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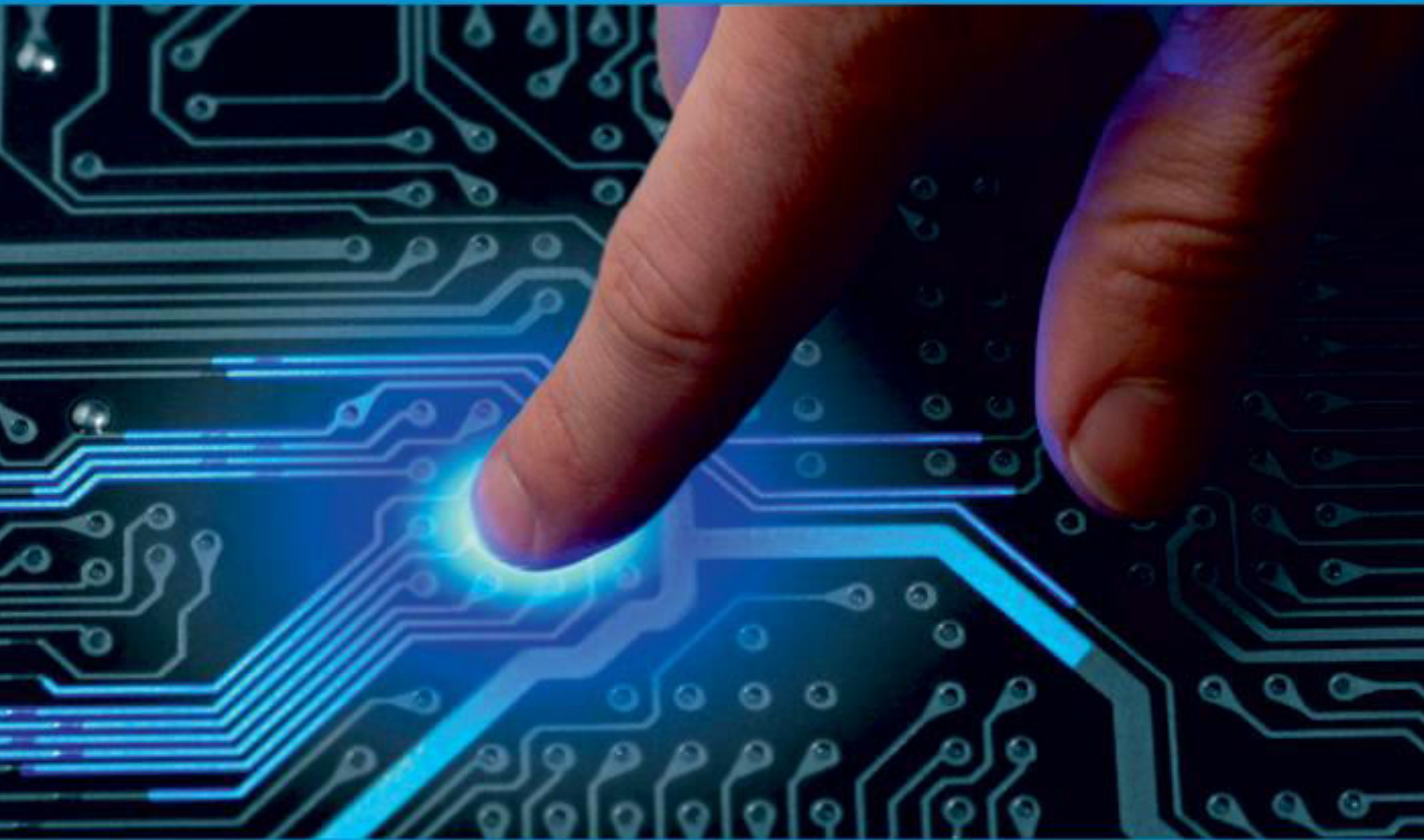

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An IOT-Based Smart Waste Management System

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ABSTRACT: Traditional waste management systems follow a daily schedule, which is inefficient and costly. The existing recycling bin has also proven useless in public since people do not properly sort their waste. The traditional trash management system can be replaced with smart sensors implanted in the system to perform real-time monitoring and enable improved waste management as the Internet of Things (IoT) develops. The goal of this study is to create a smart waste management system. Using IoT (Internet of Things) technologies, microcontrollers, and sensors, this study offers a smart trash/waste management system.

