### WASTE MANAGEMENT THROUGH DRONES

# (REVIEW-III REPORT)

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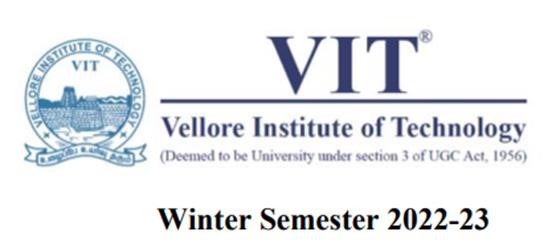
### ECE3502 – IOT DOMAIN ANALYST

*Project Guide*

### Dr. SHOLA USHARANI

# Btech in Computer Science

# SCOPE



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# ABSTRACT

The concept of automation utilized in waste management systems falls under the category of cleanliness and hygiene. In all developing nations, it is normal practice to dump trash on the ground and in public spaces, which has a negative impact on the environment and leads to various unsanitary problems. In order to deal with these problems Smart drone is an ideology put forward which is a combination of hardware and software technologies i.e., connecting Wi-Fi system to the normal drone in order to provide free internet facilities to the user for a particular period of time.

The technology helps the government officials for keeping the surrounding clean and thus work hand in hand for the proper waste management in a locality. Drones can be equipped with cameras and sensors to monitor and map waste in real-time, enabling efficient and accurate waste finding. Smart drones use multiple technologies, firstly the technology for classifying trash dumped, secondly the movement of the waste and lastly sending necessary signals and connecting the government officials to the Wi-Fi system. The use of drones in waste management has the potential to improve the efficiency and effectiveness of waste collection and disposal processes, reduce costs, and promote environmental sustainability. The proposed system will function on a cause that will assure a clean environment, good health, and pollution free society.

# PROBLEM STATEMENT

As we know our surroundings are not neat and clean which leads to various problems such as blockage of drains, polluted environment, unhealthy atmosphere, unhygienic environment and other problems.

This mainly occurred because municipality and government officials fail to clean the public places, so to solve the problem we propose an idea by which we can monitor our surroundings through drones. The drone will help us to identify where garbage is present in our surrounding this will be done by camera module present in the drone which will classify the image based on image classification model and their respective locations will be send to the government officials so that they can have the proper locations of the garbage beforehand and then they can clean it. This will help us to keep our surroundings neat and clean.

# OBJECTIVES:

* Real-time monitoring: IoT sensors on drones can provide real-time information on waste levels, helping waste management companies to optimize their collection routes and schedules. This can reduce fuel consumption and carbon emissions, while also improving the overall efficiency of waste management operations.
* Environmental protection: Effective waste management through drones can reduce the negative impact of waste on the environment, including air and water pollution, greenhouse gas emissions, and damage to natural habitats. This can help protect the environment and promote sustainable development.
* Efficient waste collection: Where municipal trucks of garbage cannot go, drones can help in finding the place and municipalities can send small vehicles to collect the garbage there. This reduces the time for heavy trucks to go the narrow roads and saves time. It maintains a high compaction rate.

# LITERATURE REVIEW OF PAPERS

**1. The development of sustainable IoT E-waste management guideline for households**

**Date of publication:** 24 May 2022.

**Authors -** Marym MohamadRazip, K.S.Savita, Khairul ShafeeKalid, Mohammad NazirAhmad,

MaryamZaffar, Eidia ErrianyAbdul Rahim, DumitruBaleanu, AliAhmadian

**Problems and Objectives –**

The advent of new technology, like the Internet of Things (IoT), necessitates an increase in digital devices, which, if improperly handled, could eventually lead to a substantial volume of electronic waste (e-waste) creation. In addition, there are yet no regulations regarding the potential generation of "IoT E-waste," perhaps as a result of the IoT's recent developments and widespread adoption. Therefore, a sustainable IoT E-waste Management guideline for families was developed in this research. In Malaysia, a sustainable household IoT e-waste management initiative may be developed and put into action with the help of government agencies and policymakers. This study uses a qualitative case study research methodology and is exploratory in nature. The Integrated Sustainable Waste Management Model was used as a foundation for developing the guidelines. This guideline contributes to Malaysia's sustainability agenda in reducing carbon emissions intensity towards 2030 by 45 percent.

**Methodology:**

A multiple case study research methodology was used in this study, which is especially appropriate for exploratory studies. (Yin, 2003). Participants' experiences and the environment of the activities are crucial for understanding complex, temporal processes (the why and how of a phenomena), rather than factors or causes. (what)Participants' perceptions and the environment of activities are crucial for understanding complex, temporal processes rather than factors or causes. (why and how of a phenomenon) identifying problems and making suggestions for solutions

From the data gathering, a number of problems and difficulties that customers encounter in managing their household E-waste are discovered. Data are classified and analyzed based on the model's projected themes during the adaption process. Then, recommendations are made for improving the substance of the guidelines further on in the study.

**Performance Limitations –**

In this paper the goal was to manage the e-waste. The idea was to propose different solutions based on the problems faced by different people but this could lead to scalability issues.

They collected different data from different households and proposed accordingly this could create problems in scalability of the proposed methodology because a large amount of data needs to be taken care-off.

**2. The role of 4IR technologies in waste management practices-a bibliographic analysis**

**Date of publication:** 2022

**Author** – Radhakrishnan Viswanathan, ArneshTelukdarie

**Problems and Objectives –**

Natural resource depletion is a problem the world faces because it results from environmental disturbances brought on by rapid industrialisation, population growth, and a careless attitude toward the environment. The amount of waste produced is growing exponentially along with population expansion. Authorities are forced to effectively manage the systems and work toward environmentally friendly alternatives, such as diverting garbage from landfills. The SDGs for the environment, human health and wellbeing, and responsible consumption and production all overlap with waste management.

Waste produced by various societal sectors necessitates quick monitoring, data collection, and the capacity to support decision-making in all areas of waste management activities. The use of Industry 4.0 (4IR) technology is expected to alter the dynamics of the entire chain of events in waste management. Critical examinations are necessary to comprehend this technological development and its effects on several parts of waste management. Through a thorough review of the studies done by renowned academics, this article seeks to explain how 4IR technologies have affected waste management.

**Methodology –**

Using the keywords "Waste management" AND "Industry 4.0" in the Scopus database, the study's systematic literature review (SLR) found 173 publications for the years 2010–2021 without the use of any filters. The data is taken into account for a descriptive analysis before being further examined with the help of the VOS viewer programme. This includes keyword and bibliographic coupling analysis as well as citation analysis (author and co-author relationship). The threshold is kept at a minimum of one (one document is provided per author) when the software is running for author inclusion under citation, co-authorship, etc., producing 656 terms (author). To reach 23 nations for various country-based analyses, the threshold was kept at 4. To guarantee 110 terms, the bibliographic coupling with the texts had a minimum of one citation.

Fractional counting is now widely used.

**Performance Limitation –**

This idea proposes the use of technology wherever it is possible but this may create problems as it will reduce the job in those sectors and also lots of data will be generated and it will be very tough to manage those data which can create problems .

