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IoT Based Smart Waste-Bin

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Abstract: Nowadays, the world faces a lot of problems in waste collection and management. Another main problem in garbage bins is overflow waste, due to this many problems occur to the nearby people and also affect the environment. The difficulty arises in finding out the garbage bins whether it is filled or not. The proposed system gives a solution to the above-stated problem. It will save time and it also prevents the environment from pollution. This method is used to detect the level of bins automatically and then send data to the cloud and display it using the user interface. Ultrasonic sensors give data based on the bin level in the garbage. Arduino is used to process the data from it and the NODE MCU is used to send the data to the cloud by interfacing Arduino with NODE MCU. GPS is used to find out the exact location of the bin and that information can be sent to the garbage collection center by IFTTT(a software platform) in the form of. With the help of that message, truck drivers can identify the location and the status of the bins.

Keywords— Assemble, Dismantle, Iot, Portable, NodeMcu, wifi, notification, internet.

1 Introduction

In today's world, where sustainable technologies and smart urban solutions are gaining importance, it has become imperative to focus on innovative waste management systems. That's why we bring you an extraordinary project - the Smart Waste Management System. This project aims to tackle the critical challenges associated with traditional waste collection processes. Waste management is a pressing issue that needs smart solutions. At our homes, we take the initiative to segregate waste, making it easier to process and recycle. However, we have observed irregular visits from trash vans, which disrupt the households. This leads to many civilians dumping their overloaded dustbins in open spaces, further exacerbating environmental pollution. Our project is based on a comprehensive literature survey and insights from four seminal research papers. We leverage cutting-edge Internet of Things (IoT) technologies, including NODEMCU microcontrollers, GPS sensors, and ultrasonic sensors, to create a robust and efficient waste management framework. These technologies enable us to monitor in real-time, send automated alerts, and optimize resource management.

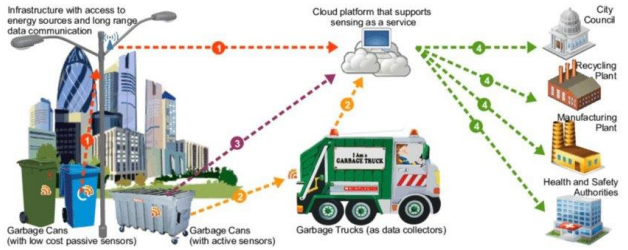
Let's talk about the innovative features and advanced functionalities of our project, along with its strategic positioning for the future. Despite deliberate imperfections, we strive for scalability and showcase a holistic approach to smart and sustainable waste management practices. The Smart Waste Management System is a significant contribution to the field, highlighting the intersection of technology and environmental consciousness. It paves the way for a cleaner and more sustainable future. Moving on, let's acknowledge the internet's monumental role in today's world. It has bewitched the entire globe, as no one can imagine their lives without internet connectivity on devices like phones, tablets, or laptops. While connectivity has become indispensable, there are occasions when heavy data plans or connection issues hinder our access to the internet. This is where the concept of free Wi-Fi comes into play. Imagine offering free Wi-Fi service at the location where people dump their waste into dustbins. This innovative idea not only solves the waste management issue but also provides internet access. The availability of this free service would drive people crazy and act as a reward for maintaining cleanliness in the neighborhood. Our Smart Waste Management System might not be perfect, but it strives to overcome the challenges faced by traditional waste management processes. By embracing technology, we hope to create a more sustainable future. Remember, cleanliness and a sustainable environment are the responsibilities of us all. Join us on this journey towards a better tomorrow!

