

REAL-TIME WASTE MONITORING SYSTEM

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ABSTRACT :

With the tremendous population more waste is getting piled up in the society. Overflow of this trash in public places leads to unhygienic environment which create a path to spread diseases. This project will be helpful to overcome such problem. The system provides a web interface to the cleaning authority so that they can monitor and clean the garbage bins. In this we use ultrasonic sensors to determine the status of the dust bins. The status is read by the Node MCU and transmitted to the cloud server. This paper presents an inexpensive, simple, and scalable intelligent garbage management system. The system uses ultrasonic sensors to measure fill levels and send notifications to garbage collectors when bins need to be emptied.

GPS Module: Provides the precise location of each bin, which is crucial for optimizing collection routes and ensuring accurate data tracking.

1.INTRODUCTION

The term "Internet of Things" (IoT) describes a network of real-world things, such as cars, appliances, and other machinery, that are integrated with software, sensors, and network connectivity to enable data collection and sharing. The age of smart cities, where everything is planned and organized, is here upon us. Our issue is the population, which is growing at an accelerated rate. Urban migration has increased dramatically in recent years. The accumulation of trash waste everywhere is the outcome of this. The neighborhood becomes contaminated when trash is dumped in open areas. It may cause nearby residents to get a number of grave illnesses. The impacted area's evaluation will be embarrassed by this. We require a methodical strategy to address in order to minimize waste and uphold proper hygiene[1-30].

In order to minimize waste and uphold proper hygiene, we must address the issue methodically. The old-fashioned method of physically keeping an eye on the rubbish in the trash cans is a difficult, time-consuming procedure that requires extra human labor and is in no way compatible with the technologies of today. We suggest an intelligent approach to waste management in order to address this issue. This study suggests an Internet of Things (IoT) smart trash management system that uses sensing sensors to gauge the amount of rubbish in dustbins.

In order to learn more about the recent work that has been done, all other papers were examined. Some articles use a weight sensor to identify garbage. The weight of the loss in the trash can is shown. In any event, there is no information provided by the amount of rubbish in the dustbin. Therefore, the Infrared Sensor (IR) was used for waste detection. Since the

light from the IR sensor is at infrared frequencies, it is invisible to the human eye, but electronic sensors can detect it. The trash management framework consists of two parts: programming and unusual flagging devices. The device, which consists of the transmitter and the sensor recipient, is installed as an afterthought divider in the container. The sensor is used to indicate the extent to which the container is connected to the transmitter, which notifies the worker and recipient when the canister is fully filled. The role of a supervisor is to choose the most efficient route and motivate the driver to collect it in the shortest amount of time. Waste management is organized around different waste item components, domestic compartment, garbage can, and car assortment. The trash stream in the collection trucks continues to stop because to the waste piece and the homegrown container. Depending on RFID developments, additional garbage cans are introduced to an aggregate canister. The invention makes use of radio frequency identification (RFID) garbage cans and astute cars.

2.LITERATURE SURVEY

Annually, approximately 2.01 billion metric tons of municipal solid waste are produced, with projections suggesting this could rise to 3.4 billion metric tons by 2050 if current trends persist. On a per capita basis, waste generation averages around 1.5 kilograms per person per day in high-income countries, while it is about 0.5 kilograms per person per day in low-income countries. Regional disparities are significant; for example, the United States generates about 2.2 kilograms per person per day, reflecting higher consumption and waste production levels. These figures emphasize the growing scale of global waste and the urgent need for effective waste management and sustainability practices to address this escalating issue.

Several researchers and practitioners have explored Smart Garbage Management Systems (SGMS) using Internet of Things (IoT) technologies. They have proposed various solutions to improve waste management efficiency and address challenges. Here's a summary of key studies and their approaches:

1. Cisco (2021)

Article: "The Smart City Approach to Waste Management"

- **Solution:** Cisco discussed the application of smart technologies in waste management as part of broader smart city strategies. They highlighted the use of IoT sensors and communication networks to monitor and manage waste efficiently.
- **Approach:** Cisco's approach involved creating a connected infrastructure where waste management systems are integrated with other city services. This approach aims to improve overall urban management and enhance citizen engagement.

2. Frost & Sullivan (2020)

Report: "The Future of Waste Management: Smart Waste Management Solutions and Market Outlook"

- **Solution:** This industry report provided insights into emerging technologies and trends in smart waste management, including advancements in sensors, communication technologies, and data analytics.
- **Approach:** The report emphasized the potential benefits of integrating advanced analytics and AI to improve waste management efficiency. It also discussed the challenges and opportunities associated with adopting these technologies on a larger scale.