**3. IoT-based smart bin allocation and vehicle routing in solid waste management: A case study in South Korea**

**Date of publication:** September 2022

**Authors:** Arindam Roy, Apurba Manna, Jungmin Kim, Ilkyeong Moon

**Problems and Objectives –**

Due to population increase and fast urbanization, rising garbage generation has become a significant problem. As a result, the majority of trash cans easily overflow due to poor waste management practices and inconsistent trash can cleaning. The internet of things (IoT) is an amazing contemporary technology that provides potent solutions to modernize conventional systems. The fill level of garbage bins is taken into account in this study together with IoT-based waste bins. In order to improve solid waste management, this study develops an integrated IoTbased smart bin allocation system with a central monitoring system (CMS) and improved truck routing algorithm. If these garbage bins are not emptied as soon as they are full, the timedependent penalty concept is suggested in this article to waste management agencies. An intelligent variable neighbourhood search with ant colony optimisation approach (VNS- ACO) is created to get the solution with a quicker execution time. A sensitivity analysis is established using several parameters, and the proposed model is presented with some numerical data. Additionally, testing on various cases of the travelling salesman problem (TSP) from the travelling salesman problem library demonstrates the superiority of our created VNS-ACO algorithm. (TSPLIB). Results have been compared using genetic algorithm (GA) and ACO approaches in their advanced forms.

**Methodology –**

Our proposed model of an IoT-based smart bin system has the potential for detecting the overflow of waste bins (Fig. 1).

Detail configuration:

Ultrasonic sensors (USs): Ultrasonic sensors measure the space between a smart bin's closing lid and the amount of trash it contains. Real-time data from the smart bin's US sensor is communicated over the wireless module to a smart waste management system from the continually captured data by USs provided to a Wi-Fi module via the Arduino Uno system.

**Performance Limitation –**

It can fail in some areas because to make it successful we need to change the mindset of the people as if the dustbin does overflow then also people will drop their garbage there only in open surroundings they won’t move to next locality to drop their garbage bag.

**4. Emerging Paradigm of IoT Enabled Smart Villages**

**Date of publication:** [2022](https://ieeexplore.ieee.org/xpl/conhome/9730107/proceeding)

**Authors:**[Rohani Rohan;](https://ieeexplore.ieee.org/author/37088597477) [Debajyoti Pal;](https://ieeexplore.ieee.org/author/37086333160) [Bunthit Watanapa;](https://ieeexplore.ieee.org/author/38132856600) [Suree Funilkul](https://ieeexplore.ieee.org/author/37085608390)

#### Problems and Objectives –

An emerging concept called the "smart village" uses numerous IoT technologies to try and digitize different parts of rural activities. Its scope includes several endeavors including smart agriculture, waste management, irrigation control, livestock management, smart energy, smart healthcare, and smart education. Infrastructure and cost are the two main obstacles to the implementation and sustainability of a smart village, which sets it apart from a smart city. In light of this, we developed a thorough taxonomy to show the state-of-the-art in smart communities. The resource limitations in a smart village are taken into consideration when a collaborative edge computing paradigm is presented. The challenges and open research issues are then highlighted.

**Methodology –**

Its scope includes several endeavors including smart agriculture, waste management, irrigation control, livestock management, smart energy, smart healthcare, and smart education.

Infrastructure and cost are the two main obstacles to the implementation and sustainability of a smart village, which sets it apart from a smart city. In light of this, we developed a thorough taxonomy to show the state-of-the-art in smart communities

**Performance Limitation –**

The idea is to make smart villages to increase the efficiency and reduce the waste but there will be money issues as rural areas don't have funding and as rural area people are not much educated so that it will be difficult for them to manage these devices if some problem will arise . So, these are the two major issues.

**5. IoT Based Smart Garbage Management System**

**Date of publication:** [2022](https://ieeexplore.ieee.org/xpl/conhome/9767722/proceeding)

**Authors:** [Rifatul Islam Rifat;](https://ieeexplore.ieee.org/author/37089380724) [Farah Binte Haque;](https://ieeexplore.ieee.org/author/37089299426) [Tashreef Jahan;](https://ieeexplore.ieee.org/author/37089379948) [Zunayeed Bin Zahir;](https://ieeexplore.ieee.org/author/37089172703) [Riasat Khan](https://ieeexplore.ieee.org/author/37085405006)

**Problems and Objectives –**

The internet of things (IoT) is integrated to offer data transfer, interconnection, and accountability characteristics to a wide range of various end systems. Intelligent cities assemble a peaceful human existence by fusing a wide range of sensors, electronics, and IoT resolves. One of these strategies is to support an effective waste management system that is friendly to the environment. However, one of the most ignored issues in developing nations is trash management, thus it is urgent to solve this issue. For underdeveloped nations like Bangladesh, we will create an IoT-based intelligent waste management system in this paper that assures proper waste collection, disposal, and transportation while using the fewest resources possible. This study illustrates a strong design of the waste management system that guarantees proper waste storage for a constrained amount of time. The suggested gadget was created using an Arduino Mega microcontroller, USR-C215 IoT WiFi, GPS, and GSM modules, as well as ultrasonic and infrared sensors. When waste is placed in the bin, if it fills to the top, an alarm will sound to notify the collectors that the trash can is full, saving time and preventing spills. The primary goal of this article is to create a highly effective waste management system that is economical and will conveniently assemble the waste collection.

**Methodology –**

The smart bin's shutting lid is detected by ultrasonic sensors along with the amount of rubbish within. The Arduino Uno system sends the continuously captured data by USs to a Wi-Fi module in real-time, and the wireless module then transmits the data to a smart waste management system.

**Performance Limitation –**

It can fail in some areas because to make it successful we need to change the mindset of the people as if the dustbin does overflow then also people will drop their garbage there only in open surroundings they won’t move to the next locality to drop their garbage bag.

**6. Internet of Things (IoT) adoption barriers of smart cities’ waste management: An Indian context**

**Date of publication:** July 2020

**Authors:** ManuSharma, Sudhanshu Joshi, DevikaKannan, KannanGovindan

**Problem and Objectives:**

The smart city in developing countries is promoted as a potential answer to the problems brought on by urbanization. Today, integrated waste management is a growing area of waste management since, without the simultaneous adoption of other acceptable non-technical measures, some technologies alone will not be able to sustainably address the problems associated with garbage. However, as the scope of integrated waste management strategies grows daily, the difficulty of implementing them smoothly also gradually grows, necessitating the urgent need to develop a sustainable framework of efficient integrated waste management strategies. To create a structural framework for the Internet of Things (IoT) adoption hurdles that stand in the way of smart cities' waste management systems in emerging markets like India. To affect the SCWM, identify the important IoT obstacles (IoTBs) and their advantages. Create a structural framework that accounts for the IoTBs' driving and dependent computing capabilities.

**Methodology Adopted:**

The current study, which employs hybrid Multi-Criteria Decision-Making Methods (MCDM), has identified 15 adoption IoT Barriers (IoTBs) impeding the IoT deployment in India's smart cities. The Fuzzy Matriced'Impacts Croisés Multiplication Appliquéan Classement (MICMAC) model, the Total Interpretative Structural Modeling (TISM) technique, and the Decision Making Trial and Evaluation Laboratory (DEMATEL) method are used to further examine the IoTBs. In smart cities' waste management (SCWM) initiatives, a structural foundation for IoTBs is developed using the TISM methodology.

**Performance Limitations:**

It is difficult to identify the Iot obstacles at each point of these applying models and in smart cities, we need to educate people at a large scale and also the time to create these models will be more. By making these models, the job number will get reduced and unemployment will increase in that area. After time, it can cause problems for higher authorities to maintain those models and to notice each model after a certain period of time if workers are not available.

