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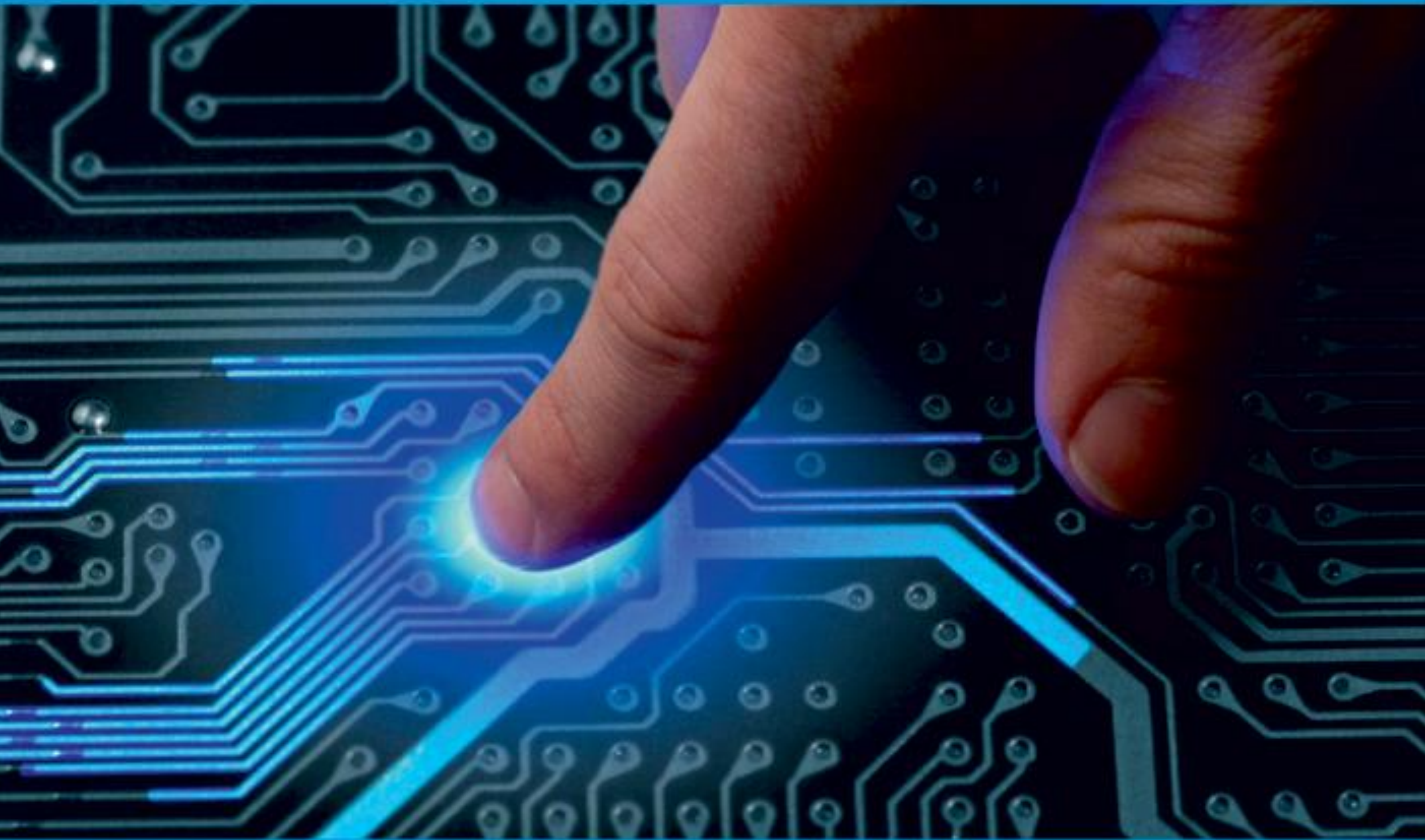

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Sensor based Smart Garbage Management using IoT

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ABSTRACT: Garbage management presents a universal challenge across societies, particularly in urban areas where waste disposal and transportation pose significant concerns. Improper waste management not only leads to environmental degradation but also contributes to the spread of diseases among local populations. Consequently, there is a growing interest in waste management driven by the scarcity of disposal sites and the potential value of recycling. Recycling, in particular, holds promise for repurposing waste materials, offering economic benefits to companies. However, the efficacy of recycling hinges on effective waste segregation, a process hindered by inadequate household practices. Leveraging technological advancements, such as the Internet of Things (IoT) and Cloud computing, offers innovative solutions to address these challenges and improve waste management practices, thereby enhancing environmental sustainability and public health outcomes.