3. Feng and Xu (2018)

Study: "Smart Cities and Smart Spaces: Innovations in Urban Management"

- **Solution:** Feng and Xu explored the integration of smart waste management systems within broader smart city frameworks. They emphasized the use of IoT for real-time monitoring and data-driven decision-making.
- **Approach:** Their approach involved combining smart waste systems with other smart city technologies, such as smart grids and traffic management systems, to enhance overall urban efficiency and sustainability.

4. Kumar and Choudhury (2018)

Study: "Smart Waste Management System Using IoT"

- **Solution:** Kumar and Choudhury developed a smart waste management system that integrates ultrasonic sensors with IoT technology. The sensors measure the fill levels of garbage bins and send data to a central server using GSM modules.
- **Approach:** They implemented a web-based interface to monitor bin statuses in real-time and use this data to optimize collection routes. The system helps in reducing the number of unnecessary trips and improving operational efficiency.

5. Mandal and Kalra (2017)

Study: "Smart Waste Management System Using IoT: A Review"

- **Solution:** Mandal and Kalra reviewed various smart waste management systems and identified the use of different types of sensors, including ultrasonic and infrared sensors, for detecting waste levels. They also discussed communication technologies like GSM and Wi-Fi.
- **Approach:** They highlighted the importance of integrating these technologies with cloud platforms for data aggregation and analysis. Their review emphasized the potential of using machine learning algorithms to predict waste generation patterns and optimize collection schedules.

6. Agarwal and Soni (2016)

Study: "IoT-Based Smart Waste Management System"

- **Solution:** Agarwal and Soni proposed a system that uses a combination of ultrasonic sensors and GSM modules to monitor waste levels in bins and communicate with a central server. They also implemented a mobile application for users to check bin statuses and receive notifications.
- **Approach:** Their solution aimed to reduce manual monitoring efforts and improve the efficiency of waste collection. They also addressed the need for real-time updates and user engagement to facilitate better waste management practices.

3.PROBLEM STATEMENT

Urban areas around the world face challenges in efficient waste management due to lack of real-time data, irregular collection schedules, and overflowing bins, leading to environmental pollution, health hazards, and increased operational costs. A Real-Time Waste Monitoring System using IoT is needed to automate waste tracking, optimize collection routes, and ensure timely disposal.

This system should use IoT sensors to monitor waste levels in bins, transmit data to a central platform, and notify municipal authorities or waste management companies when bins are full. The aim is to improve operational efficiency, reduce human intervention, and promote cleaner and smarter cities.

4.EXISTING SYSTEM

In recent years, some smart cities have started using IoT-based waste monitoring systems to improve garbage collection. These systems typically use sensors such as ultrasonic or infrared devices placed inside waste bins to measure the fill level. The data is then collected by a microcontroller (like Arduino or Raspberry Pi) and sent via internet connections such as Wi-Fi, GSM, or LoRa to a central server or cloud platform. This information is displayed on a dashboard or mobile app, allowing waste management teams to identify which bins are full and need to be emptied. Some systems also include GPS to help optimize collection routes and reduce unnecessary trips. However, these systems have several limitations. They can be expensive to install and maintain, especially across large urban areas. Many rely on battery-powered sensors that need regular charging or replacement. Their functionality is often basic, limited to just detecting bin fullness without offering features like predictive analysis or route planning. The accuracy of the data can be affected by sensor errors, waste shape, or environmental conditions like moisture. In addition, most systems do not monitor whether waste is properly segregated, missing out on opportunities for better recycling. They often require manual intervention for bin maintenance and are not always integrated with other smart city technologies. Furthermore, public awareness and involvement in using smart bins effectively is still very limited, which reduces the overall efficiency of the system.

Limitations:

1. High Installation and Maintenance Cost

Setting up sensors, controllers, and communication devices across all bins is expensive, especially for large cities.

2. Battery Dependency

Most sensors run on batteries which need frequent charging or replacement, increasing maintenance efforts.

3. Limited Accuracy

Sensors may give false readings due to the irregular shape of waste, moisture, or interference from bin contents.

4. Network Connectivity Issues

Systems rely on stable internet or GSM signals, which may not be available in all areas, especially in rural or underground locations.

5. No Waste Segregation Monitoring

Current systems only detect waste levels, but do not track if the waste is separated into dry, wet, or recyclable categories.