**7. IoT-Based Smart Waste Bin Monitoring and Municipal Solid Waste Management**

**System for Smart Cities (SPRINGER)**

**Date of publication:** June 2020

**Authors:** Tariq Ali, Muhammad Irfan, Abdullah Saeed Alwadie, Adam Glowacz

**Problem and Objectives:**

Due to tremendous population expansion and urbanization, rising waste output has become a significant concern in emerging nations. Numerous concerns have been researched from the literature that show a clear connection with the rise in waste material generation and associated challenges to handle it in a smart city. Inadequate waste material collection and disposal methods, rising migration patterns to urban areas, and a lack of intelligent technology supporting the municipal solid waste management system are the causes of these problems. The main objectives are to design a Iot based model and device and municipal solid waste management model. To reduce the burden on site vendors, the models will play an important role in work distribution thus, making it the main objective.

**Methodology Adopted:**

It is recommended to use IoT to monitor smart waste bins and manage municipal solid waste. As mentioned above, this technology aids in resolving issues with trash management and IoT-based waste collection for the smart city. Effective garbage collection, fire detection in waste materials, and waste generation predictions are all capabilities of the proposed system. The IoT-based device controls and keeps an eye on the electric bins. These units are wirelessly linked to the central hub in order to transfer data regarding the degree of filling for the bins to the current location.

**Performance Limitations:**

More smart bins will be required and for this more units need to be produced, it will require a huge factory to produce this. For smart bins to be installed at each part of the smart city, the installation people need to be educated well enough to do the installations and to educate the people of the city is also a big task, how to use the smart dustbin and how to operate it. The cost will be higher for these smart bins in every city if installed in a big country like India.

**8. A Smart IoT System for Waste Management**

**Date of publication:** December 2018

**Authors:** Whai-En Chen, Yu-Huei Wang, Po-Chuan Huang, Yu-Yun Huang, Min-Yan Tsai **Problem and Objectives:**

One of the difficulties with smart cities is trash management. Usually, trash cans are positioned in open spaces. Without proper management, the trash cans may overflow or emit an offensive odor that compromises public health.

Public health is very important for the country’s GDP growth and economic growth. An efficient waste management can reduce the operation cost that is man power and fuel of a garbage clean company. To build an efficient waste management system for the cities and to install them in a small area are the main objectives of this paper.

**Methodology Adopted:**

An embedded system design and the prototype of a waste management system. Ultrasonic sensors are adopted to detect the waste status. An intelligent waste connection is proposed by measuring the waste level and optimizing the route of the waste collection. By this the smart waste collection can save up to 80 percent of the operational cost. Smart sensors that assess the fill levels in bins and containers using ultrasound technology are part of the waste management solution. They use a number of IoT connection protocols to deliver the data to the Smart Waste Management System, a potent cloud-based platform (Sigfox, LoRaWAN). The goal is to give businesses and localities the ability to make data-driven decisions and to optimize waste collection routes.

**Performance Limitations:**

It may not succeed in some instances since changing people's attitudes is necessary. For example, if a trash can overflow, people will still put their trash there in an open area rather than moving to another location to dispose of it. There are a number of drawbacks, such as the dustbin's price rising. Three sensors must be installed, one sensor for each level if there are three levels. Sensors may get harmed due to excessive heat in the weather. Sensors are sensitive to temperature changes and also the range of sensors may get affected by color and it may get affected due to extreme weather.

**9. Designing an effective two-stage, sustainable, and IoT based waste management system**

**Date of publication:** December 2021

**Authors:** AmirhosseinSalehi-Amiri, NavidAkbapour, MostafaHajiaghaei-Keshteli,

YuvrajGajpal, ArminJabbarzadeh

**Problem and Objectives:**

Waste management systems (WMS), particularly in smart cities, have received a lot of attention throughout the history of sustainable development. The Internet of Things (IoT) idea can be used to look at the application of real-world assumptions with the fill levels of waste bins in real-time. This topic has not been addressed in earlier research. To propose a novel waste management approach in real-time using Iot in the smart city. To develop a two-stage model to optimize value recovery and reduce pollution.

**Methodology Adopted:**

Using the idea of the vehicle routing problem, two sub-models are created. The first sub-model may determine the threshold waste level (TWL) parameter by using contemporary traceability IoT-based devices to collect data in real-time. The first sub-model is crucial for finding a collection route that is both efficient and novel in order to achieve positive long-term social and environmental effects on WMS. It is also important for prioritizing bin visits depending on their significance. In the second model, waste sorting and transfer into the recovery value center are both taken into account in order to optimize recovery value and reduce visual pollution.

**Performance Limitations:**

In smart cities, we need to educate people widely, and it will take more time to construct these models. It is challenging to identify the IoT hurdles at each stage of these applicable models. Making these models will result in fewer jobs being created and higher unemployment rates in the region. When workers are not present, it can become difficult for higher authorities to maintain those models and to notice each model after a set amount of time. The cost of these two models will be very high and installing those to everywhere will be such a great task.

**10. Waste Management of Residential Society using Machine Learning and IoT Approach**

**Date of publication:** March 2020

**Authors:** Sonali Dubey, Murari Kumar Singh, Pushpa Singh, Shivani Aggarwal

**Problem and Objectives:**

Waste management has evolved into a difficult problem for all of us as a result of the growing population and industrialization of nations. The potential benefits of small-scale waste management are similar to those of large-scale waste management. Waste management systems for residential societies that are IoT and machine learning based aim to improve the same issue as smart city waste management.

**Methodology Adopted:**

The monitoring of several trash cans situated in distinct residential societies is the focus of this research. Dustbins come with sensors that keep an eye on their capacity, metal content, and hazardous gas content. In order to regulate society's waste, the accuracy of alarm signals sent to third parties is tested using machine learning classification techniques such as SVM, NB, RF, DT, and KNN. Additionally, the findings imply that the RF algorithm generated the most precise projections of the alert message. The RF algorithm's accuracy is 85.29%. This study's overall effect is to improve green technology through lowering pollution in smart cities.

**Performance Limitations:**

There are several negative effects, such as the dustbin's rising cost. If there are three levels, three sensors must be put, one for each level. Due to the extreme heat, sensors may suffer damage. Sensors are sensitive to changes in temperature, and color and extreme weather conditions may also have an impact on their range. People won't move to another spot to dispose of their trash if a trash can is overflowing because they will still dump it there in a public space.

11. **E-waste management: A review of recycling process, environmental and occupational health hazards, and potential solutions**

**Date of publication:** December 2020 **Authors:** RajeshAhirwar, Amit, K.Tripathi

**Problem and Objectives:**

An important environmental concern is the exponential rise in electronic waste, which includes obsolete electrical and electronic equipment. E-waste recycling, which entails the methodical collecting of e-waste and its processing for the recycling of useful materials, provides a useful tool to reduce the growing e-waste pile, make up for the depletion of some primary resources, and boost the economy. However, depending on the recycling processes used, e-waste may also contain harmful materials like heavy metals and persistent organic pollutants, such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), brominated flame retardants (BFRs), perfluoroalkyl and polyfluoroalkyl substances (PFASs), polychlorinated dibenzo-pdioxins (PCDDs), and polych (PCDFs). A comprehensive strategy involving improved product design, a higher recycling rate, and little to no release of hazardous e-waste pollutants into the environment is needed to effectively harness the benefits of e-waste recycling without endangering human health. We address the prospects, challenges, and options for better e-waste management in this review. We also discuss the recent global trend in e-waste generation, the recycling of e-waste, and the effects of e-waste toxins on human health. Finally, a few methods that can be used to make recycling e-waste more effective and secure have been presented.

