

# **LITERATURE REVIEW**

## **1. IoT-Enabled Solid Waste Management in Smart Cities**

This IoT based process is to check whether the dustbins all over the city are full or not. In case if the bins get filled, it detects overweight through a moisture sensor and then workers come to collect the garbage.

The trash bins were filled with wastes at different levels and the corresponding unfilled levels of every trash bin were monitored through the intelligent GUI. It manages the waste in different types of boxes by using automation. In this system, it detects the dry and wet waste and separates them automatically using a Moisture sensor.

The ultrasonic sensor is so accurate that there is no dead zone within the sensing range. Several trash bins must be placed to manage solid waste over a large area. For the garbage truck to collect garbage, the geo location coordinates for each trash bin are necessary. For that we use GPS (Global Positioning System). The Moisture sensor is used to measure the water content (moisture) in garbage.

### **Advantages**

- The proposed IoT-enabled solid waste management system is well suited for monitoring real-time trash bin information in smart cities.
- It includes a smart dustbin that separates dry and wet waste so that the waste recycling can be done more efficiently.
- It helps the smart cities to collect the dustbins on time over the cities.
- It helps the people in the city to live in hygienic conditions.
- It also makes the cities free from unpleasant odors from dustbins.

### **Disadvantages**

- Increasing cost of the dustbin.
- The trash bins were filled with wastes at different levels and if there are three different levels, then three sensors have to be placed; one sensor for each level.
- Rough action and usage of the user may cause damages to the sensors.

## **2. IoT Enabled Smart Waste Bin with Real Time Monitoring for efficient waste management in Metropolitan Cities**

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 is communicated, recorded and monitored by the local bodies through an android app or a centralized server.

The waste level inside the bin is determined by estimating the distance between the bottom of the bin and the lid using an ultrasonic sensor. The sensors are connected with the controller and the levels are continuously recorded in the cloud. When the waste level exceeds the threshold value, which is set according to the dimension of the bin, the controller alerts the responsible municipal persons or the sanitary inspector with the bins ID, bin location and the bin level, whenever it perceives a person nearby to the bin. A power supply unit provides a necessary power to the operation of the bin. Once the bin is emptied and serviced, it returns to the default operation.

### **Advantages**

- It is effective for the economical aspects as it reduces the cost of labor and fuel cost of collecting vehicles by minimizing their extra visits in checking bins' status.
- Once a bin reaches its threshold limit, it informs the collecting vehicle for the cleaning process, which saves time, cost, and energy.
- It is user-friendly as it obstructs the overflow of bins.
- It is useful for IoT-based smart cities, which helps to keep the environment clean and disease-free for the citizens.

### **Disadvantages**

- Since the bin is in the street, it is possible that the bin will be opened if the person passes nearby to the bin even if he/she doesn't want to put the waste.
- The shortest path finding for collecting vehicles has not been installed which results in reduced transportation and has a difficulty to remove collecting barriers.
- It saves less energy so additional automated segregating TBs have to be installed for dry, wet, and hazardous types of waste.

### **3. Smart Waste Management: Garbage Monitoring Using IoT**

This is a Smart bin system that identifies hazardous gasses and fullness of bins. The system is designed to collect data and to deliver the data through a wireless mesh network. To collect data and to obtain bin utilization and bin daily information, with such information, wastage bin providers and cleaning contractors are able to make better decisions.

The ultrasonic sensor intimates the load of the garbage dump if it is full. If the dustbin is not cleaned in a specific time, then the record is sent to the higher

authority who can take appropriate action against the concerned contractor. A Gas sensor node is installed in every Smart bin which will detect hazardous gasses on the dustbin due to some chemical waste and bio-waste. The Ethernet shield will be used to update the status of the bin whether it is having hazardous gas or not. The buzzer will give the alert when there is any hazardous gas from the smart bin.

### **Advantages**

- This reduces the total number of trips of garbage collection vehicles and hence reduces the overall expenditure associated with the garbage collection.
- This system also helps to monitor the fake reports and hence can reduce the corruption in the overall management system.
- Smart bin providers are able to identify and decide whether a particular area needs extra litter bins to be placed nearby or remove and relocate existing litter bins to other places where they are needed.

### **Disadvantages**

- We have to change the system of user's authentication and the atomic lock of bins which would help in securing the bin from any kind of damage or theft.

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

In this paper, the waste management is achieved by predicting the probability of the waste level in trash bins. By using machine learning and graph theory, the system can optimize the collection of waste with the shortest path.

In this work, an optimal algorithm combining graph theory and LR has been described. This study also presented two experiments: first, a test was conducted by simulating the location of arbitrary trash bins and finding the shortest path

between the trash bins. Second, the logistic regression equation was applied to estimate the probability of collecting the waste. The algorithm used the database of classes used in each university building and data received from smart buckets (e.g., occupancy rate) as input data.

