**Smart Waste Management System using IoT**

**Authors:** Prof. S.A. Mahajan, Akshay Kokane, Apoorva Shewale, Mrunaya Shinde , Shivani Ingale

With rapid increase in population, the issues related to sanitation with respect to garbage management are degrading immensely. It creates unhygienic conditions for the citizens in the nearby surrounding, leading to the spread of infectious diseases and illness. To avoid this problem, IoT based “Smart Waste Management” is the best and trending solution. In the proposed system, public dustbins will be provided with embedded device which helps in real time monitoring of level of garbage in garbage bins. The data regarding the garbage levels will be used to provide optimized route for garbage collecting vans, which will reduce cost associated with fuel. The load sensors will increase efficiency of data related to garbage level and moisture sensors will be used to provide data of waste segregation in a dust bin. The analysis of ceaseless data gathered will help municipality and government authorities to improve plans related to smart waste management with the help of various system generated reports.

1. This paper shows how the smart waste management using IoT can be implemented. This proposed system assures the collection of garbage soon when the garbage level reaches its maximum level.
2. The system will thus provide accurate reports, increasing the efficiency of the system. The real-time monitoring of the garbage level with the help of sensors and wireless communication will reduce the total number of trips required of GCV and thus, will reduce the total expenditure associated with the garbage collection.
3. Thus, the dustbins will be cleared as and when filled, giving way to cleaner city, better infrastructure and increased hygiene.

**IoT-Based Smart Waste Bin Monitoring and Municipal Solid Waste Management System for Smart Cities**

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The devices are wirelessly connected with the central hub to transmit the information about the bins filling level with the existing location. The significant advantage of the system is to collect waste material on time in order to avoid the overflow of bins that would help in saving the environment from pollution.

**Implementation of spatial smart waste management system in Malaysia**

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Enevo one is a comprehensive logistics solution that saves time, money and the environment. It uses wireless sensors to measure and forecast the fill-level of waste containers and generates smart collection plans using the most efficient schedules and routes. The solution provides up to 50% in direct cost savings. Receive automatically generated schedules and optimised routes which take into account an extensive set of parameters future fill level projections, truck availability, traffic information, road restrictions, container and content types the vehicle can collect etc. New schedules and routes are planned not only looking at the current situation, but considering the future outlook as well. Enevo using WSN and Ultrasound sensor for measuring the fill level of waste container.

**Smart Waste Bin with Real-Time Monitoring System**

**Authors:** Norfadzlia Mohd Yusof1, Mohd Faizal Zulkifli , Nor Yusma Amira Mohd Yusof , Azziana Afififie Azman.

The control station contains the central server which hosts the web server, database, SMS notification system in Figure 4 and a webbased waste bin real time monitoring system in Figure 5. The data sent by the smart waste bin is received by the control station and stored in the database server. Control station runs two systems which handle different jobs. The systems are SMS notification system and web-based was bin monitoring system.

# IOT Enabled Smart Waste Bin with Real Time Monitoring for efficient waste management in Metropolitan Cities

**Authors:** Manju Mohan, Kuppan Chetty Ramanathan, Vijayram Sriram, Mohd Azeem

 Waste bins are part of our lives for decades and mostly its condition are overflowing due to improper waste dumping, collection and management, which leads in foul smell and unhygienic condition, thus inherently results in environment pollution. Therefore, in this paper, design of a Waste Bin with real time monitoring is presented and a smart waste management system is proposed using the recent technical advancements of automation and Internet of Things (IoT). The capacitance sensor in the bin continuously monitors the level of the bin in real time and communicates to the central cloud where the bins are connected. Ultrasonic sensor is used to open and close the lid of the bin whenever the persons are nearby the bin. Such smart bins are connected to the cloud, where the bin status are communicated, recorded and monitored by the local bodies through and android app or a centralized server. Thus the designed smart bin and proposed waste management system have better level of smartness compared to existing ones in metropolitan cities in a centralized manner.

**Smart Waste Management System**

**Authors:** Tejashree Kadus, Pawankumar Nirmal, Kartikee Kulkarni

It is based on the concept of Automation used in

waste management system under the domain of Cleanliness and Hygiene. Dumping garbage onto the streets and in public areas is a common synopsis found in all developing countries and this mainly end up affecting the environment and creating several unhygienic conditions.

# Smart Waste Management System for Crowded area

**Authors:** Rasha Elhassan, Mahmoud Ali Ahmed.

In implementing the smart cities the great challenge is how to manage waste with low cost and high performance. Waste has a negative impact in the society quality which smart city aims to improve it. Makkah and holy sites [Mona, Arafat, and Muzdalifah] are very congested areas where waste management is a big challenge. Three factors make it a big challenge, behind its natural, small area, short period of time and the increasing of the Pilgrimages' member. The process of collected wastes, separated it, and transports the containers daily and quickly to avoid any prospect of a spread of diseases is a complex process. This paper aims to study the concept of the waste management and proposed smart systems for waste management system with recycling .The proposed system will use the sensors technique insite the container, as a lower level, to separate the waste into 4 categories [food, plastics, papers, and metal] and use actuator at a top level to inform the management system to collect the container. The proposed system will save time, money and efforts compared to the recent process of the waste management system and improve the society quality as all.