**Methodology Adopted:**

E-waste contains rare earth elements, metals, polymers, glass, and other secondary resources.

Estimates indicate that a typical cathode-ray tube TV carries about 450 g Cu, 227 g Al, and 5.6 g

Au, illustrating the richness of e-waste for important elements (Zeng et al., 2018).Similar to how

17 metric tonnes of gold ore may not yield as much gold as a tonne of used personal computers (Bleiwas and Kelly, 2001).

The amount of electronic garbage produced worldwide is steadily rising at a significant rate. While incorrect e-waste recycling without suitable protections might possibly endanger human health on the one hand, it also gives many low-wage employees a means of support, especially in developing nations. Therefore, attempting to control the e-waste problem by just enacting regulations and creating routes for its organized recycling may not be sufficient.

**Performance Limitations:**

The aim of this article was to control e-waste. The goal was to design various solutions based on the issues that various people faced, however this would cause scaling concerns.

They gathered various data from various households in order to achieve their goals, but because a huge quantity of data needed to be handled, this could represent a difficulty for the scalability of the intended methodology.

**12. Household Waste Management System Using IoT and Machine Learning**

**Date of publication:** April 2020

**Authors:** SonaliDubey, PushpaSingh, PiyushYadav, Krishna Kant Singh

**Problem and Objectives:**

The goal of an IOT and machine learning-based household trash management system for a green, intelligent society is to increase the efficiency of managing waste from every apartment in the community by utilizing this brand-new technology. In order to maximize the value of the trash and effectively reduce actual waste, this paper explains the proper collection and breakdown of garbage. This essay focuses on the segregation of trash at two levels: the first level is at each household within a society, and the second level is at the level of the entire civilization. Writer, talk about composting biodegradable garbage that has been recycled. For different combinations of three sensor values, such as the amount of biodegradable and non-biodegradable garbage, or the concentration of toxic gas, a machine learning approach called KNN is utilized to generate an alert message. The overall effect of this research is to improve green technologies through the use of technology to lower pollution, conserve, repurpose, and reuse energy.

**Methodology Adopted:**

##### Level 1: House Level

A smart dustbin at the home level has two chambers. The following diagram shows the steps needed to reach level one:

* Automatically raises the dustbin lid whenever a hand approaches it.
* There are two buttons: the green one indicates biodegradable garbage, while the red one indicates non-biodegradable waste.
* Rotation of the dust bin's inner drum according to the types of waste—biodegradable and nonbiodegradable.
* Notification of the facility supervisor utilising the alert message when the dustbin reaches the predetermined level of fill or if any dangerous gas is found.
* Using a line follower, move the trash can outdoors once either the biodegradable or nonbiodegradable compartment reaches the reference level. Then, bring it inside once it is empty.

##### Level 2: Society Level

* Non-biodegradable waste from the level 1 which has different types of non-biodegradable waste, is spread on the conveyer belt for second level segregation.
* The Inductive proximity sensor on the conveyor belt is responsible for the segregation of Metal waste. As it senses metal and is moved to the metal collecting box.
* The capacitance proximity sensor on the conveyor belt is responsible for the segregation of plastic and wooden waste.
* The remaining garbage is the non-biodegradable waste, which cannot be further separated with this model, as it detects plastic and is moved to the plastic and the wooden collecting box.
* When the level of this separately stored non-biodegradable waste exceeds 90%, a notification is issued to the municipal corporation to arrange for collection.
* To create compost, level 1 biodegradable home garbage is combined with discarded roots, earthworms, and fallen leaves from the community's green space.

**Performance Limitations:**

It may not succeed in some instances since changing people's attitudes is necessary. For example, if a kid or adult passes through the polythene in non-biodegradable form, the polytene will contain biodegradable waste so at last we need a work-force to separate it again . So this can work only for small households. We cannot implement this for bigger places because as discussed in the above example the problem will arise again .

**13. Challenges and Opportunities of Waste Management in IoT-Enabled Smart Cities:**

**A Survey**

**Date of publication:** July 2018

**Authors:** Theodoros Anagnostopoulos, Arkady Zaslavsky, Kostas Kolomvatsos, Alexey Medvedev, Pouria Amirian

**Problem and Objectives:**

The exponential growth of electronic trash, which comprises outdated electrical and electronic equipment, is a significant environmental hazard. E-waste recycling, which comprises the methodical collection of e-waste and its processing for the recycling of useful materials, offers an effective instrument to lessen the expanding e-waste pile, make up for the depletion of some main resources, and strengthen the economy. To properly leverage the advantages of e-waste recycling without harming human health, a complete plan involving improved product design, a greater recycling rate, and little to no release of hazardous e-waste pollutants into the environment is required. In this paper, we discuss the possibilities, obstacles, and strategies for better e-waste management.

**Methodology Adopted:**

The emergence of new technologies like RFIDs, sensors, and actuators has paved the way for the Internet of Things (IoT) paradigm. In order to track and gather ambient data, smart devices (i.e., objects with high computational capabilities) are embedded in the environment. This results in frameworks for Smart Cities in a city. On top of such information on any area of human activity, intelligent services are provided. In order to address the problem of trash management, this article makes extensive use of IoT and machine learning models. SVM and KNN models are employed.

**Performance Limitations:**

It is difficult to pinpoint the IoT obstacles at each stage of these relevant models. Less jobs will be created as a result of the production of these models, and unemployment rates will rise. Higher authorities may find it challenging to maintain such models and to notice each model after a specific period of time if personnel are not present. These two variants will be highly expensive, and putting them everywhere will be a huge undertaking. The sensor cost will be very high as there will be many bins in the city itself. All the Iot materials will be of high cost and not so affordable at a large scale.

**14. Analysis of IoT-Enabled Solutions in Smart Waste Management**

**Date of publication:** December 2018

**Authors:** Sibongile Mdukaza, Bassey Isong, Nosipho Dladlu, Adnan M. Abu-Mahfouz **Problem and Objectives:**

The Internet of Things (IoT) has attracted a wide range of applications, including waste management, water, smart communities, and smart cities. Its strength comes from the significant effects it had on daily life and the actions of potential users. However, it must be energyefficient, able to interact, and able to transmit information across expanded coverage in order to be more successful and promote its acceptance. The goal is to obtain understanding of the advantages and disadvantages so that advancements and innovations may be made to effectively and efficiently manage garbage and to preserve a healthy environment in our communities. We reviewed 15 research articles from the literature, and the findings indicate that while the technologies used in the existing solutions were similar, they did have some disadvantages, such as sensing accuracy being hindered by different weather conditions, users being vulnerable to unauthorised access, and short range capabilities.

**Methodology Adopted:**

As this paper is a review of all the Iot based solutions regarding waste management system, it consists of so many methodologies and systems for waste management improvement. Low Power Wide Area Network (LPWAN) with Long Range (LoRa) technology already in use has shown promise. Several various IoT-enabled trash management solutions have been put out, each with its own strengths and drawbacks that need to be improved. Use of sensors and other items like Iot devices and system devices that are used are reviewed in this paper.

**Performance Limitations:**

It is challenging to identify the IoT challenges at each stage of these important models. The creation of these models will result in fewer jobs being generated, which will increase unemployment rates. If workers are not present, higher authorities may find it difficult to maintain such models and to notice each model after a certain amount of time. It will be extremely expensive and difficult to install these two types everywhere. Due to the abundance of trash cans in the city itself, the cost of the sensors will be very high. All of the IoT materials will be expensive and difficult to use on a wide scale.

