# MAR ATHANASIUS COLLEGE OF ENGINEERING , KOTHAMANGALAM

## Initial Project Report

### SMART WASTE BIN MANAGEMENT USING IOT


Done by

**ABIN JOSE**

Reg No: MAC23MCA-2005


Under the guidance of

Prof. SIBU SKARIA

# Mar Athanasius College of Engineering, Kothamangalam

## Department of Computer Application

### Project Synopsis

## Smart Waste Bin Management Using IOT

The “Smart Waste Bin Management Using IoT” designed to address the challenges of waste accumulation and management in urban areas. The system utilizes an Arduino microcontroller integrated with multiple sensors, including the ESP8266 Wi-Fi module, ultrasonic sensors for detecting waste levels, and weight measurement sensors for calculating waste quantity. The ultrasonic sensors detect the waste level and automatically open the bin cover when a person approaches, ensuring user convenience and hygiene. Additionally, the sensor data is processed and displayed on an LCD screen and a mobile application, with the information also being uploaded to a Firebase cloud application for comprehensive monitoring and data analysis. The system includes a buzzer to give alerts. We can use a GPS module or unique identifiers with predefined locations to track the bin. RFID readers on the bins can identify users with RFID tags, provide awareness to those who don't use the bins, and reward those who do.

The smart waste system operates by continuously monitoring the waste level and weight in the garbage bins. When the waste level reaches 80% or the weight exceeds a certain threshold, the system triggers alerts for timely waste collection. This automation reduces the need for manual intervention, minimizes the workload of sanitation workers, and helps prevent overflows and unsanitary conditions. The integration of real-time data processing and display enhances the system's efficiency and relevance in maintaining urban cleanliness.

In conclusion, the proposed IoT-based smart waste system offers a comprehensive solution to urban waste management challenges. By automating waste detection and alerting, and providing real-time monitoring through an LCD screen, mobile application, and Firebase cloud application, the system ensures a cleaner and healthier environment. This innovative approach not only improves the efficiency of waste management processes but also contributes to the overall well-being of urban communities.

**References:**


1. Rahman MW, Islam R, Hasan A, Bithi NI, Hasan MM, Rahman MM. Intelligent waste management system using deep learning with IoT. Journal of King Saud University-Computer and Information Sciences. 2022 May 1;34(5):2072-87

2. John J, Varkey MS, Podder RS, Sensarma N, Selvi M, Santhosh Kumar SV, Kannan A. Smart prediction and monitoring of waste disposal system using IoT and cloud for IoT based smart cities. Wireless Personal Communications. 2022 Jan;122(1):243-75.

3. Jasim AM, Qasim HH, Jasem EH, Saihood RH. An internet of things based smart waste system. International Journal of Electrical and Computer Engineering (IJECE). 2021 Jun 1;11(3):2577-85



Submitted By :
Name: Abin Jose
Reg No: MAC23MCA-2005
S3 MCA, 2023 – 25 Batch

Faculty Guide:
Prof. Sibu Skaria
Associate Professor
MCA Dept, MACE

# LITERATURE REVIEW

## Paper 1:

| | |
|---|---|
| **Title of paper** | Rahman MW, Islam R, Hasan A, Bithi NI, Hasan MM, Rahman MM. Intelligent waste management system using deep learning with IoT. Journal of King Saud University-Computer and Information Sciences. 2022 May 1;34(5):2072-87 |
| **Area of work** | The study aims to develop an efficient and user-friendly system using deep learning and IoT to improve waste management. By enhancing waste classification accuracy, real-time data monitoring, and system usability, this research contributes to more effective waste management practices. |
| **Components used** | • Raspberry pi<br>• Ultrasonic sensor<br>• Camera Module<br>• ESP8266 Node MCU<br>• Servo Motor<br>• Load Measurement Sensor<br>• Android Application<br>• GSM Module<br>• Roller<br>• Waste Bin |
| **Algorithm** | Convolutional Neural Network (CNN), Capsule Neural Network (Capsule-Net), ResNet-50, Support Vector Machine (SVM), Region-based Convolutional Neural Network (RCNN) |
| **Accuracy** | Capsule-Net:96.3% SVM:87% RCNN:90-97% |
| **Methodology/Strategy** | The intelligent waste management system combines deep learning for waste classification and IoT for real-time monitoring. Convolutional Neural Networks (CNNs), such as AlexNet, VGG16, and ResNet34, classify waste based on images from a camera module, with ResNet34 performing best. Images are resized for processing, and smart trash boxes with ultrasonic and load sensors measure waste levels and weight. An ESP8266 microcontroller processes sensor data and communicates with an Android app via Bluetooth or Wi-Fi, sending data to the cloud when available. A servo motor and roller move waste to the correct bin based on the CNN's classification. The system captures images, classifies waste, sorts it, and monitors bin status in real-time, sending alerts to users when bins are full, ensuring efficient waste management. |
| **Advantages** | High Accuracy in Waste Classification, Efficient Recycling and Composting, Environmental Sustainability, Support for Smart Cities Initiatives. |
| **Limitations** | Limited waste categories.<br>The system can incorrectly indicate that the bin is full when it is not, due to the nature of the waste.<br>Limited use of sensors |
| **Future proposal** | To improve the intelligent waste management system, the proposal includes expanding the dataset and adding sensors like MQ gas sensors to enhance accuracy and classification of waste. |