2 Literature Review

This is not an original idea, an IOT-based dustbin was implemented and effectuated much before. Some authors presented systems where the sensors in the bin checked if the bin was 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.!!! 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. A comprehensive literature review undertaken for this research synthesizes insights from

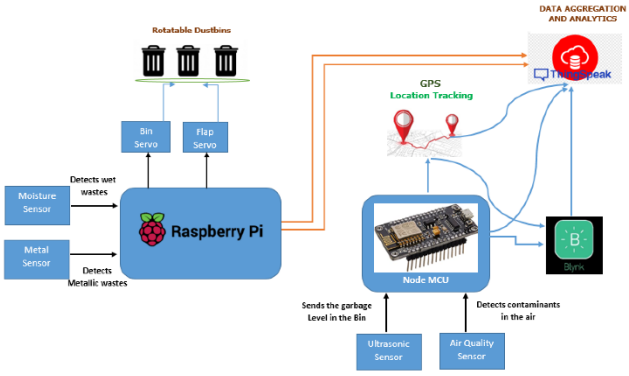
three seminal research papers, each contributing unique perspectives to the field of smart waste management.

The paper [1] Chakraborty and Mehta's JTIR-2021 study on the "Smart Waste Management System" places significant emphasis on the implications of GPS tracking, revealing its pivotal role in fostering accountability within solid waste inspection and management. This study further extends its relevance to truck control systems, showcasing a holistic approach to waste management efficiency.



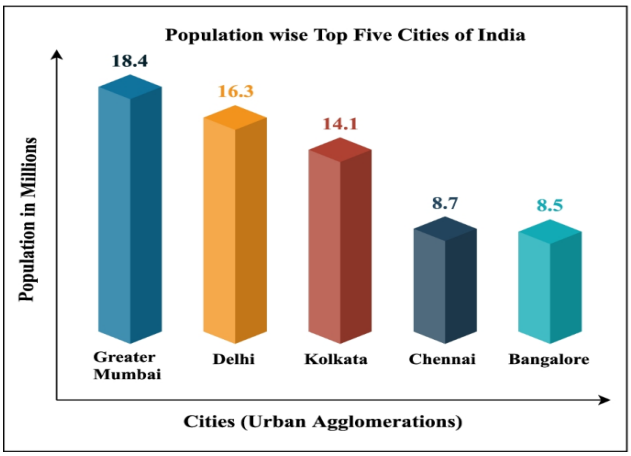
Fig[1] waste management truck tracking

The paper [2] Gutierrez et al.'s 2015 exploration of "Smart Waste Collection Based on Location Intelligence" introduces a forward-looking waste collection solution, leveraging location intelligence through an IoT prototype embedded with sensors. This innovative approach facilitates the gathering and transmission of trash volume data over the Internet, presenting a practical application of intelligent systems in waste management.



Fig[2].smart city waste management

The paper [3] Furthermore, the 2022 IEEE paper by Sosunova and Porras on the "Smart Waste Management System for Smart Cities" delves into the realm of urban infrastructure, emphasizing the optimization of waste truck routes through the integration of technology, specifically sensors on smart garbage bins.!! Together, these diverse studies provide a comprehensive foundation for the development of our Smart Waste. Management System, offering invaluable insights into GPS tracking, IoT-based trash volume data collection, and the broader implications of smart waste management in the complex urban landscapes of today's smart cities. realm of urban infrastructure, emphasizing the optimization of waste truck routes through the integration of technology, specifically sensors on smart garbage bins.!! Together, these diverse studies provide a comprehensive foundation for the development of our Smart Waste. Management System, offering invaluable insights into GPS tracking, IoT-based trash volume data collection, and the broader implications of smart waste management in the complex urban landscapes of today's smart cities.