**15. Smart garbage management system for a sustainable urban life: An IoT based application**

**Date of publication:** September 2020

**Authors:** Minhaz UddinSohag, Amit KumerPodder

**Problem and Objectives:**

One of the biggest issues for highly populated metropolitan areas is proper trash management. Due to environmental degradation, maintaining a healthy, sustainable lifestyle in metropolitan settings is becoming more and more challenging. Lack of a proper waste management strategy leads to issues like a trash overflow that seriously damages our ecosystem. Polluted environments contribute to the pandemic spread of many different diseases. Waste management is a problem for both industrialized and developing nations' long-term growth. Because of the rising population, urbanization, and industry, proper waste management is becoming more difficult.

**Methodology Adopted:**

A smart IoT-based integrated system that includes an identification system, an automated lid system, a display system, and a communication system has been described. The microcontroller Arduino Uno is used to synchronize all four systems. Sensors are employed for rubbish level measurement and identification. The system offers the capability of ongoing waste bin monitoring and displays the percentage of the bin that is full on a liquid crystal display (LCD).

When the garbage can is full, the communication system uses a global system for mobile communications (GSM) module to alert the appropriate authority to collect the rubbish.

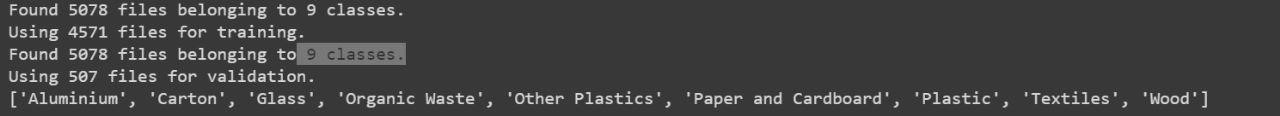
**Performance Limitations:**

Numerous negative consequences exist, including the increased cost of trash cans. Three sensors, one for each level, must be installed if there are three levels. Sensors may be harmed by the intense heat. Since sensors are sensitive to temperature variations, they may also be affected by color and severe weather. Even though a trash can is overflowing, people will still drop their trash there in a public area rather than go to another location to do so. Number of sensors depending on the type of trash bin in a particular area.

#### Problem Identification in the Domain

# 1. Data collection approach and strategies:

• GITHUB dataset



Images collected from the Drone camera and converting them into a required dataset format.

#### 2. Data Analysis Approach

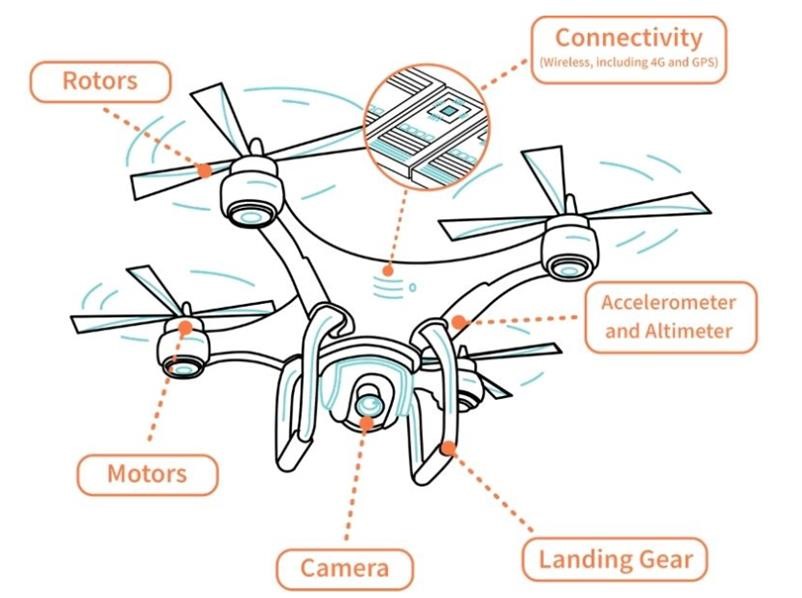
Choosing the best Deep Learning model where it identifies the percentage of waste as well as analyzing the waste present in the particular area so that the municipality must be alerted to clean that area and also introduce a garbage dustbin in that area for this we have used mobilenetV3 model for image classification. MobileNetV3 is a convolutional neural network architecture designed for efficient and lightweight computer vision tasks on mobile devices and embedded systems for drones. It is a state-of-the-art deep learning model that is optimized for running on low-power devices with limited computational resources and memory. MobileNetV3 for drones is used for a variety of computer vision applications, such as object detection, tracking, and recognition. The lightweight nature of the network allows it to be run in real-time on small computing devices, making it ideal for use on drones, which typically have limited computing power and battery life.

# PROPOSED METHODOLOGY –

We came up with the idea of smart drones. We will use a drone simulator so that the drone will fly in the given locality and will click images of areas in the locality. Then we will perform image classification on the images to identify the waste or garbage present in the locality and we will send the data to the municipality to clean the localities using automatic email simulation. We will be using deep learning models to train the dataset and classify them into 9 classes of waste namely 'Aluminum', 'Carton', 'Glass', 'Organic Waste', 'Other Plastics', 'Paper and Cardboard', 'Plastic', 'Textiles', 'Wood' and then we will test the model using our drone that will take video of locality and transform them into frames using python code. Then the frame or picture will be tested from our model and waste will be identified and then the email will be sent to the nearby municipal council to clean that respective area.

This will help to maintain a clean environment as no mentality change needs to be established on the people of society and also it will be reliable.

SYSTEM DESIGN:



# PROPOSED ARCHITECTURE –

* Drone deployment: The first step in this architecture is to deploy drones equipped with high-resolution cameras to fly over designated areas and collect images of the waste. The drones can be manually operated or programmed to fly autonomously using GPS navigation. To cover a larger area, multiple drones can be used simultaneously.

* Image Transferring: The images captured by the drones are then send to the cloud for further processing. Cloud processing requires a stable internet connection and sufficient cloud resources.

* Image analysis: The image data from the drone should be transmitted to the cloud or to the main pc for further analysis. The cloud-based system will have a Deep Learning Model that can classify the waste into different categories such as plastic, metal, glass, organic, etc. and also detect the presence of waste. The Deep Learning Model is trained using a large dataset of waste images to ensure high accuracy.

* Waste Detection: Based on the classification results, the waste can be classified and detected. Now using this, the appropriate coordinates of the areas where waste was detected is further passed as an output from the DL model.

* Data analytics: The data collected from the drone and cloud-based system can be used to generate insights on the waste generation patterns, waste composition, and recycling rates. These insights can be used to optimize the waste management process and make informed decisions. For example, the data can be used to identify areas with high waste generation rates and prioritize waste management efforts accordingly.

* Maintenance and monitoring: The drones and the cloud-based system should be regularly maintained and monitored to ensure optimal performance and reliability. Any issues or faults should be promptly addressed to minimize downtime and ensure the smooth functioning of the system. Regular maintenance and monitoring can help extend the lifespan of the equipment and reduce the risk of costly repairs.