### **Advantages**

- This system saves time by finding the best route in the management of waste collection.
- It is implemented through a simple circuit designed with low cost, ease of use, and replace ability.
- This system provides better operations for optimizing employee use, saving operating costs, and collecting data on time.
- The system will be extensively applied in all campuses of the Ton Duc Thang University, a Smart University, to unify the filling level of the trash bins by using an ultrasonic sensor.

### **Disadvantages**

- This system is only applicable for predicting the probability of the waste level in trash bins in a particular university.
- Since its purpose is fully on predicting the filling level of the trash bins, it can't identify which type of waste it is.
- Furthermore, it may cause smell due to rotten wastes.
- The system did not provide clarity about communication and optimization for all trash bins in the system.

## **5. Optimal Management of Solid Waste in Smart Cities using Internet of Things**

We designed an algorithmic approach that allows dumpsters to connect with the server in the municipal authority via a wireless network that reports the status of accumulated waste levels before the start of the collection process. We use the IOT technology to determine the schedule and pathways of waste collection trucks. The smart dumpsters are equipped with the sensors that measure levels of waste and a controller to send updates to the central management system using wireless network.

We developed the MITRA algorithm applying the timing constraint on capacitated vehicle routing problems. MITRA divides the metropolitan area into a set of sectors each containing a number of dumpsters. We guide the routing in waste collection by selecting the order of sectors to be served then apply genetic algorithms to compute the optimal route to serve the full dumpsters in the sector.

It manages the pathways to multiple trucks. Managing waste consists of waste collection that comprises disposal of waste and transportation. Guided routing would result in significant reduction of cost and efficient processing for the municipal authority.

### **Advantages**

- It provides trip length and utilization of vehicles.
- It saves time and money by using smart waste collection bins and systems equipped with fill level sensors.
- It improves the waste collection process by reducing the congestion on the road, the service time spent and the overall trip length.

### **Disadvantages**

- Poor sensor performance
- Lack of any contribution to the trash sorting at the recycling facility.

## **6. IoT based Smart Waste Management System using Arduino**

In this system, a 24×7 monitoring system is designed for monitoring dumpsters. Here an automated system is provided for segregating wet and dry waste. A mechanical setup can be used for separating the wet and dry waste into separate containers here sensors can be used for separating wet and dry. For detecting the presence of any waste wet or dry can be detected using an IR sensor. In the next step for detecting wet waste a moisture sensor can be used. In this process, if only IR is detected, the motor will rotate in the direction of the dry waste container. If both sensors detect the waste then it will go to the wet container. Both these containers are embedded with ultrasonic sensors at the top, the ultrasonic sensor is used for measuring distance. This makes it possible to measure the amount of waste in the containers. If one of the containers is full then an alert message will be sent to the corresponding person.

DC motor powered platform is used for segregating wet and dry waste, IR sensor and moisture sensor is used for separating wet and dry waste. If either of the containers is full then an alert message is sent from the dustbin to employees and the cloud. In turn, employees can clear the corresponding dumpsters. All these sensors are connected to an Arduino Uno board. It can be used for controlling all mechanical setup based on current conditions.

### **Advantages**

- It will monitor each dumpster individually for the amount of waste deposited.
- This project is very effective in managing waste in any big city.

- Rather than using conventional periodic collection methods here priority system is used to ensure the city is clean all the time without any overflowing dumpsters.
- It has been tested and verified properly to make sure all the different parts work together for a smooth function of the whole system.

### **Disadvantages**

- Cost is high
- Lots of sensors are used.
- Management of sensors will be difficult.

## **7. Smart Waste Collection System**

In most of the city the overflowed garbage bins are creating an environment. This will further lead to different types of diseases. To overcome these situations this efficient smart waste collection has been developed.

Sensor Based Smart Waste Collection (SWC) system is used to identify the status of waste bins and detect the percentages of waste. Real time Smart Waste Collection (SWC) system by using smart dustbins to check the fill level of dustbins, through this system the information of all smart dustbins can be accessed from anywhere and anytime by the concerned person. Person can locate the waste bin. In case of unavailability of internet there will be another option of SMS alerts through telecom networks. It will also send alerts for the installation of additional bins. Requirement reports will be generated automatically on a single click which would further be shared via email and SMS. There is a lot of scope of this project in smart cities. It will stop overflowing of dustbins along roadsides and localities as smart bins are managed in real time.



## **Advantages**

- By using the route algorithm it will smartly find the shortest route.
- Send optimized routes directly to drivers.
- Less amount of fuel consumed by vehicles thus can save a large amount of money as well.