KEYWORDS: Smart waste segregation, Smart waste monitoring, Internet of Things[IoT], cloud computing, Level monitoring, Blynk app, Esp32.

I. INTRODUCTION

The global issue of garbage management remains a pressing concern across diverse societies, particularly in urban areas where waste disposal and transportation present formidable challenges. The ramifications of improper waste management are far-reaching, as it serves as a primary catalyst for numerous diseases, directly impacting the health and well-being of local populations. This recognition has fueled a surge in interest towards waste management, propelled by the dual factors of diminishing waste disposal lands and the increasing recognition of the economic potential inherent in recycling initiatives. With the majority of waste materials being either decomposable or recyclable, the value proposition for companies engaged in recycling endeavours is significant.

However, the effectiveness of recycling efforts hinges upon efficient waste segregation, a process hampered by inadequate policies and practices at the household level. The integration of technological innovations, particularly the convergence of IoT and Cloud computing, presents a promising avenue for revolutionizing waste management practices. By harnessing the power of Web Services, compute-intensive tasks essential for optimizing waste segregation can be executed even in resource-constrained environments, such as those encountered in IoT deployments. This amalgamation of technology and waste management not only promises to mitigate health risks associated with improper waste disposal but also stands to yield substantial environmental and economic benefits.

Through the development and implementation of a proposed system aimed at enhancing waste management efficiency, this paper seeks to contribute towards the collective effort to foster cleaner, healthier, and more sustainable communities. Subsequent sections of the paper delve into a comprehensive exploration of related works, detailed insights into the proposed system, its practical implementation, observed results, concluding remarks, and avenues for future research and development in the field.