# Communication Model Used

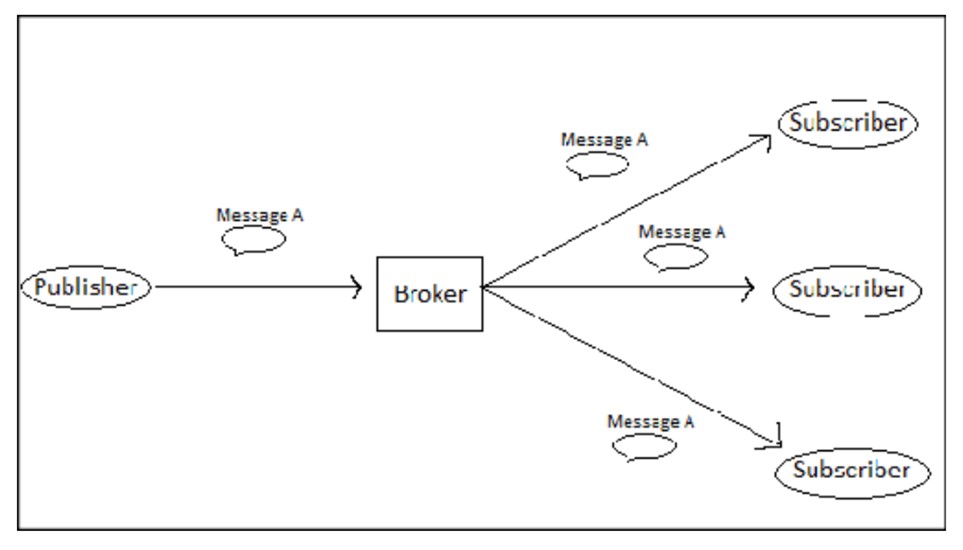
***Publisher-Subscriber***

This model comprises three entities: Publishers, Brokers, and Consumers.

· **Publishers** are the source of data. It sends the data to the topic which are managed by the broker. They are not aware of consumers.

· **Consumers** subscribe to the topics which are managed by the broker.

· Hence, **Brokers** responsibility is to accept data from publishers and send it to the appropriate consumers. The broker only has the information regarding the consumer to which a particular topic belongs to which the publisher is unaware of.



**Use of this model in Drones:**

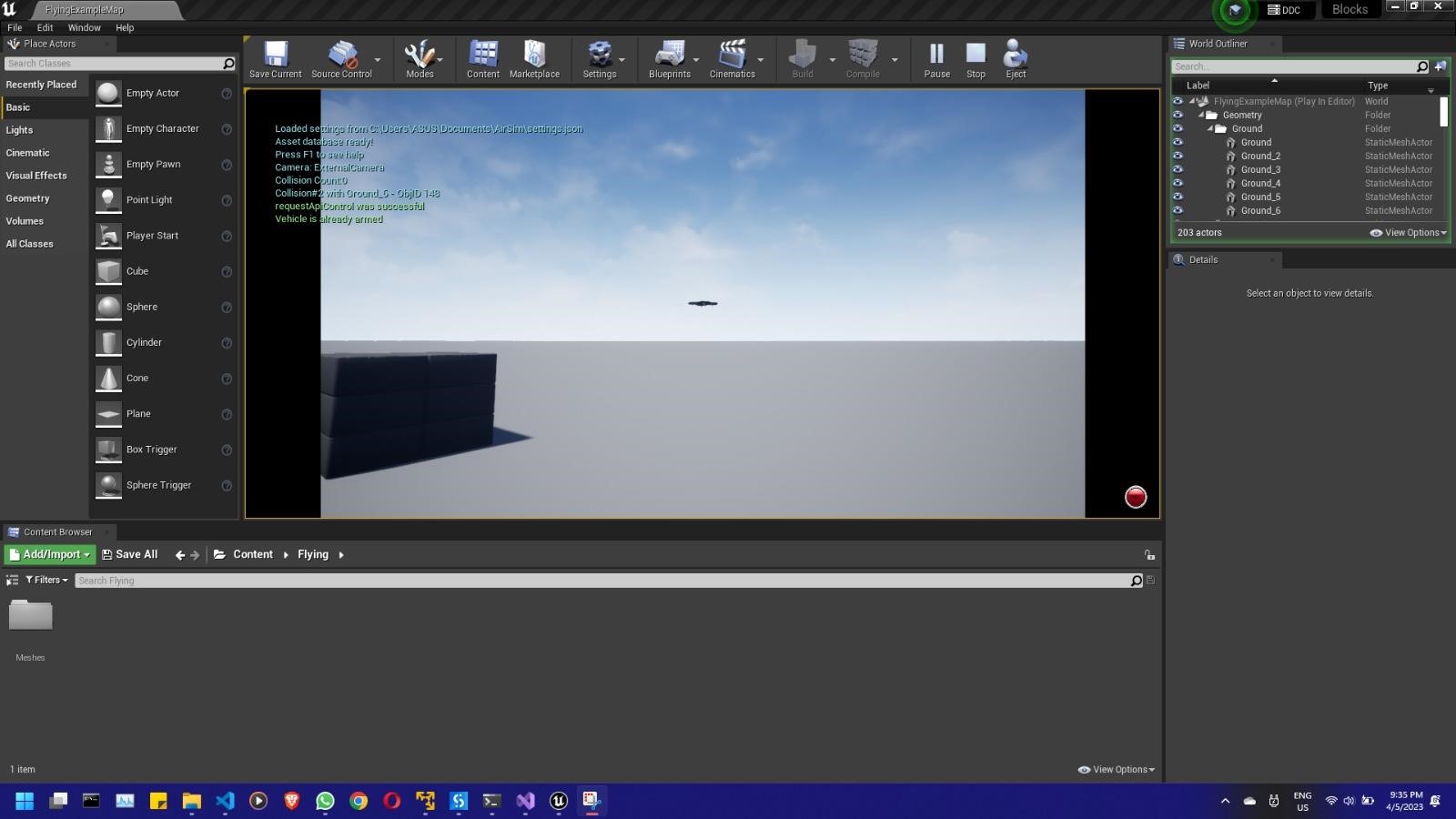
The Publisher can be any component on the drone that generates data, such as a sensor or a flight controller. The Subscribers can be other components on the drone, such as an autopilot or a camera, or they can be external devices, such as a ground station or a remote controller.

The Publisher-Subscriber model in drones enables efficient and flexible communication between different components, allowing them to share information without the need for direct communication or knowledge of each other's existence. This can improve the overall performance and functionality of the drone, as well as make it easier to integrate with other devices and systems.

# IMPLEMENTATION AND RESULTS :

We have used AirSim drone simulator to make our drone simulator

In AirSim we can add the coordinates of the drone and we can also manage the speed of the drone



Once coordinates are set it will record the video of the environment and we are recording the video at 30fps .