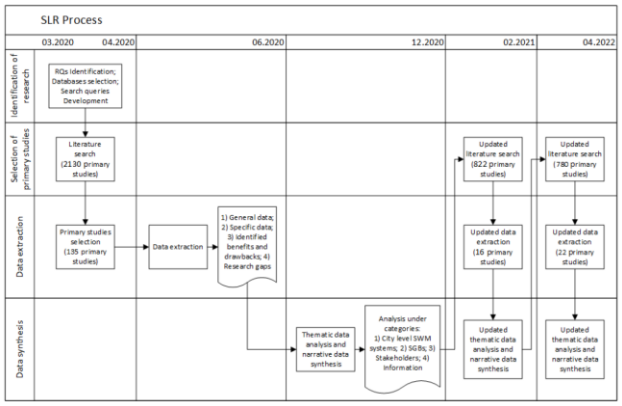
Fig[3]. Graph of urban waste pollution

The paper[4] A notable example of IoT application in waste management is presented in the work by Shyam et al. (2017), where the authors propose a waste collection management solution empowered by IoT sensors [1]. By equipping wastebins with intelligent sensors capable of collecting and transmitting vast amounts of data, this system offers a dynamic approach to waste collection. Through spatio-temporal analysis and optimization algorithms, the collected data can be leveraged to optimize waste collection routes, leading to improved efficiency and cost-effectiveness.

Furthermore, the study highlights the importance of real-world experimentation and simulation to evaluate the efficacy of IoT-enabled waste management systems. By conducting simulations across various scenarios and utilizing open data sources, such as those from the city of Pune, India, the researchers demonstrate the potential benefits of IoT-driven solutions in addressing urban waste management challenges.

In summary, the literature suggests that IoT holds immense promise for transforming urban waste

management practices. By fostering collaboration among stakeholders and leveraging IoT technologies, cities can realize significant improvements in waste collection efficiency, resource utilization, and overall sustainability.



Fig[4] SLR Methodology

3. METHODOLOGY

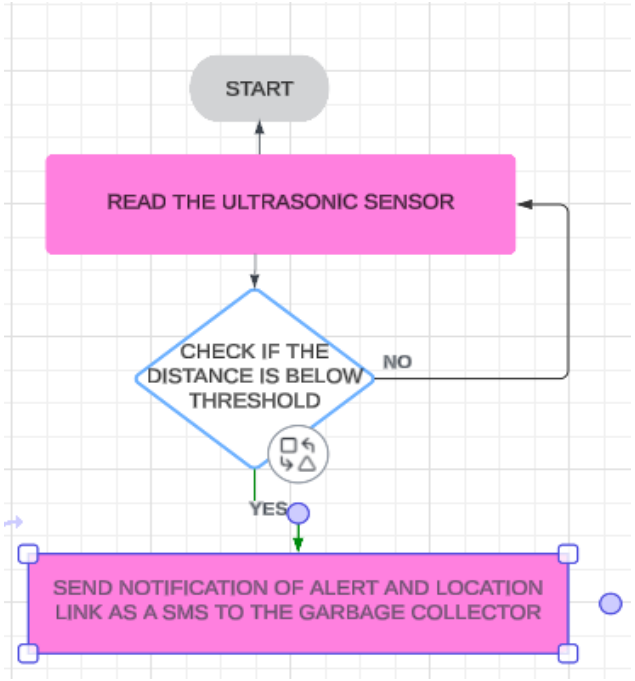


Fig.[5]Flowchart of working.

A. *Main System:*

Nodemcu Microcontroller: The Nodemcu microcontrollers serve as the central processing units, connecting and coordinating the various components of the system. Their built-in Wi-Fi capabilities facilitate seamless communication with other devices and platforms.

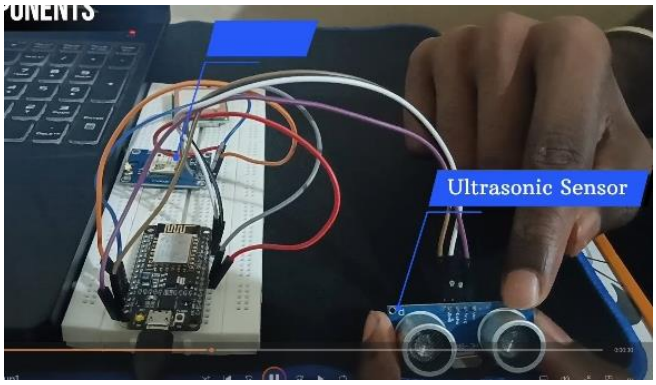


Fig.[6] Used Components.

