

Waste Management System Using IOT and Machine learning

Abstract

The fast population growth throughout the world has resulted in a lack of proper waste management, which has resulted in several health and environmental problems. Only once or twice a week do the garbage-collecting vehicles bring in rubbish. The rubbish in the dustbin gets dispersed across the city as a result of inefficient waste collection methods. Using machine learning and the Internet of Things (IoT), this study proposes an effective approach for smart and effective trash management to overcome this predicament. The Arduino UNO microcontroller, an ultrasonic sensor, and a moisture sensor were employed in the suggested solution. The waste index of a given dumping place may be determined using image processing. The suggested framework also includes a hardware prototype. As a result, the proposed system for waste management achieves the goal of creating pollution-free and clean cities.

Key words : Waste, Management, System, Machine, learning, IoT etc

Introduction

Disposal and treatment of various forms of garbage is supported by the waste management system. As a result, it helps to keep animals, people, and the environment safe. Improved air quality and reduced environmental pollution may be achieved by using proper waste management procedures. Advanced areas are simultaneously developing and adopting effective waste management solutions that are yielding enormously positive consequences. The existing scenario will not be able to handle such a large volume of garbage in the next five years. As a result, it is preferable to take all necessary steps to ensure appropriate waste management. To maintain a healthy environment, we must use the most advanced waste management systems and procedures. The amount of rubbish produced each day throughout the world is skyrocketing. Every year, some 1.9 billion tonnes of trash are produced, and at least 35% of that waste is not properly processed. Daily trash generation per person ranges from 0.17 to 4.67 kg, according to the statistics. By 2055, the total amount of garbage is expected to reach 45 billion tonnes, which is more than twice the growth rate for the same time. There is a clear correlation between income and the amount of garbage generated. Because waste is a major source of revenue, it must be treated and disposed of as effectively as possible.

Low- and middle-income countries are expected to generate 45 percent more garbage per day by 2050, whereas high-income countries are expected to generate 20 percent more waste per day.

A waste management system based on Internet of Things (IoT) and machine learning (ML) is the most effective way to combat environmental pollution. These technology may supply garbage collection vehicles with real-time data and an optimal route, decreasing both the costs and the time of the process as a whole. A major problem with present waste management systems is that collectors don't realise they have to pick up the rubbish because of poor scheduling. They are also unsure of the exact location of the drop-off. One important use of IoT innovation is that it has become a powerful tool for creating dazzling urban environments. The rapid growth of urban populations and the resulting increase in trash creation is a critical challenge for a smart city.

In urban areas, trash management may be a daily chore that involves organising garbage truck routes that take into account ecological, financial, and social factors. Second, by using the diagram hypothesis, the length should be shortened to keep a safe distance from high fuel prices while also reducing the total amount of effort. For improved decision-making, a few arrangements have offered IoT devices to assess mailbox fill levels.

Review of literature

(Anh Khoa et al. 2020) studied "*Waste Management System Using IoT-Based Machine Learning in University*" I came upon this Waste management has emerged as a major concern as the Internet of Things (IoT) has grown. In metropolitan places, waste management is a daily activity that needs a big number of labour resources and has a significant impact on environmental, fiscal, efficiency, and social considerations. There are several ways to improve waste management, including the closest neighbour search, colony optimization, genetic algorithm, and particle swarm optimization. As it is, the findings are too general and cannot be applied to real-world institutions like colleges or cities.

(Khan et al. 2021) studied "*Machine Learning and IoT-Based Waste Management Model*" the trash disposal and treatment of various waste kinds is largely corroborated by the system in place, us, it protects people, animals, and the environment. Improved air quality and reduced environmental pollution may be achieved by using proper waste management procedures. Advanced areas are simultaneously developing and adopting effective waste management solutions that are yielding enormously positive consequences.