Then we will extract frames from the video and it will be converted to image

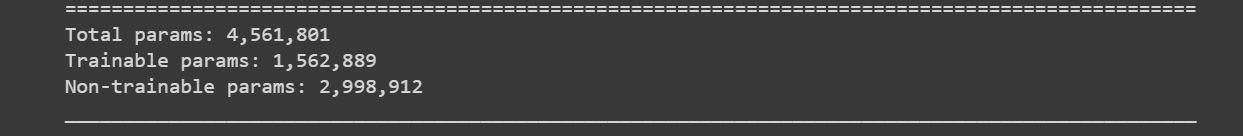
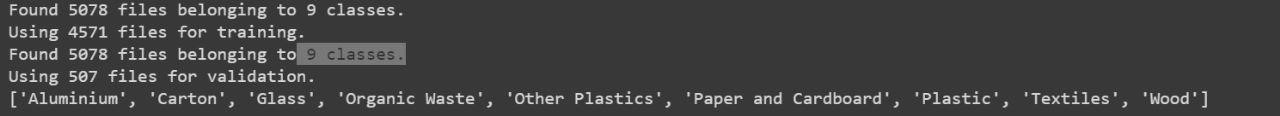


We will save the image name with its coordinate so that we can easily get the location of the waste

Then this image will be send to our deep learning model which is trained using

Mobilenetv3 model and we have a total of 9 classes to classify different waste type

Total training image ->

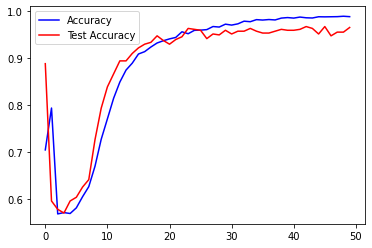
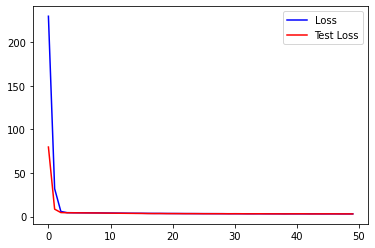


#### TESTING AND PERFORMANCE EVALUATION

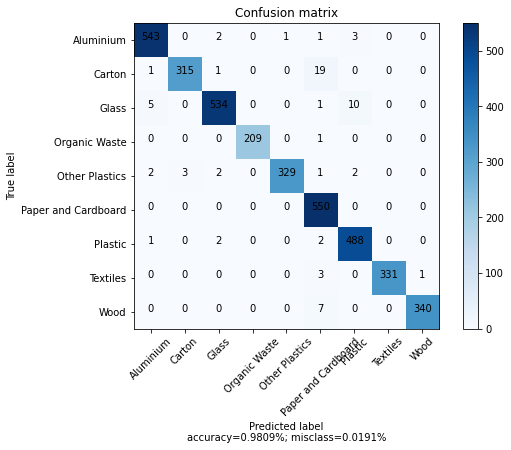
Accuracy curve for the training of model **(98 Percent Accuracy)**

Accuracy curve

Loss Curve



CONFUSION MATRIX





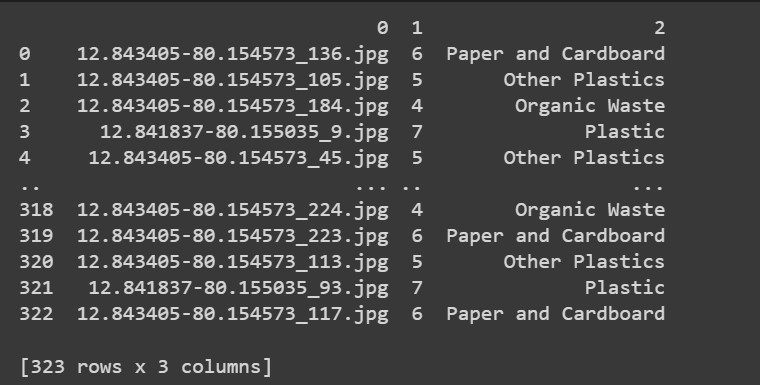
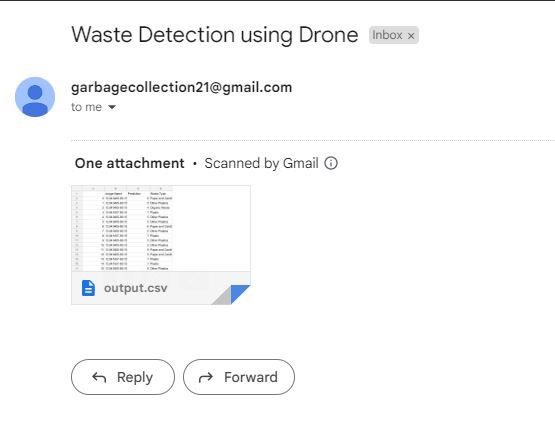
Testing data ->

We will test the 323 frames which got from our drone’s video

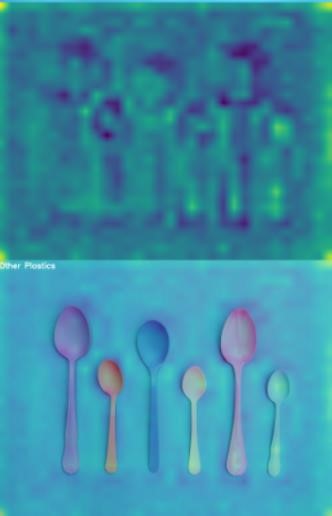


Testing results ->

Once we get the testing result we will save it as a csv file and then we will send the csv file to the cleanliness authorities through mail



**Advanced Filter Visualization:**



**Drone image -**





# CONCLUSION -

In conclusion, the proposed architecture for solid waste management through drones and cloud analysis offers a scalable, efficient, and cost-effective solution for managing waste. It can help reduce the environmental impact of waste and contribute to the sustainable development of our communities. Waste management through drones has the potential to revolutionize the way we manage waste. With the help of advanced sensors and cameras, drones can be used to classify and sort waste into different categories such as 'Aluminum', 'Carton', 'Glass', 'Organic Waste', 'Other Plastics', 'Paper and Cardboard', 'Plastic', 'Textiles', 'Wood'. Drones can also cover a larger area in a shorter amount of time, which can result in faster and more effective waste management. Drones will tell the exact place of waste and type of waste from where we need to collect the waste in a shorter period of time. This can help in improving the efficiency and effectiveness of waste management processes. Overall, the use of drones for waste management can bring about significant improvements in the way we handle and dispose of waste. With further advancements in technology and increased adoption of this approach, we can expect to see a cleaner and more sustainable environment. However, the implementation of this architecture requires significant investment in hardware, software, and cloud resources, as well as regulatory approvals and community support.

# FUTURE ENHANCEMENTS -

There are numerous future developments that could increase the efficacy and efficiency of this strategy, which has the potential to revolutionize the waste management sector. Using drones with sophisticated sensors and machine learning algorithms to classify the types of waste existing in a certain location is one potential improvement.

Drones might gather comprehensive data on the garbage that is present in a specific area, including its composition, volume, and location, using sensors like cameras, LIDAR, and other types of remote sensing technology. The exact sorts of garbage that are present, such as plastics, paper, or organic materials, might then be identified using machine learning algorithms that interpret this information.

The drones might then be used to transfer the material to the proper disposal or recycling site after it has been sorted. For instance, drones could be programmed to deliver rubbish to a nearby recycling plant that specialized in processing plastic materials if they detect a considerable amount of plastic waste in a specific location.

In general, employing drones for trash management has the potential to greatly increase the effectiveness and efficiency of this vital sector. Drones could assist to classify waste more precisely and carry it to the proper facilities more rapidly by integrating cutting-edge sensors and machine learning algorithms, minimizing the environmental impact of waste and promoting a more sustainable future.