# Improved Smart Waste Management for Smart City

# Authors: Edin Golubovic, Yasin Acikmese.

In the system advocated above, the fusion of sensors, identification technology, and internet connectivity will lead to a uniquely smart disposal trash bin. Together with the cloud, these trash bins would become irreplaceable elements in the waste management cycle where the collection, transportation, storage, and recycling of waste could be automated. The use of RFID technology in waste collection services not only increases the efficiency of waste management through automation but also increases environmental responsibility which is one of the pillars of the Smart City.

**Waste Management System Using IoT-Based Machine Learning in University**

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IoT-based waste management models perform a vital function in improving the standard of living and human well-being by increasing energy-efficiency, enhancing governance, and reducing cost. In Vietnam, Ton Duc Thang University has set a goal to become an elite research university in the world’s top 500 universities. With the successful model and dream of a top Vietnamese university, the application of IoT technology to waste management is one aspect of this model.

This article presents a novel platform for smart trash control at the university, which is able to keep the university clean at low cost, requiring low labour resources. A novel microcontroller system is designed with a sensor module for measuring the filling height of garbage using ultrasound and geolocation of collected data based on LoRa technology. Furthermore, the paper presents a new method for predicting the probability of the filling level of each trash bin by applying LR in ML; furthermore, a graph theory-based optimization solution is proposed to compute the paths of waste collection with different time schedules in order to minimize the environmental and socio-economic impacts, as well as supporting the workers of the university.

The contributions of our work are:

(i)Previous articles have mostly evaluated results on a test board; our work introduces the design of a single microcontroller board, which is of low cost and straightforward, with an ultrasound sensor which can measure the filling height of a garbage can and send information using LoRa E32 technology.

(ii)We present a novel IoT-based machine learning method, which is employed to predict the probability of collecting waste in the real environment based on the historical input data.

(iii)Our article is the first to propose the use of the sigmoid function for predicting the probability of waste collection and to apply Dijkstra’s algorithm to optimize the path for waste collection from trash bins.

**Smart Waste Management System using IOT**

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This is not an original idea, IOT based dustbin was implemented and effectuated much before. Some authors presented systems where the sensors in the bin checked if the bin are filled up to the brim or not. If it was filled an automated

message was sent to the server end of the system, through the Arduino SIM module, which used the application of the Arduino board. Once the server received the message it forwarded the message to the worker in charge, if the worker was available, he would notify his/her presence by accepting the work and would reach the required destination. If the worker was not available, the work would be transferred to another worker.

Some proposed smart garbage management system using IR sensor, microcontroller and Wi-Fi module. This system assured the cleaning of dustbins soon when the garbage level reached its maximum. If the dustbin was not cleaned in specific time, then the records were sent to the higher authority who took appropriate action against the concerned contractor. This system also helped to monitor the fake reports and hence helped to reduce the corruption in the overall management system. It ultimately helped to keep cleanliness in the society.

# Smart Waste Management System Based On A IoT Platform

September 11, 2021 by

# AUTHORS: Memon S. K , Aaditya Jain , M H A Wahab et al

Memon S. K proposed a smart waste management system in which they are collecting the data from ultrasonic sensors and writing the data to the thing speak channel using the Wemos D1 mini (it is like a little Arduino with a Wi-Fi module). Their work is only limited to glowing the led in the thing speak channel on reaching the threshold value, or in other words glowing the led when the bin gets filled. Our proposed work not only glows the led on reaching the threshold but also sends a mail alert to the municipal corporation and it is capable of predicting the future levels of the bin.

Aaditya Jain implemented a model of smart waste management by using an ultrasonic sensor, for detecting the distance between waste and the lid of the bin and also used a force sensor to calculate the weight of the bins. The use of force sensors is impractical as waste can be of low weight or even heavyweight.

M H A Wahab et al have suggested the concept of ‘Smart Recycle Bin’ with the help of RFID tags, to identify the person throwing the garbage. RFID-based systems are not possible, as we cannot provide each person with RFID tags and they cannot carry them every time they go on to dispose of waste into a garbage bin. In this model, they are not transferring the data to the cloud.

**Smart waste management using Internet-of-Things (IoT)**

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To make the cities greener, safer, and more efficient, Internet of Things (IoT) can play an important role. Improvement in safety and quality of life can be achieved by connecting devices, vehicles and infrastructure all around in a city. Best technological solutions can be achieved in smart cities by making different stakeholders to work together [5][6][7]. System integrators, network operators and technology providers have a role to play in working with governments to enable smart solutions. But, building such solutions on an open, standards-based communications platform that can be continuously used is a challenge. We present a waste collection management solution based on providing intelligence to wastebins, using an IoT prototype with sensors. It can read, collect, and transmit huge volume of data over the Internet. Such data, when put into a spatio-temporal context and processed by intelligent and optimized algorithms, can be used to dynamically manage waste collection mechanism. Simulations for several cases are carried out to investigate the benefits of such system over a traditional system. We try to replicate the scenario using Open Data from the city of Pune, India stressing on the opportunities created by this type of initiatives for several parties to innovate and contribute to the development of Smart waste management solutions.