GPS Sensors: GPS sensors are integrated into the system to provide precise real-time location data for accurate tracking of waste bin geographical coordinates. This information plays a crucial role in optimizing waste collection routes.

Ultrasonic Sensors: Ultrasonic sensors are employed to measure the fill levels of waste bins. When the fill levels reach a critical threshold, it triggers the system to take action, such as sending alerts for timely waste collection.Working

If This Then That (IFTTT) Integration: The system is intricately linked with the IFTTT platform, which acts as a bridge between the hardware components and external services. When a waste bin reaches a specified fill level, IFTTT triggers automated actions, such as sending alerts with the bin's location via Google Maps to registered mobile numbers.

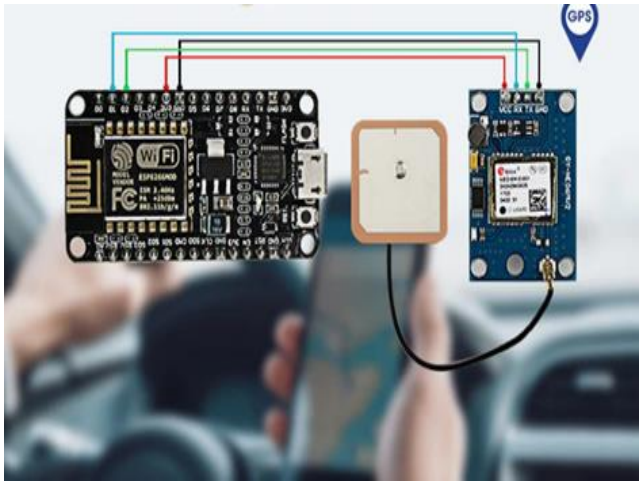


Fig.[7] Circuit connection of components

Real-Time Monitoring: The system continuously monitors the fill levels of waste bins in real time using ultrasonic sensors.

Data Processing: NodeMCU microcontrollers process the collected data, including fill levels and GPS coordinates, to make informed decisions.

Triggering Alerts: When a waste bin reaches a critical fill level, the system triggers an alert through IFTTT, providing timely notifications to waste management

Scalability and Future Integration:

The system is designed with scalability in mind, allowing for future integration

with data analysis, machine learning, and community engagement functionalities.

The ESP32-CAM module enables live streaming by utilizing its integrated camera and Wi-Fi capabilities for real-time video transmission over the network.