# APPENDIX (Coding)

## Code for drone simulation

import airsim import os

# connect to the AirSim simulator client = airsim.MultirotorClient() client.confirmConnection() client.enableApiControl(True) client.armDisarm(True)

# Async methods returns Future. Call join() to wait for task to complete. client.takeoffAsync().join() client.moveToPositionAsync(50, -50, -20, 5).join()

# take images responses = client.simGetImages([ airsim.ImageRequest("0", airsim.ImageType.DepthVis), airsim.ImageRequest("1", airsim.ImageType.DepthPlanar, True)]) print('Retrieved images: %d', len(responses))

# do something with the images

# import cv2

# i = 0

for response in responses: if response.pixels\_as\_float:

print("Type %d, size %d" % (response.image\_type, len(response.image\_data\_float))) airsim.write\_pfm(os.path.normpath('temp/py1.pfm'), airsim.get\_pfm\_array(response)) airsim.write\_pfm("/temp.py1.pfm", airsim.get\_pfm\_array(response))

else:

print("Type %d, size %d" % (response.image\_type, len(response.image\_data\_uint8))) airsim.write\_file(os.path.normpath('temp/py1.png'), response.image\_data\_uint8) airsim.write\_file("/temp.py1.png", response.image\_data\_uint8)

## Video to frame conversion code

# Importing all necessary libraries import cv2 #open CV to solve computer vision problems

import os

def extractFrameLoc(path\_of\_file, cordinate): # Read the video from specified path cam = cv2.VideoCapture(path\_of\_file)

try:

# creating a folder named data

if not os.path.exists('data'):

os.makedirs('data')

# if not created then raise error except OSError:

print ('Error: Creating directory of data')

# frame currentframe = 0

while(True):

# reading from frame ret,frame = cam.read()

if ret:

# if video is still left continue creating images name = './data/' + cordinate + '\_' + str(currentframe) + '.jpg' print ('Creating...' + name)

# writing the extracted images cv2.imwrite(name, frame)

# increasing counter so that it will

# show how many frames are created

currentframe += 1

else: break

# Release all space and windows once done cam.release() cv2.destroyAllWindows()

path1 = "s1.mp4" cordinate1 = "12.841837-80.155035" path2 = "s2.mp4" cordinate2 = "12.843405-80.154573" extractFrameLoc(path1, cordinate1)

**1. Email generator code** import smtplib import certifi certifi.where() import ssl

from email.message import EmailMessage

# Define email sender and receiver email\_sender = "garbagecollection21@gmail.com" email\_password = "rhagkxhdbqqhpdii" email\_receiver = "xyz.123@gmail.com"

# Set the subject and body of the email subject = 'Waste Detection using Drone' body = 'Here Find the attachment of what the drone saw.'

em = EmailMessage() em['From'] = email\_sender em['To'] = email\_receiver em['Subject'] = subject attach = "output.csv" em.set\_content(body)

# Add SSL (layer of security) context = ssl.create\_default\_context()

# Log in and send the email with smtplib.SMTP\_SSL('smtp.gmail.com', 465, context=context) as smtp:

smtp.login(email\_sender, email\_password) smtp.sendmail(email\_sender, email\_receiver, em.as\_string())

## Google colab link:

1. [https://colab.research.google.com/drive/1OCZuJUywDTn0XZm5l99KQw6awrsLdXF\_? usp=sharing](https://colab.research.google.com/drive/1OCZuJUywDTn0XZm5l99KQw6awrsLdXF_?usp=sharing)

1. [https://colab.research.google.com/github/cardstdani/WasteClassificationNeuralNetwork/b lob/main/WasteClassification.ipynb#scrollTo=df4Mof98nn8j](https://colab.research.google.com/github/cardstdani/WasteClassificationNeuralNetwork/blob/main/WasteClassification.ipynb#scrollTo=df4Mof98nn8j)

## Video Demonstration of project:

• https://drive.google.com/drive/folders/1Ccdyue9lsv0hM3BybGFOzXCmNXOqTA3f?usp=sharing

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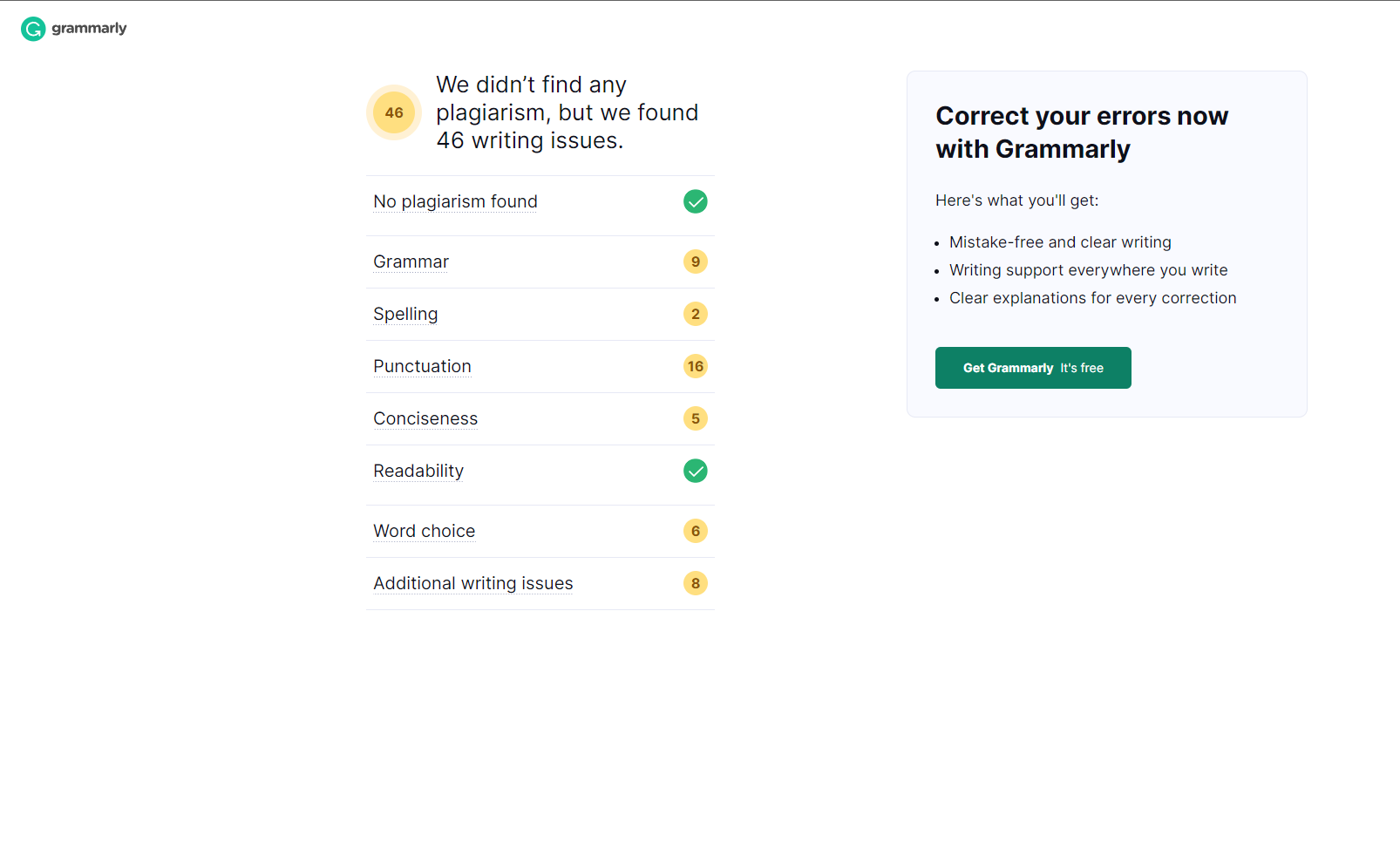
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# Plagiarism Report:

Plagiarism Report for Abstract, Introduction and Literature Survery:



Plagiarism Report for Problem Identification, Data Analysis Approach, Methodology