(Dubey et al. 2020) studied "*Household Waste Management System Using IoT and Machine Learning*" that each item is given an IP address and is equipped to autonomously distribute data across the network without the need for human-to-human or human-to-computer contact, as a result of The Internet of Things (IoT) and machine learning. It is thus possible to include any physical object that has an IP address into an IoT system by using electronic hardware such as sensors, software, and networking equipment. The Internet of Things (IoT) enables increased connection of a wide range of devices, services, protocols, and applications, as well as a vision of heterogeneity. The Internet of Things (IoT) is not only successful in home automation, smart cities, and social challenges, but it is also admirable.

(Rahman et al. 2020) studied "*Intelligent waste management system using deep learning with IoT*" Recycling and landfilling are two methods used to dispose of trash in waste management. Using IoT in conjunction with deep learning enables nimble categorization and real-time data monitoring. This article describes a waste management system design that makes use of deep learning and the Internet of Things. A convolutional neural network (CNN), a common deep learning paradigm, is used to categorise digestible and indigestible waste un the proposed model. An architectural design for the use of a microcontroller with various sensors is also included in the scheme. An IoT-based and Bluetooth-enabled approach to data monitoring has been presented. In the Internet of Things, data can be controlled in real time from any location, whereas in the Bluetooth era, data may be monitored across small distances using an android app.

(Sheng et al. 2020) studied "*An Internet of Things Based Smart Waste Management System Using LoRa and Tensor flow Deep Learning Model*" discovered that the traditional waste management system is incredibly inefficient and expensive since it works on a daily basis. People's failure to properly recycle their rubbish has exposed the ineffectiveness of the current recycle container. The conventional trash management system may be replaced with smart sensors implanted in the system to conduct real-time monitoring and improved waste management with the advent of the Internet of Things (IoT) and artificial intelligence (AI). A smart trash management system combining LoRa and TensorFlow deep learning models is the goal of this project.

(Joseph 2019) studied "*Smart Waste Management Using Deep Learning with IoT*"

in which it was discovered that the nation's growing population and urbanisation is a source of concern for the environment. Cities with rapid expansion face grave danger if garbage is not

properly handled and disposed of. As a result, effective garbage collection and waste categorization with suitable disposal are now more important than ever. Currently, India's waste disposal system collects and segregates trash without classification or organisation at various points. Aside from the fact that hand sorting poses a health risk to workers, it is also inefficient, time consuming, and not entirely viable owing to the sheer volume of garbage it produces.

(Bin n.d.) studied "*WASTE MANAGEMENT SYSTEM BASED ON LOCATION INTELLIGENCE*" that the Internet and its applications have become an essential aspect of modern human existence. It's become a must-have in just about every situation. Researchers have to go beyond just connecting computers to the internet due to the overwhelming demand. The Ultrasonic of the Internet of Things, a fantastic gadget, is the result of these studies (IoT). There has been a shift in the nature of internet communication from user-to-user to user-to-device. The Internet of Things (IoT) has been around for a while, but it's still in the early stages of commercial adoption. The Internet of Things (IoT) is transforming the home automation and transportation sectors at a fast pace.

(Singh n.d.) studied "*IoT based Smart Waste Management System using Arduino*" and it was noticed. Big cities throughout the globe are grappling with the same issue: how to keep the city clean while keeping rubbish out of the way. Every day, a huge number of personnel are assigned to monitor a set number of dumpsters, and this is done on a regular basis.. There will be dumpsters that are overflowing and others that aren't even half-full as a result of this wasteful and unhygienic approach. City population density or any other random circumstance causes it to be hard to tell which portion of the city is in need of urgent assistance. Each dumpster is equipped with a sensor that sends an alert when it's full, making this a new concept in solid waste management. As a result of this technique, moist and dry waste may be separated into different containers. The waste management issue may now be effectively addressed with the help of this method.

Existing system

Unorganized trash are collected and then separated at a station in India's rubbish collection system. The segregation still relies on human labour, which is inefficient, time-consuming, and forces employees to pay a portion of their wages. Due to the disorderly way in which garbage is dumped, overflowing landfills on the fringes of towns and cities have generated dumps that cannot be reclaimed and have serious environmental implications in terms of ground water

contamination and contributing to global warming. Manual segregators have been shown to have a shorter lifespan as a result of this. A novel idea employs a hardware component that can sort garbage from the beginning of the process, making waste management more powerful and productive. For example, a metal, dry, and wet waste sorting system has been devised to separate various types of trash into three separate groups.