5.PROPOSED SYSTEM

In the proposed system is can be solved by smart garbage monitoring system using IoT. Here the concept of IoT has been used in so many sectors from Smart Home to Smart City. Ultrasonic is used to know the status of the dust bin whether it is full or empty. It will detect distance of object using the sound waves. Servo motor is used for automatic opening and closing of the dustbin. The buzzer will be enabled as a local alert when the bin is full. LCD is used for display the status of dustbin. GSM is also used to send alert messages to the cleaner globally when the dustbin gets filled.

Currently using Think Speak cloud to store data. Each and every minute data will be stored in theThink Speak Cloud. So regular monitoring and intimating make the system useful in waste management. This leads to clean city for the better living. The mobile app is designed to ensure the greenish in the environment and support for swachhbharat for cleanness.

1. **Efficiency:** Streamlines waste collection processes by ensuring that collections are scheduled based on actual needs rather than fixed schedules.
2. **Cost Savings:** Reduces operational costs associated with waste collection by optimizing routes and minimizing unnecessary trips.
3. **Environmental Impact:** Promotes environmental sustainability by reducing the carbon footprint associated with waste collection and encouraging proper waste disposal practices.
4. **Enhanced Service:** Improves the quality of waste management services by providing timely information and addressing issues promptly.
5. **Data-Driven Decisions:** Provides valuable insights into waste generation patterns and bin usage, supporting better decision-making and policy development.

6.METHODOLOGY

The methodology for Real-Time Waste Monitoring System using IOT is structured into several key phases:Sensor Integration, Microcontroller Unit, communication Module, Cloud Server and Data Storage, Real-Time Monitoring and Visualization, Alert System and Route Optimization, Maintenance and Power Supply. Each phase plays a crucial role in ensuring the system's accuracy and reliability.

1. Sensor Integration:

Ultrasonic or infrared sensors are installed in waste bins to detect the fill level. These sensors measure the distance from the top of the bin to the waste surface, providing accurate real-time data on how full the bin is.

2. Microcontroller Unit:

A microcontroller such as Arduino, Raspberry Pi, or ESP8266 is used to collect data from the sensors. It acts as the central processing unit that reads sensor inputs and processes them for transmission.

3. Communication Module:

The system uses communication technologies like GSM, Wi-Fi, or LoRa to transmit the data from the microcontroller to a remote server. The choice of communication protocol depends on the application area and network availability.

4. Cloud Server and Data Storage:

Data transmitted from the bins is sent to a cloud server where it is stored and processed. This centralized system enables scalable and secure data management for multiple bins across different locations.

5. Real-Time Monitoring and Visualization:

A web or mobile-based dashboard is developed to visualize bin statuses in real time. This platform provides users or municipal authorities with an interface to view current fill levels, location of bins, and alerts for full bins.

6. Alert System and Route Optimization:

When a bin reaches a predefined threshold (e.g., 80% full), the system generates an alert for immediate collection. Additionally, algorithms can be implemented to suggest optimized routes for garbage collection trucks, improving efficiency and reducing fuel consumption.

7. Maintenance and Power Supply:

To ensure continuous operation, the system can be powered by batteries or solar panels, depending on the location. Regular maintenance of sensors and modules is essential for system accuracy and reliability.

This methodology provides a smart, efficient, and eco-friendly approach to waste management, supporting cleaner cities and data-driven municipal operations.

7.PROJECT REQUIREMENTS

HARDWARE REQUIREMENTS

❖IR Sensor

An Infrared (IR) sensor is an essential component in a Smart Garbage Management System, used to measure the fill level of a garbage bin. It works by emitting infrared light from an IR LED and detecting the reflected light with a photodiode. The amount of reflected light varies depending on the distance between the sensor and the top of the waste. As the bin fills, the distance decreases and alters the reflected light intensity, allowing the sensor to determine the fill level accurately. This data is then processed by the bin's microcontroller and transmitted via the Internet to the IoT Hub, integrating it into the broader system for real-time monitoring and optimized garbage collection scheduling. The IR sensor's non-contact, reliable, and cost-effective measurement makes it ideal for this application.

❖LCD Display

In a Smart Garbage Management System, an LCD (Liquid Crystal Display) serves as a critical user interface component mounted on each smart garbage bin. The LCD provides real-time visual feedback on the bin's status, such as current fill levels, operational alerts, and maintenance notifications. By displaying this information directly on the bin, the LCD allows users and maintenance personnel to quickly and easily assess the bin's condition without needing to access the system remotely. This immediate visibility enhances user convenience and operational efficiency, ensuring timely interventions when the bin reaches capacity or requires attention. The integration of an LCD into the smart bin improves communication between the system and its users, contributing to a more effective and responsive waste management process.