KEYWORDS: Sensors, IOT, Arduino, Wi-Fi controller, Internet, Notification message.

I. INTRODUCTION

"The only thing certain in life is death, the second is change, and the third is waste." Nobody can stop these things from happening in our lives. However, with better management, we can better prepare ourselves. We shall discuss waste and trash management in this section. However, with increased urbanization, rapid adoption of the "use and throw concept," and equally rapid communication between urban and rural areas. Rural solid trash is more biodegradable, but urban solid waste contains more non-biodegradable components such as plastics and packaging. However, both industries share a disgusting attitude toward solid waste and its disposal. 'Keeping garbage out of sight' is a widely practiced behavior.

In this work, we are attempting to address waste management issues using an IoT-based system with several sensors connected to the Node MCU, which aids in connecting all of the sensors and using a smart bin, which indicates the level of garbage inside the bins and alerts the administrator to pick up garbage from a specific region. Next, we are taking a societal perspective because it is a smart waste management system. People might also follow the garbage in their civilization or close by. And, regardless of whether the garbage collector is attending to a certain community or location, the goal of creating this prototype is to take one step toward a waste management solution.

IoT advancements have enabled the existing waste management system to be improved. Sensors installed in the garbage bin and IoT connectivity enable real-time monitoring, which is currently unavailable in the waste management system. Sensors can capture data such as filling level, temperature, humidity, and any other essential data. The processed data can then be utilized to investigate and access the limitations of the existing waste management system, thereby improving the system's overall efficiency. The use of IoT in the garbage can is one step toward a smart city.

II. RELATED WORK

Waste management and garbage dumping in India have been studied, and the findings suggest that municipal solid wastes are largely made up of biodegradable and non-biodegradable components. Furthermore, the body in charge of evacuating this garbage does not do so regularly. It was also discovered that the current trash disposal scenario is likely to deteriorate due to rapid municipal development in the state, an increase in unplanned settlements and housing, and a lack of sustainable waste management technology in India's capital.

The Internet of Things (IoT) is a communication paradigm that predicts a future paradigm in which common objects are outfitted with a microcontroller and some type of communication protocol. The smart city is a well-known IoT product, which can be characterized as a city with smart technology, smart people, and smart collaboration.

Wastes are classified into different types and segregated into respective compartments with the help of sensors, as each type of waste that this model is attempting to segregate will have separate compartments and similar to that type of

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waste will be subjected to a process that initiates servo motor activation of that particular compartment, which aids in the storage of that particular waste.

The distance measurement from the ultrasonic sensor was used in the "Analysis of obstacle detection using an ultrasonic sensor" conducted in 2017 [5] and published in IRJET (journals). The study discovered that the system presented a consistent pattern based on the measured distance for various sorts of barriers and that by using this obstacle as input of the level of the bin, we can create an alert signal if its filling level is greater than 80%.[1]

"A smart IoT system for waste management", 2018 1st IC3. The system will send a text or message to an authorized individual over Wi-Fi informing them of the current filling level of the garbage container, pushing them to act and collect the garbage before it reaches its maximum capacity. This early reminder will help to promote proper trash management and minimize overflowing or littering, resulting in a cleaner and healthier environment.[2]

The base paper which is our reference helps smart waste disposal system, described in the research article "Design of a Convolutional Neural Network Based Smart Waste Disposal System" published in IEEE Access, makes use of an efficient convolutional neural network (CNN) based image classifier to detect and recognize garbage-related objects. This system can not only recognize and count the labeled objects, but it can also assign a monetary value to each one. The benefits of this technique include less rubbish on the roadside and less work in waste collection. However, one potential downside may be the responsibility of individuals to correctly use conventional trash cans in order to assure the system's efficacy.

III.PROPOSED SYSTEM

The proposed system is an IoT-based smart waste management system that integrates various sensors, automation mechanisms, and data analytics to optimize waste collection, improve waste segregation, and enhance overall efficiency in waste management processes.The core components of the proposed system include a conveyor belt connected to rollers, a DC motor for belt rotation, and multiple sensors for waste detection and sorting. The system also incorporates a bin with three compartments: wet waste, dry waste, and metal waste collection.