Waste Management Problem in Smart Cities

Managing trash is one of the most pressing issues faced by cities throughout the world. Even if there is a large waste management workforce, including garbage collectors, scrap dealers and recyclers in smart cities, there is still a large amount of rubbish to be managed. Garbage collectors, who make up the country's biggest informal sector, are most impacted by the trash disposal process. The families of these garbage collectors normally have between 50 and 70 members, and they all work together to gather rubbish around the nation. There are around 15–20 percent of people in this occupation, and all of their family members are engaged in it.

Lack of Awareness about Waste Management

Environmental contamination may be caused by improper garbage collection and waste management, which most people are unaware of. Managing such a large volume of garbage is very tough because of the enormous population growth throughout the world in the previous several decades. Organizing seminars is a good way to reach out to the general public and raise awareness. Creating public awareness is critical to the program's success. In India, most individuals are unaware of the distinction between dry and moist trash and are unable to tell them apart. People who live in shanty towns are unfamiliar with the concept of segregation. Organizing workshops and seminars on effective waste management is essential for bringing cleanliness and trash segregation to the attention of the public in every city and neighbourhood. Educating the public on the need of proper garbage disposal will have a good effect.

Improper Classification of Municipal Waste

Municipal garbage that is misclassified and improperly disposed of puts the community at risk. Human and animal health may be affected, as well as the development of plants. The only way to deal with this problem is to sort, dispose of, and handle municipal garbage properly.

Participation of Organized Sector for Carrying Out Efficient Management of Waste

To ensure an effective waste management system, the citizens of that nation must take part in a variety of garbage collecting and disposal methods. Rag-pickers, who gather waste from various parts of cities and towns, are likewise shown to be unappreciative of any compensation from society. As a result, it is imperative that they get sufficient training. Any nation or city may become pollution-free if all sectors of society contribute equally to waste management.

Lack of Technical Solution and Public-Private Partnership

The Internet of Things, machine learning-based technology, and other emerging technologies are necessary for implementing an efficient waste management system. Some of the newest technology in this industry may turn out to be the greatest. So, a public-private cooperation is needed to develop this sort of system, which we found substantially less of in the present situation.

Transportation of Waste

The primary means through which garbage is transported across the nation is via transportation. Various vehicle types, including trucks, tractors, and more, are used to transport the gathered rubbish. Most cities in India lack a reliable transportation infrastructure, so residents must rely on rickety old cars that can't handle the volume of rubbish they generate. These are the most common issues encountered while trying to manage garbage. A more efficient route may be created via the use of safe and reliable transportation.

IoT devices, wearable gadgets, and smart technologies employ sensors to collect and analyse large amounts of data, and machine learning has a strong and significant role in making judgments and finding certain patterns. Data-driven decisions may therefore be made with the aid of machine learning. KNN is a basic machine learning algorithm for classifying user 'type' decisions in wireless networks and other areas. Improving waste management to increase public health and well-being. But it's not only about collecting and disposing of trash if you want your city to be smart. It is necessary to properly dispose of household items such as old batteries and insecticides as well as paints and motor oil in order to prevent the release of harmful gases into the air. Food trash and other biodegradable substances that are left neglected contribute to the creation of methane gas. The collection, separation, reduction, re-use, and recycling of garbage are all part of good waste management. There is a lot of information out there on smart dustbins, which are often located in a public space. Household trash disposal is a major challenge.