## Paper 2:

| | |
|---|---|
| **Title of paper** | John J, Varkey MS, Podder RS, Sensarma N, Selvi M, Santhosh Kumar SV, Kannan A. Smart prediction and monitoring of waste disposal system using IoT and cloud for IoT based smart cities. Wireless Personal Communications. 2022 Jan;122(1):243-75 |
| **Area of work** | It focuses on developing an IoT-based smart waste management system for urban areas. It involves using sensors, microcontrollers, and cloud services to monitor waste levels, predict generation patterns, and optimize collection schedules for improved efficiency. |
| **Components used** | • Arduino Microcontroller<br>• Ultrasonic sensor<br>• Infrared Sensor<br>• Weight Sensor<br>• GPS Module<br>• Temperature and Humidity Sensors<br>• Accelerometer (ADXL-335)<br>• LED Indicators<br>• ESP8266 Wifi Module<br>• Firebase Cloud Database |
| **Methodology/Strategy** | The proposed IoT-based smart waste disposal system for smart cities uses off-the-shelf components and an Arduino microcontroller with IR, UV, weight sensors, and a GPS module to measure fill levels, monitor conditions, and track bin locations. Data is sent via an ESP8266 Wi-Fi module to a Firebase cloud database for real-time processing. An LSTM neural network predicts future waste patterns, and Firebase Cloud Messaging alerts authorities when bins are full. The system includes a user-friendly web interface, real-time data visualization, automated bin height calibration, and a dynamic data dashboard for efficient urban waste management. |
| **Advantages** | Firebase Cloud Messaging sends timely notifications to authorities when bins need emptying, improving waste management efficiency. An LSTM neural network predicts future waste patterns for better planning and optimized collection schedules. Monitoring environmental conditions like temperature and humidity helps prevent harmful gases and odors, contributing to a healthier environment. |
| **Limitations** | Ensuring reliable power in remote or rural areas can be challenging and may require additional infrastructure. Initial Setup Costs are high. |
| **Future proposal** | Adding methane and temperature sensors can improve waste detection and environmental monitoring. Using LPWAN like LoRaWAN could enhance scalability and coverage. Integrating renewable energy sources can boost energy efficiency. AI-driven algorithms can optimize real-time waste collection routes by considering traffic and weather conditions. |

## Paper 3

| | |
|---|---|
| **Title of paper** | Jasim AM, Qasim HH, Jasem EH, Saihood RH. An internet of things based smart waste system. International Journal of Electrical and Computer Engineering (IJECE). 2021 Jun 1;11(3):2577-85. |
| **Area of work** | It focuses on developing an IoT-based smart waste management system for urban areas. The system is designed and implemented using two garbage baskets. This system is different from the previous works where the garbage baskets are emptied automatically using a conveyor belt. |
| **Components used** | • ESP32 Wi-Fi Microcontroller<br>• Ultrasonic sensor<br>• Conveyor Belt<br>• Brushless DC Motor with Driver Circuit<br>• DHT22 Sensors<br>• Servo Motor<br>• LCD with I2C Board<br>• GSM Module<br>• DHT-22 Sensor<br>• GPS Module<br>• Blynk Mobile Application<br>• Waste Bin |
| **Methodology/Strategy** | The IoT-based smart waste management system uses ultrasonic sensors in each bin to measure waste levels and DHT22 sensors to monitor temperature and humidity. Data from these sensors is processed by an ESP32 microcontroller, which determines if a bin needs to be emptied. The information is displayed on an LCD screen and sent to a cloud platform for remote monitoring via the Blynk mobile app. When a bin is full, the ESP32 activates servo motors to open the lid, and a conveyor belt driven by a brushless DC motor automatically transports the waste to a designated area. This automation reduces the need for manual intervention, minimizing health risks for sanitation workers. Costing approximately $120, the system is designed for widespread use in urban and rural areas, promoting efficient waste management and a cleaner environment. |
| **Advantages** | By monitoring environmental conditions such as temperature and humidity, the system helps in preventing the generation of harmful gases and odors, contributing to a healthier living environment. Integration of GPS Module helps the truck drivers to easily identify the route. They will get notified by SMS with the help of GSM Module. |
| **Limitations** | Initial Setup Costs are high. Extreme Weather Conditions may be affected. |
| **Future proposal** | Minimize environmental impact by using eco-friendly materials and establishing recycling programs. Introduce alert mechanisms. |