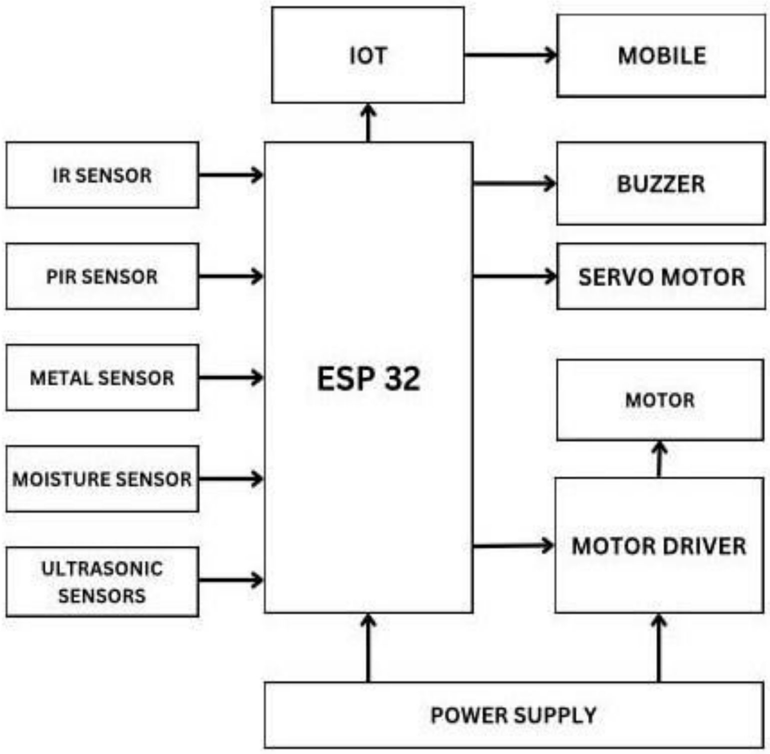
II. RELATED WORK

Smart Bin [5] Our approach simplifies waste segregation based on moisture content, distinguishing Wet and Dry waste. Unlike traditional methods requiring manual placement on sensors, our system integrates Smart Bin design and logic for automated decision-making, enhancing efficiency and sustainability in waste management. In paper [6], The author's template offers a framework for designing waste segregation and garbage level monitoring systems, alongside a glimpse into similar projects. However, it lacks consideration for practical implementation aspects. Our architecture draws inspiration from this work while prioritizing practicality, addressing cost and portability concerns. By incorporating these considerations, our system ensures feasibility and effectiveness in real-world applications. Authors of paper [7] The detailed analysis of waste types in industrial and domestic settings by the authors offers valuable insights. Their solution, "GREENBIN," facilitates waste segregation, aiming to reduce particulate matter emissions significantly. This proactive approach not only addresses waste management challenges but also projects positive environmental impacts, underscoring the importance of efficient waste segregation at the household level for overall environmental enhancement. In [5] The authors' enhancement of the AODV protocol with balanced energy consumption during route discovery is commendable. Inspired by their innovation, our project integrates these insights into an all-in-one portable waste management system. In paper [8], The proposed system excels in waste segregation, sorting materials into wet, dry, metal, and non-metal categories, yet faces drawbacks such as high operational costs and rigidity, limiting its suitability for household use. In response, our work endeavours to develop a comparable system with reduced operational costs and enhanced modularity, ensuring ease of portability and assembly, thus making it more accessible for household applications. Authors of paper [9] Through meticulous analysis of garbage collection truck routes, garbage volume per truck in specific areas, and distances to the nearest dumping grounds, the author gained insights crucial for identifying locations requiring additional dustbins and optimizing collection routes for cost efficiency. Inspired by this work, our proposed system integrates a remote monitoring and data storage module. These analyses have informed our understanding of the problem and its potential solutions, shaping the design of our system accordingly [10,11].

III. PROPOSED ALGORITHM

The proposed system is structured into four layers, each serving distinct functionalities. At the base layer, sensors and actuators are employed. Sensors collect essential data, which is then transmitted to the second layer. Actuators, on the other hand, execute decisions based on programmed logic within this layer. The second layer encompasses programmable boards where decision-making capabilities are encoded. Moving up, the third layer integrates a cloud service for remote data storage and visualization. Finally, the topmost layer features an android application facilitating access to data from the cloud service. Moreover, the system is further delineated into two subsystems: Waste Segregation and Garbage Level Monitoring. Subsystem 1, dedicated to Waste Segregation, is elucidated through a basic flowchart depicted in Flow chart 1. This process entails placing garbage on a conveyor belt, which then transports it forward for assessment. Initially, an inductive proximity sensor discerns whether the waste is metallic. If metallic, the first door closes, directing the waste into the first dustbin; otherwise, the waste proceeds. Further detection, involving rainwater and moisture sensors, aids in identifying wet waste, with both sensors employed to enhance sensitivity. If the waste is wet, the second door closes, guiding it into the appropriate bin. Conversely, dry waste continues along the conveyor, ultimately falling into the third bin designated for dry waste disposal.

IV. BLOCK DIAGRAM



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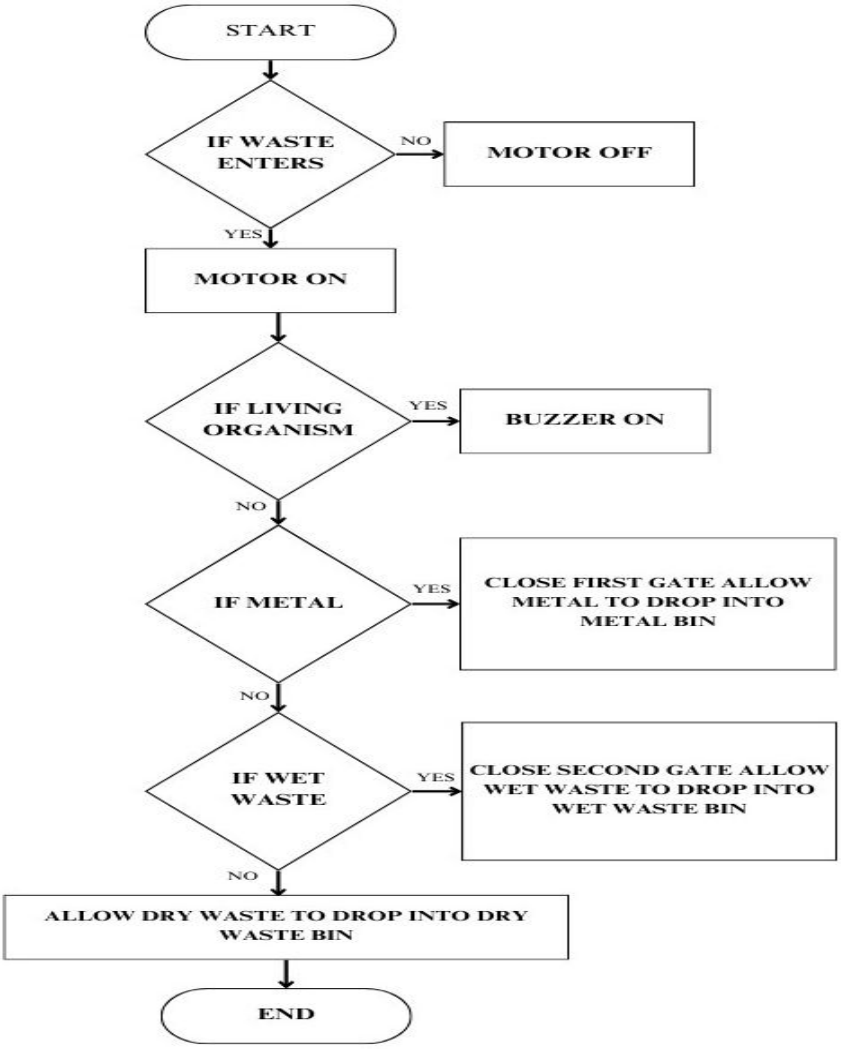
V. FLOW CHART