Machine Learning Approach for Proposed Model:

Where S_a is the actual sensor value, and S_{max} is the parameter's maximum predicted value. Different service providers may define their own maximum anticipated value. An automated judgement was made based on combinations of $N(S_i)$ to send a weather warning or not. It is expected that four trash cans in a community will transmit alarm messages or not, based on supervised learning, as a test case scenario. To forecast 'decision', the author employed the Knearest Neighbor (KNN) method. Classification, estimation, and prediction algorithms in the field of data mining employ KNN. Pandas library was used to input csv files and sklearn or other machine learning software was used to establish the simulation environment for categorization. Scikit-Learn is a machine learning package that may be used with python to create KNN classifiers. SVM, KNN, random forest, and other algorithms are supported, as are numerical and scientific libraries like NumPy and SciPy in Scikit-Learn. For a KNN classifier, the author used the following value as a parameter.

Conclusion

New and promising technology, the Internet of Things (IoT), has the potential to transform human existence throughout the world because of its wide range of connection. Connecting low-energy devices and interactions over the Internet is facilitated by the Internet of Things (IoT). An increasing number of IoT-based apps throughout the globe are providing unique services for smart cities and enhancing energy efficiency. The Internet of Things (IoT) is being used in a variety of ways, including the creation of smart cities. According to, one of the most pressing issues for a smart city is the rapid population development that results in a rise in garbage output. Trash collection and path collection are two of the most difficult aspects of waste management. First and foremost, urban garbage collection requires careful design of waste truck routes that take environmental, economic, and social concerns into account. This is a daily undertaking. By using graph theory, the journey length may be reduced in order to prevent excessive fuel expenditures and to minimise the amount of effort required. Some systems employ IoT devices to estimate the amount of inboxes and relay this information via the Internet to a server for decision-making purposes.

References

Anh Khoa, Tran, Cao Hoang Phuc, Pham Duc Lam, Le Mai Bao Nhu, Nguyen Minh Trong, Nguyen Thi Hoang Phuong, Nguyen Van Dung, Nguyen Tan-Y, Hoang Nam Nguyen, and Dang Ngoc Minh Duc. 2020. "Waste Management System Using IoT-Based

Machine Learning in University.” *Wireless Communications and Mobile Computing* 2020. doi: 10.1155/2020/6138637.

Bin, Waste Collection. n.d. “WASTE MANAGEMENT SYSTEM BASED ON LOCATION INTELLIGENCE PROJECT REFERENCE NO .: 40S _ BE _ 1714 Introduction : Objective : Methodology :” 2–5.

Dubey, Sonali, Pushpa Singh, Piyush Yadav, and Krishna Kant Singh. 2020. “Household Waste Management System Using IoT and Machine Learning.” *Procedia Computer Science* 167(2019):1950–59. doi: 10.1016/j.procs.2020.03.222.

Jobin Joseph. 2019. “Smart Waste Management Using Deep Learning with IoT.” *International Journal of Networks and Systems* 8(3):37–40. doi: 10.30534/ijns/2019/10832019.

Khan, Rijwan, Santosh Kumar, Akhilesh Kumar Srivastava, Niharika Dhingra, Mahima Gupta, Neha Bhati, and Pallavi Kumari. 2021. “Machine Learning and IoT-Based Waste Management Model.” *Computational Intelligence and Neuroscience* 2021. doi: 10.1155/2021/5942574.

Rahman, Md Wahidur, Rahabul Islam, Arafat Hasan, Nasima Islam Bithi, Md Mahmodul Hasan, and Mohammad Motiur Rahman. 2020. “Intelligent Waste Management System Using Deep Learning with IoT.” *Journal of King Saud University - Computer and Information Sciences* (xxxx). doi: 10.1016/j.jksuci.2020.08.016.

Sheng, Teoh Ji, Mohammad Shahidul Islam, Norbahiah Misran, Mohd Hafiz Baharuddin, Haslina Arshad, Md Rashedul Islam, Muhammad E. H. Chowdhury, Hatem Rmili, and Mohammad Tariqul Islam. 2020. “An Internet of Things Based Smart Waste Management System Using LoRa and Tensorflow Deep Learning Model.” *IEEE Access* 8:148793–811. doi: 10.1109/ACCESS.2020.3016255.

Singh, Vijay. n.d. “FREE 60 Min Crash Course On AI Using Python.”