# LITERATURE SUMMARY

| | TITLE | AUTHOR | COMPONENTS | METHODOLOGY |
|---|---|---|---|---|
| 1 | Intelligent waste management system using deep learning with IoT | Rahman MW, Islam R, Hasan A, Bithi NI, Hasan MM, Rahman MM. | - Raspberry pi<br>- Ultrasonic sensor<br>- Camera Module<br>- ESP8266 Node MCU<br>- Servo Motor<br>- Load Measurement Sensor<br>- Android Application<br>- GSM Module<br>- Roller<br>- Waste Bin | CNNs like AlexNet, VGG16, and ResNet34 classify wastes, in which ResNet34 performing best. Smart bins with ultrasonic and load sensors measure waste levels and weight. An ESP8266 microcontroller sends sensor data to an Android app via Bluetooth or Wi-Fi . A servo motor and roller sort waste based on CNN classification. The system captures, classifies, and sorts waste, monitoring bin status in real-time and alerting users when bins are full, ensuring efficient waste management. |
| 2 | Smart prediction and monitoring of waste disposal system using IoT and cloud for IoT based smart cities | John J, Varkey MS, Podder RS, Sensarma N, Selvi M, Santhosh Kumar SV, Kannan A | - Arduino Microcontroller<br>- Ultrasonic sensor<br>- Infrared Sensor<br>- Weight Sensor<br>- GPS Module<br>- Temperature and Humidity Sensors<br>- Accelerometer(ADXL335)<br>- LED Indicators<br>- ESP8266 Wifi Module<br>- Firebase Cloud Database | Arduino with IR, UV, weight sensors, and GPS to monitor bins. Data is sent via ESP8266 to Firebase for real-time processing. An LSTM neural network predicts waste patterns, and Firebase Cloud Messaging alerts authorities when bins are full. The system features a user-friendly web interface, real-time data visualization, automated bin calibration, and a dynamic dashboard for efficient urban waste management. |
| 3 | An internet of things based smart waste system | Jasim AM, Qasim HH, Jasem EH, Saihood RH. | - ESP32Wi-Fi Microcontroller<br>- Ultrasonic sensor<br>- Conveyor Belt<br>- Brushless DC Motor with Driver Circuit<br>- DHT22 Sensors<br>- Servo Motor<br>- LCD with I2C Board<br>- GSM Module<br>- GPS Module<br>- Blynk Mobile Application<br>- Waste Bin | Ultrasonic sensors are used to measure waste levels and DHT22 sensors to monitor temperature and humidity. An ESP32 microcontroller processes this data, displaying it on an LCD and sending it to the cloud via the Blynk app. When a bin is full, the ESP32 activates servo motors to open the lid, and a conveyor belt transports the waste automatically. |

# PROJECT PROPOSAL

## OVERVIEW

The proposed system is to improve urban waste management by integrating an Arduino microcontroller with ultrasonic sensors, load measurement sensors, and an ESP8266 Wi-Fi module. The ultrasonic sensors is used detect waste levels and automatically open the bin cover when approached, load sensors measure the quantity of waste. Real-time data is displayed on an LCD screen and a mobile application. Information is also uploaded to a Firebase cloud application for detailed monitoring and analysis. A buzzer alerts when waste levels or weights exceed predefined thresholds, ensuring timely collection and reducing the need for manual intervention. This system enhances efficiency, prevents overflows, and supports a cleaner urban environment through automation and real-time data processing. GPS module/unique identifiers with predefined locations to track the bin. RFID readers on the bins can identify users with RFID tags, provide awareness to those who don't use the bins, and reward those who do.

## OBJECTIVE

The objective is to create an efficient and automated system for managing waste collection and disposal in urban areas. The system aims to monitor waste levels in real-time, optimize collection routes, reduce operational costs, and improve environmental cleanliness.