Flow Chart 1:



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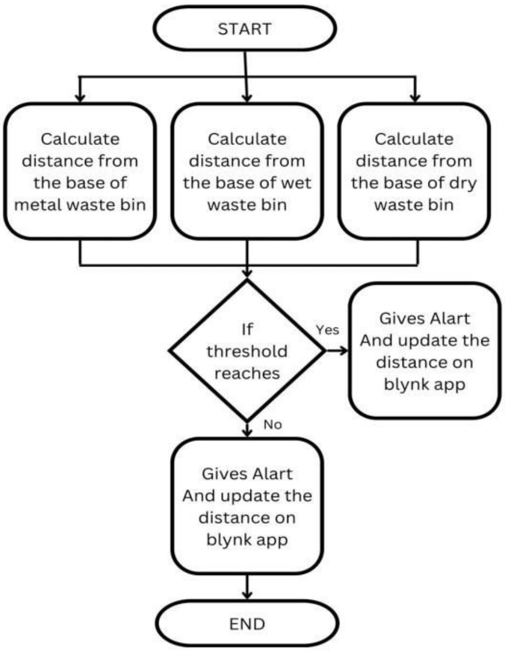
Flow Chart 2:



VI. PROJECT IMPLEMENTATION

In this section, the hardware and software tools utilized for realizing the proposed system are delineated, alongside the overarching connections. Table I presents a comprehensive list of components employed in the implementation of the proposed system and their corresponding functionalities. The 12V external power source interfaces with the L293D motor driver, distributing voltage to provide 5V output to one terminal and 12V output to the DC motor at alternate terminals. Control over the DC motor is facilitated through the digital input pin of the motor driver, linked to the digital pin of the ESP32. The ESP32 i characterized by their low power consumption, operating at 5V, thus drawing power from the 5V output terminal of the motor driver. While the Moisture Sensor operates at 3.3V and interfaces directly with the digital pins of the ESP32, other components such as the Inductive Proximity Sensor, Ultrasonic Sensors, and Servo Motors operate at 5V.

Consequently, logic converters are employed to adapt the 3.3V logic output of the ESP32 to the 5V requirements of the corresponding sensors or actuators. Beyond the electronic aspects, the design and materials chosen for implementation contribute significantly to its cost-effectiveness. The platform is modularized into three detachable blocks, prioritizing portability without compromising assembly convenience. Although the selected materials initially lacked the necessary strength to maintain required tension for the conveyor belt, slight modifications to load distribution bolstered the design's resilience. Moreover, in terms of the arrangement of electronic components across the blocks, a strategy was adopted to consolidate all electronics onto one block, with other blocks featuring extension points for direct connection to the main unit, streamlining integration and maintenance processes.

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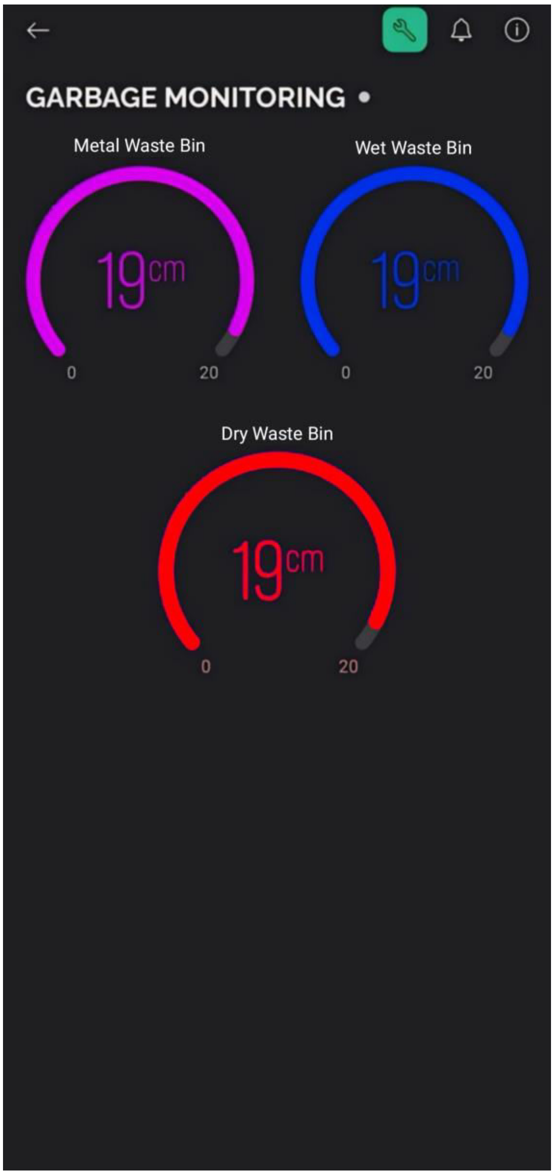