❖Node mcu

In a Smart Garbage Management System using IoT, the NodeMCU plays a pivotal role as a microcontroller board that facilitates communication and data processing. Based on the ESP8266 Wi-Fi module, the NodeMCU enables the smart garbage bin to connect to the internet, allowing it to transmit data on fill levels and other sensor readings to the IoT Hub or central server. It handles the integration of various components, including sensors and an LCD display, by executing the necessary logic and control functions. The NodeMCU's built-in Wi-Fi capabilities ensure that data is sent and received in real-time, contributing to seamless system operation and efficient garbage management. Its versatility, ease of use, and cost-effectiveness make it an ideal choice for enabling IoT functionalities in smart garbage bins.

❖GPS Module

In a Smart Garbage Management System, a GPS module is used to enhance the system's capabilities by providing precise location tracking for each smart garbage bin. The GPS module determines the geographical coordinates of the bin, enabling real-time tracking and monitoring of its location. This feature is particularly useful for optimizing garbage collection routes and ensuring efficient waste management. By integrating GPS data with the system's overall functionality, waste management authorities can plan and execute collection schedules more effectively, reduce fuel consumption, and improve service coverage.

Additionally, GPS tracking can aid in the recovery of lost or stolen bins and provide valuable data for geographic analysis and route optimization.

❖ GSM

In a Smart Garbage Management System, a GSM (Global System for Mobile Communications) module provides critical connectivity by enabling communication between the smart garbage bins and the central server via cellular networks. The GSM module allows bins to send real-time status updates, including fill levels and maintenance alerts, even in areas with limited or no Wi-Fi coverage. This ensures that data can be transmitted reliably over long distances, making it ideal for remote or widespread waste management operations. By leveraging GSM technology, the system enhances its ability to monitor and manage garbage collection efficiently, facilitates timely notifications to waste management services, and supports continuous communication without reliance on local internet infrastructure.

SOFTWARE REQUIREMENTS

❖ Arduino IDE

The Arduino IDE (Integrated Development Environment) is a crucial tool in the development and programming of smart garbage management systems using IoT. It provides a user-friendly interface for writing, compiling, and uploading code to Arduino microcontrollers, which are often used in smart bins for managing sensor data and controlling various components. With its intuitive environment, the Arduino IDE simplifies the programming process by offering a range of built-in libraries and examples tailored for various sensors and actuators. This makes it easier to develop and debug code, facilitating the integration of features such as data collection, communication, and user interface management. The IDE's support for a wide array of microcontroller boards and its active community contribute to a streamlined development process, ensuring that the smart garbage management system operates effectively and efficiently.

8.SCREENSHOTS

Login

Username:

Password:

Don't have an account? [Register here](#)

Fig1: Home page

Login

Username:

Password:

Don't have an account? [Register here](#)