To ensure efficient waste segregation, the system utilizes sensors such as a metal detector and a soil moisture sensor. The metal detector identifies metallic waste items passing over it, diverting them to the metal waste compartment of the bin. The soil moisture sensor detects the presence of moisture in waste items, allowing for the identification of wet waste. When wet waste is detected, the bin rotates by 180 degrees, directing the wet waste into the designated compartment.The proposed system also includes an ultrasonic sensor placed in the wet waste compartment. This sensor continuously measures the gap between the waste and the sensor, indicating the filling level of the compartment. When the gap falls below a certain threshold, such as 10cm, the system triggers a notification through CallMeBot, alerting an authorized person to empty the bin. Additionally, the filling level data is continuously monitored and recorded on the ThinkSpeak platform, providing real-time insights into waste accumulation patterns.

Furthermore, the proposed system incorporates IoT connectivity, allowing for remote monitoring and control. The collected data from the sensors, including filling levels, waste types, and temperature, is transmitted and stored in a cloud-based platform. This data can be accessed and analyzed by waste management authorities to make informed decisions regarding waste collection routes, scheduling, and resource allocation. Real-time monitoring and data analytics enable proactive measures to be taken, ensuring timely waste collection and preventing overflowing bins.The proposed system offers several advantages over traditional waste management practices. It automates waste segregation, reducing the reliance on manual sorting and minimizing errors. Real-time monitoring and notifications facilitate the timely waste collection, preventing environmental pollution and promoting efficient resource utilization. The integration of IoT technology and data analytics enables data-driven decision-making, leading to optimized waste management strategies and improved overall efficiency.

The proposed IoT-based smart waste management system provides an innovative solution to address the challenges of traditional waste management practices. By incorporating advanced sensors, automation mechanisms, and data analytics, the system optimizes waste collection, promotes efficient waste segregation, and enhances overall efficiency in waste management processes. This system has the potential to revolutionize waste management practices, leading to a cleaner and more sustainable environment.

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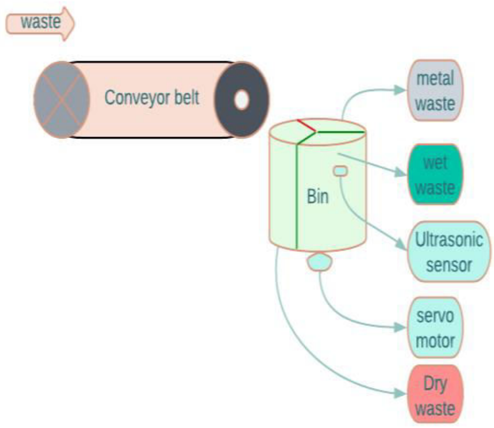
IV. METHODOLOGY



The methodology for implementing the IoT-based smart waste management system involves several key steps. Firstly, the hardware components, including the conveyor belt, rollers, DC motor, and sensors such as the metal detector, soil moisture sensor, and ultrasonic sensor, are assembled and integrated into the waste bin structure. The Node MCU (esp8266) or a similar microcontroller is utilized to connect and interface the sensors, motor, and other components.

Next, the software development process begins. The firmware for the microcontroller is programmed to control the motor rotation, sensor readings, and data transmission. The programming language used can be Arduino, C++, or any other suitable language compatible with the microcontroller.The system's intelligence lies in the algorithm that governs waste segregation and filling level monitoring. The algorithm is designed to detect and differentiate between wet waste, dry waste, and metallic waste based on the readings from the sensors. When wet waste is identified, the algorithm triggers the motor to rotate the bin by 180 degrees, ensuring proper segregation. Similarly, the algorithm detects metal waste and rotates the bin by 90 degrees to direct it to the metal waste compartment.The ultrasonic sensor continuously measures the gap between the waste and the sensor, providing real-time data on the filling level of the wet waste compartment. This data is processed by the algorithm to determine if the filling level has reached a threshold, such as 10cm. If the threshold is exceeded, the system triggers a notification using CALL ME BOT, alerting the authorized person responsible for waste collection.