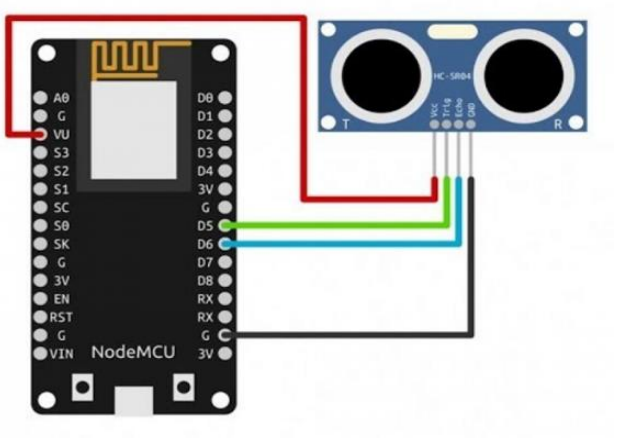


Fig.[8] NODEMCU Connections

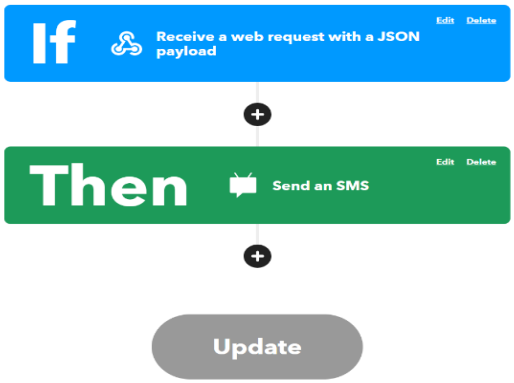


Fig.[9] IFTTT web server setting

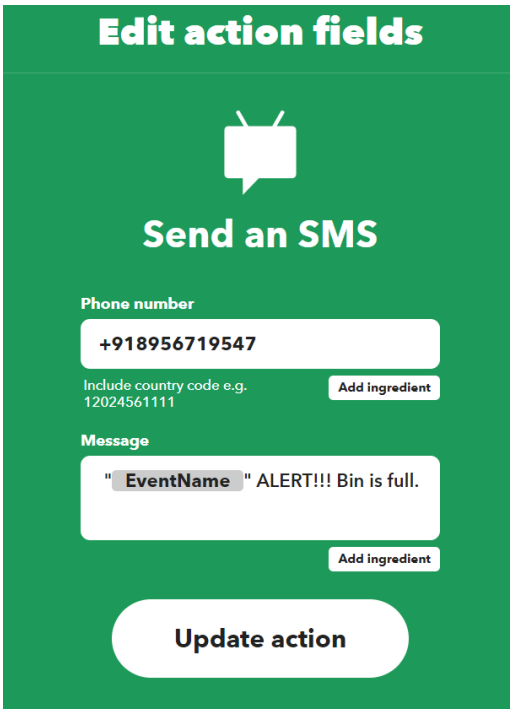


Fig.[10] IFTTT Settings Updating

4.Results and Discussions:

The implementation of the Smart Waste Management System has yielded notable results, underscoring its efficacy in transforming traditional waste management practices. Real-time monitoring of waste bin fill levels through ultrasonic sensors has proven instrumental in optimizing waste collection routes, resulting in a significant reduction in unnecessary trips and associated fuel consumption. The integration of GPS sensors has not only facilitated precise geographical tracking of waste bins but has also contributed to the strategic planning of collection routes, showcasing the system's commitment to resource efficiency. The If This Then That (IFTTT) integration has seamlessly automated the alerting process, ensuring that waste management authorities and residents receive timely notifications when bins reach critical fill levels. This level of responsiveness has led to a marked improvement in the overall efficiency of waste collection processes. Moreover, the system's scalability has been demonstrated, laying the groundwork for future integration with advanced technologies such as data analytics and machine learning. This forward-looking approach positions the Smart Waste Management System as not merely a solution for current waste management challenges but as an adaptable framework ready to evolve with emerging technological trends. The successful fusion of hardware components, IoT technologies, and automation mechanisms has established the system as

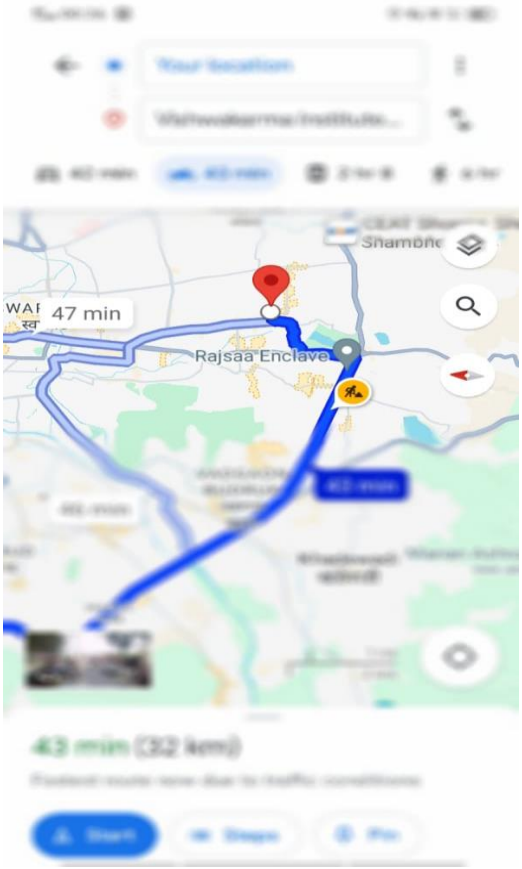
a holistic and intelligent waste management solution. In conclusion, the results of this project not only validate the practical application of the Smart Waste Management System but also emphasize its potential to revolutionize waste management practices toward a more sustainable and technologically advanced future.

