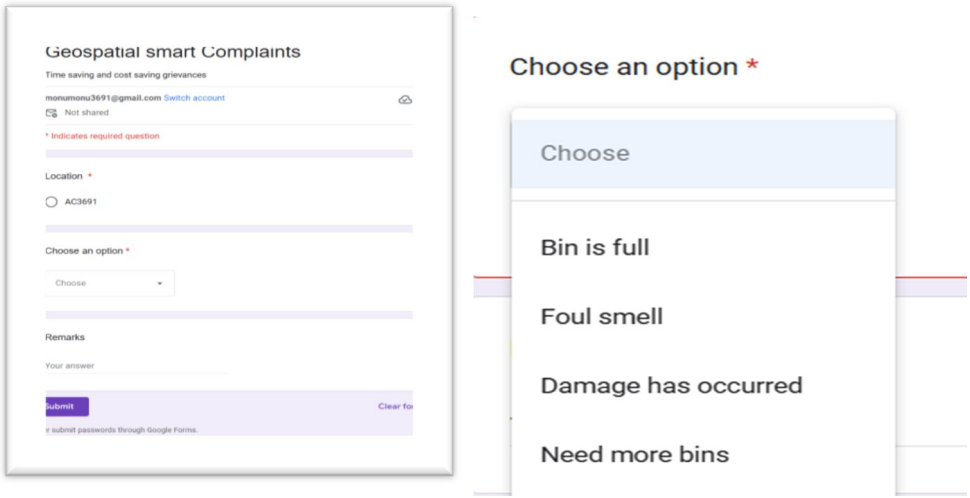

Figure1.5. Google form generated for the citizens to give a complaint to the authorities

V. CONCLUSION AND FUTURE SCOPE

The integration of geospatial technology with smart bins for trash identification and cleaning, in conclusion, constitutes a revolutionary method of waste management. Geospatial technology gives authorities the ability to precisely map and monitor rubbish dispersion, which results in targeted collection routes and optimized resource allocation. Sensing-enabled smart bins provide proactive garbage collection, exact fill level monitoring, and reduced environmental risks, all of which further increase efficiency. By recognizing recycling opportunities and assisting trash reduction efforts, these technologies encourage sustainable waste management practices. In future, we can propose a method in which with the help of geospatial technology, shortest path can be generated to traverse all the smart bins which are raised by the complaints. It will help the municipal organization to save money and man power.

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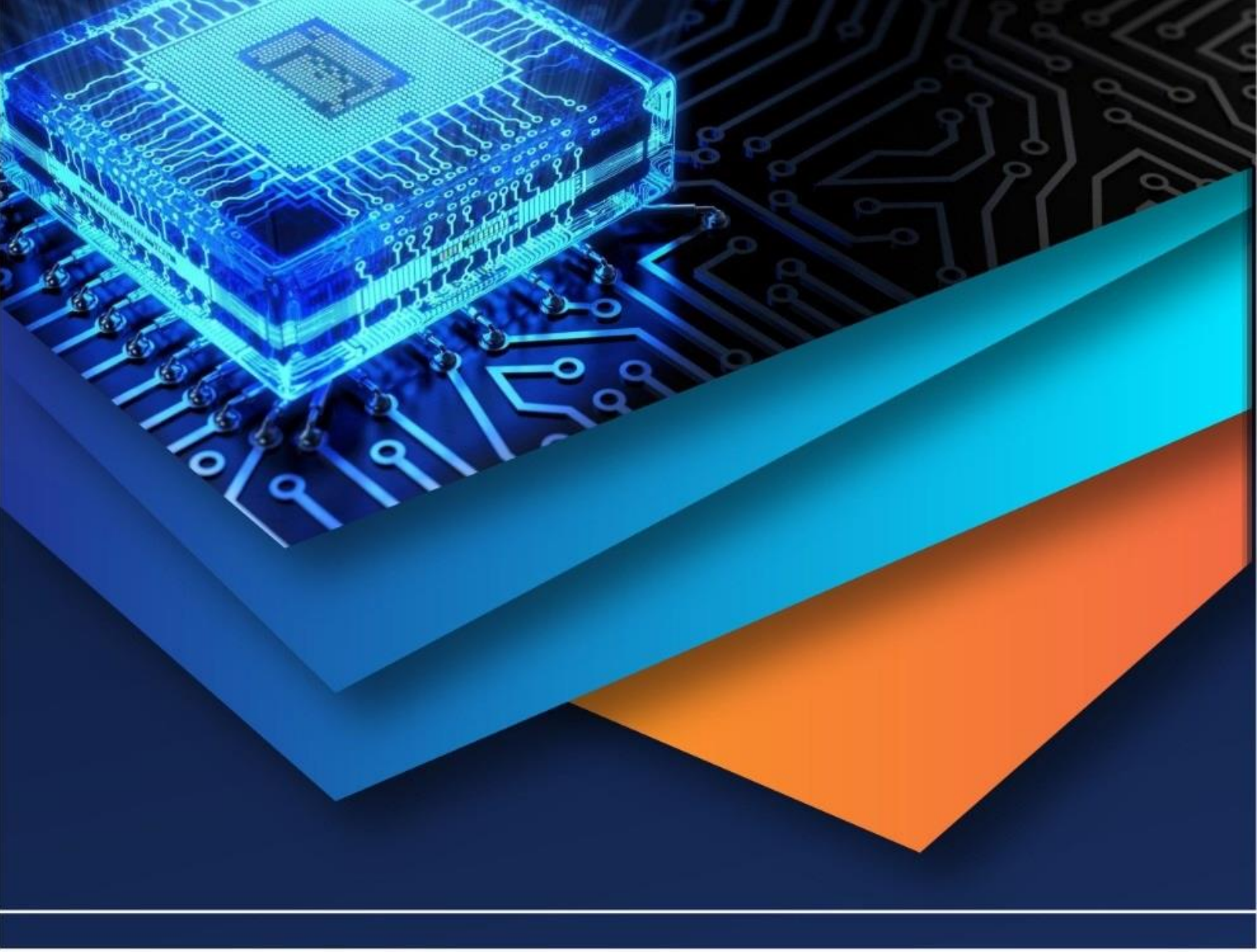

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