Fig2: Register page

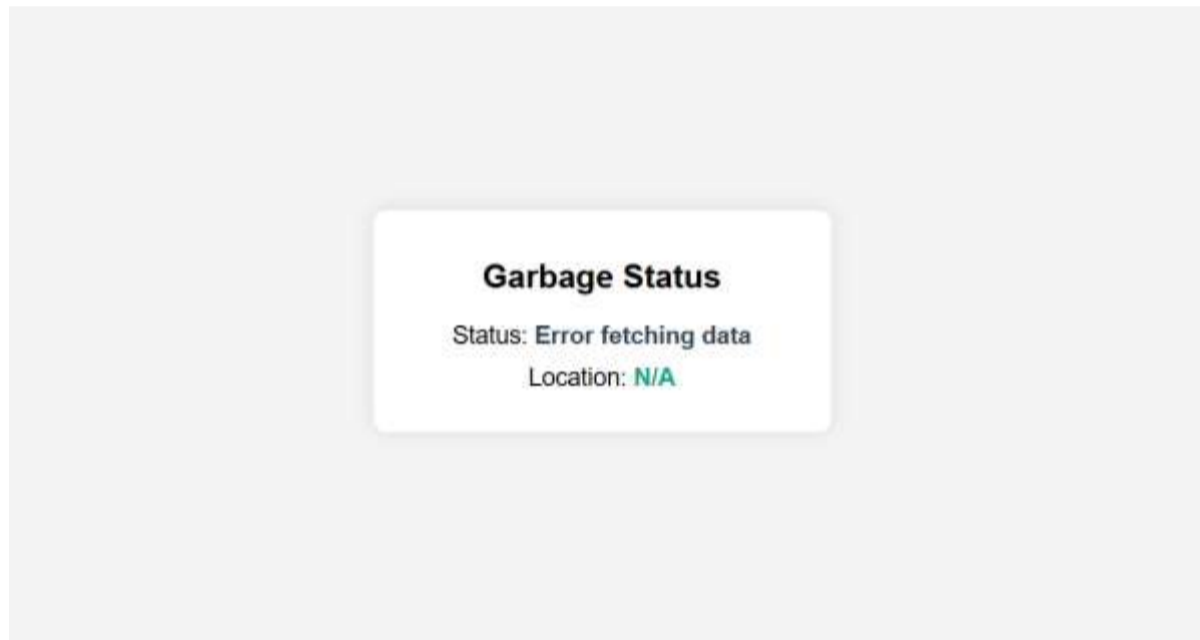


Fig3

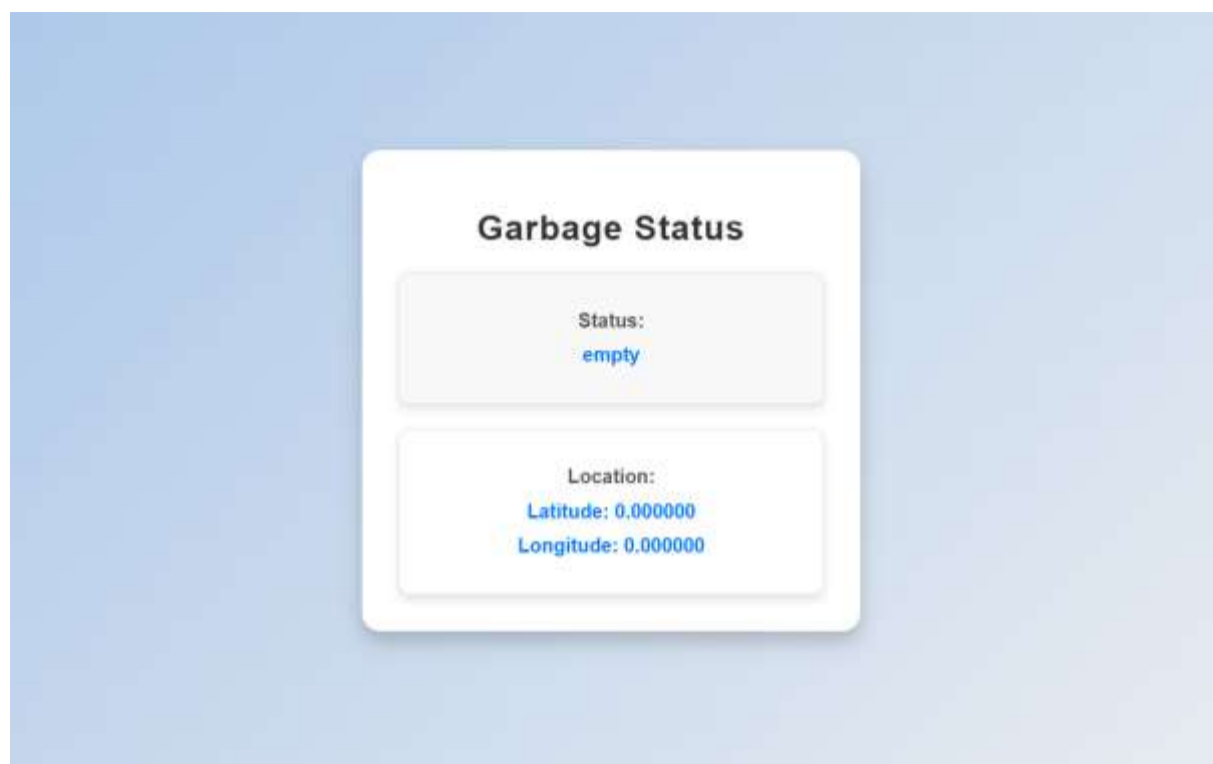


Fig4

9.CONCLUSION

This project work presents an smart garbage collection system for a smart city. The model is based on an Internet of Things sensing trashcan which measures the waste level and presence of bad smell gases and sends this information to a server for storage and processing over the internet. These data help to create an efficient collection process which saves money, manpower and time. The efficiency and economic feasibility of the system are represented in detail. It reduces chance overflow, as data are uploaded four times a day and municipal authority is aware of dustbin's physical condition. As the bad smell starts to generate, information reaches to responsible authority so that they can take necessary action. The optimal scheduling and routing of vehicles using the heuristic algorithm optimizes the total cost in planning and scheduling of vehicles by reducing the number of required vehicles and determining the optimal routes. The objective of maintain a clean and healthier city is thus achieved.

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