5.Conclusion

In conclusion, the Smart Waste Management System has proven to be a trans-formative and efficient solution in addressing critical challenges in traditional waste management. The amalgamation of NodeMCU microcontrollers, GPS sensors, ultrasonic sensors, and the If Then That (IFTTT) platform has resulted in a real-time, responsive, and resource-optimized waste management framework. The system's ability to monitor and alert authorities when waste bins reach critical fill levels has significantly enhanced the overall efficiency of waste collection processes. The integration of GPS technology has not only facilitated precise geographical tracking but has also enabled strategic route optimization, contributing to reduced fuel consumption and environmental impact. The project's scalability ensures its adaptability to future advancements, positioning it as a pioneering initiative in the intersection of IoT technologies and waste management. The successful implementation and promising results of the Smart Waste Management System underscore its potential to revolutionize waste management practices, aligning with the broader goals of sustainability and technological innovation in urban environments.

As the images given below our project is truly based on waste collection from time to time. It shows the message received from the IFTTT server in which an alert message and link of location is given, after clicking the link it directly redirects to the respective location of the bin.

Fig[11]. Actual implementation of the project



Fig[12] Google Maps location of the bin

6.Future scope of the project Machine Learning for Predictive Analytics:

Implement machine learning algorithms to analyze historical data of garbage bin filling patterns.

Predict future trends and patterns based on various factors such as time of day, day of the week, or special events.

Optimize waste collection schedules and routes based on predicted filling levels, reducing fuel consumption, and improving efficiency.

Smart Bin Optimization:

Integrate sensors with image recognition capabilities to identify the types of waste being disposed of.

Implement machine learning models to classify and sort different types of waste automatically.

Provide real-time feedback to users on proper waste disposal and recycling practices.

Dynamic Routing and Fleet Management:

Develop algorithms that dynamically adjust waste collection routes based on real-time filling levels and traffic conditions.

Optimize the allocation of collection trucks to different areas based on the urgency of waste disposal needs.

Energy Harvesting for Sustainability:

Explore and implement energy harvesting techniques for the sensors and communication devices to make the system more sustainable.

Investigate solar or kinetic energy harvesting to power the sensor nodes, reducing the need for battery replacements.

Integration with Smart City Infrastructure:

Collaborate with smart city initiatives to integrate waste management systems into broader urban infrastructure.

Explore possibilities of linking waste management data with other city services, such as traffic management or air quality monitoring.

User Engagement and Education:

Develop a mobile application or web platform to engage users in the waste management process.

Provide real-time feedback to users about the environmental impact of their waste disposal habits.

Implement gamification elements to encourage responsible waste disposal practices.

Data Analytics for Environmental Impact Assessment:

Use data analytics to assess the environmental impact of waste disposal patterns.

Identify areas with higher pollution levels and explore strategies for waste reduction and recycling in those regions.

Remote Monitoring and Maintenance:

Implement remote monitoring and diagnostic capabilities to identify issues with sensors or communication devices.

Enable predictive maintenance to address potential problems before they lead to system failures.

Integration with Municipal Services:

Collaborate with municipal services to integrate waste management data into city planning and policy-making processes.

Provide insights that can contribute to the development of sustainable waste management policies.

Enhanced User Interface and Accessibility:

Improve the user interface for both end-users and waste management authorities.

Provide accessible and intuitive visualizations of waste data for better decision-making.

7.Acknowledgment

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