Data from the sensors, including filling levels, waste types, and temperature, are collected and transmitted to a cloud-based platform. The ThinkSpeak platform or a similar service is used to store and analyze the data. The data is visualized in real-time, providing insights into waste accumulation patterns, bin status, and system performance.The system's functionality and performance are thoroughly tested and evaluated to ensure its reliability, accuracy, and efficiency. Testing involves scenarios where different types of waste are passed over the sensors to verify their correct identification and sorting. The system's response to changing filling levels and notification triggers is also evaluated.
Furthermore, user interfaces are developed to enable residents and waste management authorities to access and monitor the system. The interfaces may include web or mobile applications that display real-time bin status, historical data, and analytics. User feedback is collected to improve the user experience and address any usability issues.Throughout the implementation process, close collaboration with waste management authorities and stakeholders is maintained to ensure that the system meets their requirements and addresses the specific waste management challenges of the targeted area or community.By following this methodology, the IoT-based smart waste management system can be successfully developed, deployed, and optimized to achieve efficient waste segregation, real-time monitoring, and effective waste collection strategies.

V. OUTCOME IMAGES

Front view of the project.

Dustbin compartments

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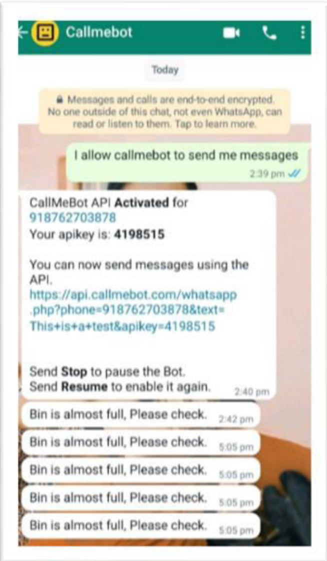
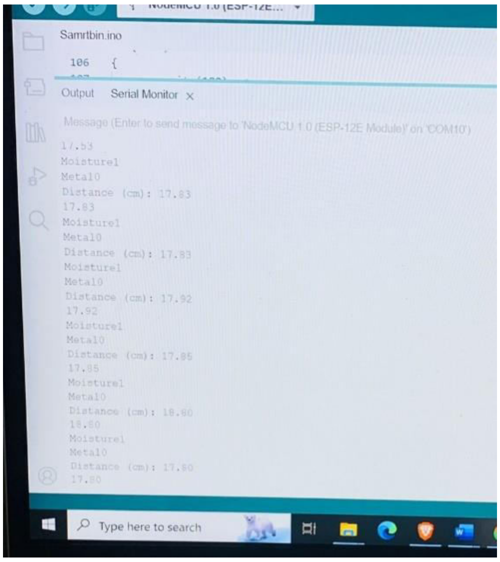


CallMeBot which sends notification to respective authority.



Serial Monitor output

VI. Conclusion and Future Work

The IoT-based smart waste management system offers a promising solution to the challenges associated with traditional waste management practices. By leveraging IoT technologies, microcontrollers, and various sensors, this system enables real-time monitoring, efficient waste segregation, and effective waste disposal. Throughout this project, we have successfully developed a prototype that incorporates a conveyor belt, multiple compartments for waste segregation, and sensors such as soil moisture sensor, metal detector, and ultrasonic sensor. These sensors play a crucial role in detecting and categorizing different types of waste, ensuring proper disposal and recycling. The integration of ThinkSpeak platform allows for continuous monitoring of waste levels, providing valuable insights into waste accumulation patterns and facilitating data-driven decision-making. The use of CallMeBot service further enhances the system by sending timely notifications to authorized personnel when the bin reaches a critical filling level, ensuring prompt waste collection and preventing overflow. The implementation and testing of the system have demonstrated its efficiency in automating waste management processes, improving resource allocation, and promoting environmental sustainability. The system's ability to optimize waste collection routes, reduce manual sorting, and promote community engagement contributes to a cleaner and healthier environment.

However, there are still areas for further improvement and refinement. Enhancements could include integrating advanced machine learning algorithms to enhance waste classification accuracy, implementing predictive analytics to optimize waste collection schedules, and exploring options for renewable energy integration to reduce the system's environmental footprint. Overall, the IoT-based smart waste management system has the potential to revolutionize waste management practices, leading to smarter and more sustainable cities. By adopting such innovative solutions, we can mitigate the environmental impact of waste, enhance resource efficiency, and improve the quality of life for individuals and communities. It is imperative that we continue to invest in research, development, and implementation of these technologies to create a greener and more sustainable future.

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