## **Disadvantages**

- It uses SMS alerts in case of network issues, so it is possible that the users may not check the messages.

## **8. Automation of smart waste management using IoT**

One of the main concerns with our environment has been solid waste management which in addition to disturbing the balance of the environment also has adverse effects on the health of the society. Many times, in our city we see that the garbage bins or dustbins placed at public places are overloaded, it creates unhygienic conditions for people as well as ugliness to that place leaving a bad smell. To avoid all such situations we are going to implement a project called IoT Based Smart Garbage and Waste Collection bins.

In this project, the dustbins are interfaced with a microcontroller based system having ultrasonic sensor systems along with a central system showing current status of garbage, on mobile web browser with html page by Wi-Fi. Hence the status will be updated on to the html page. Major part of our project depends upon the working of the Wi-Fi module; essential for its implementation.

ESP8266 WI-Fi module is used to update the status of dustbins on the mobile app. Moisture sensor is used to detect garbage is either dry or wet. Two DC motors are used; one is for moving the conveyor belt and second is for rotating the

dustbin position to collect garbage in a separate dustbin. Relays are used for driving DC motors. Ultrasonic sensors are used to detect garbage level in dustbins, to determine the dustbin is full or empty. One is used to detect the garbage level of dry dustbin and second is to detect the garbage level of wet dustbin.

### **Advantages**

- It reduces human resources and efforts along with the enhancement of a smart city vision.
- It has a separate sensor for both wet and dry garbage.
- Low cost components

### **Disadvantages**

- Since the app is fully dependent on the Wi-Fi module, we can't use it in mobile data or any other internet.
- The garbage level will only be displayed on mobile app.

## **9. A SURVEY ON SMART WASTE MANAGEMENT SYSTEMS**

The municipal solid waste generation levels are increasing significantly with the ever increasing population, urbanization, migration issues and change in lifestyle. Waste management becomes a challenge faced not only by the developing nations, but also the developed and advanced countries. The efficient management of waste has a significant impact on the quality of life of citizens. The reason is that waste disposal has a clear connection with negative impacts in the environment and thus on citizens' health. Also the quantity of waste near the streets caused a bad smell and bad hygienic conditions. It also provides a negative impact on tourism. The smart waste management system helps to remove the waste in appropriate time without overflowing and also provides better waste management.

The solid waste is increasing in urban and rural areas. The population is increasing and waste management has become a global concern. In order to manage this overflowing garbage we need to make the right decision. Mainly there are three types of sources where garbage is generated viz. Residential, commercial and industrial. The garbage produced in the residential area can be collected directly from home or by making an arrangement for mass collection in that area and can be lifted using vehicles. In case of restaurants, malls and other commercial establishment garbage are collected directly from the unit using vehicles.

### **Advantage**

- The smart waste management system collects wastes in proper time, disposes and recycles in the proper way
- These systems help in better waste management and making the cities clean and efficient.
- The waste management system provides a better health environment by proper waste management without much human intervention.

### **Disadvantage**

- The sensor node was deployed with battery power. Low power consumption sensor node must be used because of its limited power.
- The sensor node had limited memory size.

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

Proper waste management is one of the major problems for densely populated urban areas. It is getting difficult day by day to lead a healthy, sustainable living in urban areas because of environmental contamination. Due to the lack of proper waste management approach, problems like an overflow of waste occurs that badly harm our environment. Polluted surroundings result in the

spread of various kinds of diseases in an epidemic form. For developed and developing countries, waste management is a challenge to long-term development. Proper management of waste is getting tougher because of increasing population, urbanization, and industrialization. In this modern era of technology, we need to apply technology-based solutions to handle large amounts of waste for overpopulated urban areas. We have reviewed several recent research articles related to the smart waste management system, and almost all of them have some major limitations as well as progress.

To ensure environmental hygiene and sustainable urban life, we have presented a smart IoT based integrated system consisting of an identification system, an automated lid system, a display system, and a communication system. Arduino Uno is used as a microcontroller to synchronize all of the four systems. Sensors are used for identification and measuring the garbage level. The system provides the facility of continuous monitoring of the status of waste inside the garbage bin and shows the percentage filled up on liquid crystal display (LCD). The communication system uses a global system for mobile communications (GSM) module that will inform the corresponding authority to collect the waste when the garbage bin is filled up.

**Advantages:**

- This IoT based application is used to ensure environmental hygiene and sustainable urban life.
- It provides a very simple waste management system that is eco – friendly.

**Disadvantages:**

- Due to the lack of proper waste management approach, problems like an overflow of waste occurs that badly harm our environment.
- The open dumping and picking of waste within open dumpsites lead to serious health risks like skin infections and chronic diseases.