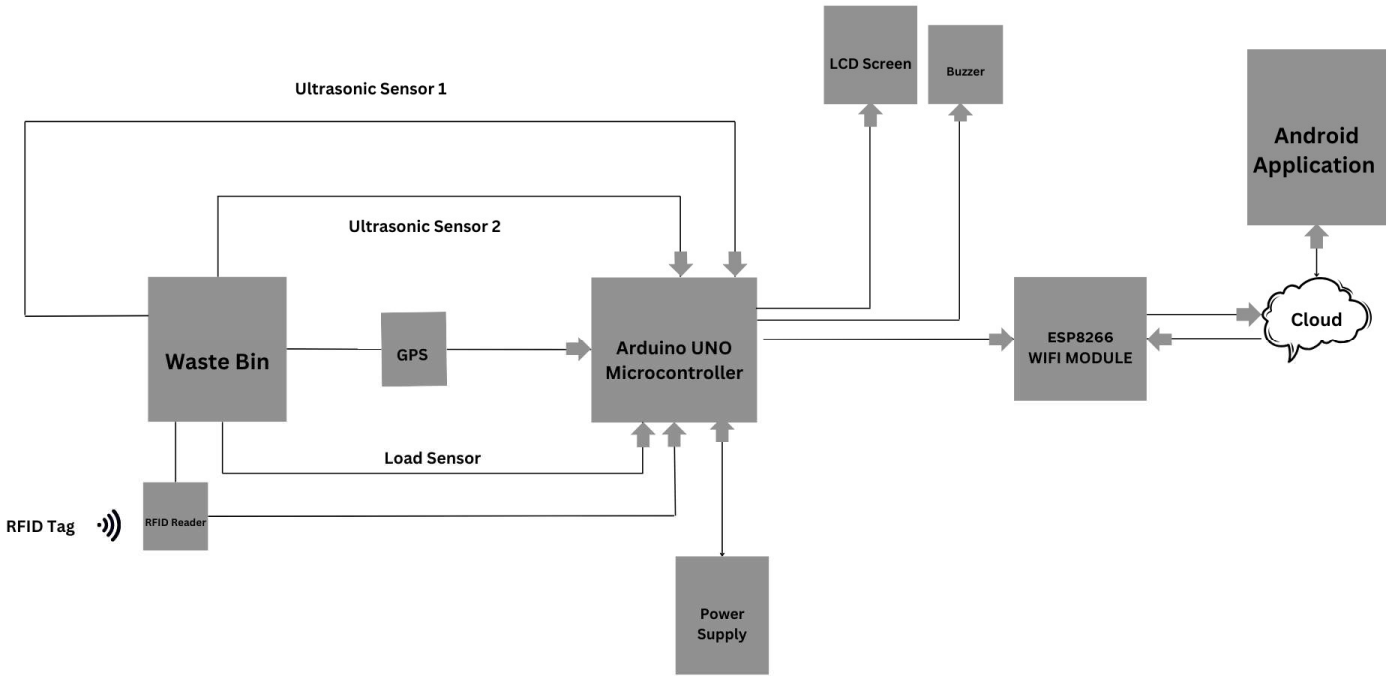
## IMPLEMENTATION

- Identify components and Hardware Setup
- Coding and Development
- Cloud Integration and Data Management
- Mobile app development
- Waste bin automation and alerts
- User Interaction and rewards

## COMPONENTS AND MATERIALS

- **Arduino Uno**: Microcontroller for processing and control.
- **ESP8266 Wifi Module**: Enables wireless data transmission to the cloud for remote monitoring.
- **HC-SR04 Ultrasonic Sensors**: For detect human and waste level in a bin.
- **HX711 Load cell**: To weigh the Waste bin and alert when threshold value reached.
- **SG90 Servo motor**: To open Waste bin.
- **16x2 LCD Screen**: Display real time data and system analysis.
- **GPS Module**: To find precise location of waste bin.
- **Piezo Buzzers**: For alerting when bin is full.
- **RFID Reader**: Used on bin to identify users with specific RFID tags.
- **Protective Diodes**: Prevent damage to the circuit by protecting against voltage spikes.
- **I2C Module**: Facilitates Communication between Arduino and other devices.
- **Battery pack**: Power supply for all components
- **Jumper Wires and Breadboard**: For connecting and prototyping components.

# BLOCK DIAGRAM




# CONCLUSION

The proposed IoT-based smart waste system has been implemented to provide a clean, litter-free environment in cities effectively. The system eliminates the need for human intervention in managing waste, positively impacting human health by reducing direct contact with garbage. It utilizes sensing and communication techniques to collect waste data from smart containers and transfer it to an online application accessible to workers, allowing them to monitor and verify the status of garbage containers deployed throughout the city. This approach reduces the workload on sanitation workers and relies on electronic monitoring, thereby promoting a healthy and clean environment free from pollutants.