In the Blynk IoT mobile application, as illustrated in Figure [insert figure number], real-time monitoring and analysis of wet, dry, and metal bin levels are seamlessly facilitated through gauge indicators. This intuitive interface empowers users to monitor the status of waste bins at any given moment, enhancing waste management practices and fostering greater environmental control. By providing immediate access to crucial data regarding waste levels, the application empowers stakeholders to make informed decisions, optimize collection schedules, and allocate resources more efficiently, thereby contributing to a more sustainable and environmentally conscious approach to waste management.

VII. HARDWARE AND SOFTWARE DESCRIPTION

ESP32:

To interface and monitor with inductive proximity sensor, moisture sensor and to control motor, monitor dustbin levels and update value on Blynk app.

INDUCTIVE PROXIMITY SENSOR:

To identify waste as metal or non-metal.

MOISTURE SENSOR:

To identify moisture content in the waste and identify the waste as wet waste.

ULTRASONIC SENSOR:

To measure the distance from the surface of the bin for indicating level of waste collected.

12V DC MOTOR:

To rotate the conveyor belt.

MOTOR DRIVER:

To control motor speed.

BLYNK IoT APP:

To visualize dust bin fill level on mobile using IoT.

ARDUINO IDE:

To program ESP32.

VIII. RESULT

This section provides insight into the operational model of the proposed prototype. In Figure 1 displays the completed assembly, featuring electronic components consolidated onto a single block for streamlined functionality. Additional electronic components on separate blocks are connected via detachable extending connections. It illustrates the full assembly, complete with a slider on the extreme left side to facilitate smoother garbage placement on the conveyor belt. The Blynk application offers access for monitoring garbage levels across three bins, with different levels of waste indicated visually. Lastly, Figure 3 showcases a mobile app interface for accessing data from Blynk. As waste levels approach a predefined threshold (set at 20cm in this instance), the user receives an alert message signalling that the bin is nearing full capacity, facilitating timely intervention and efficient waste management.

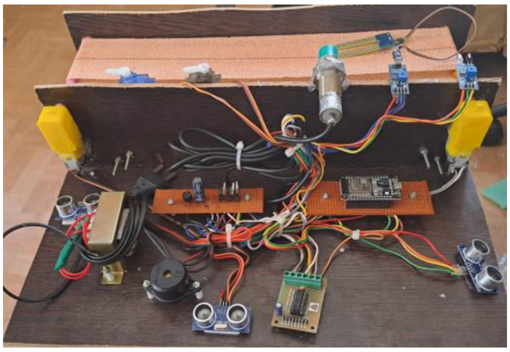

FIGURE 1

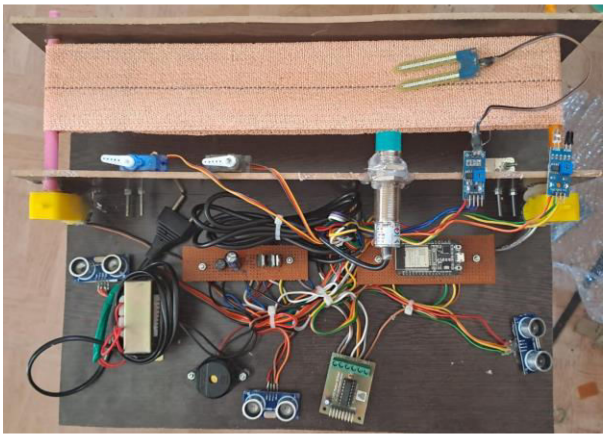

FIGURE 2

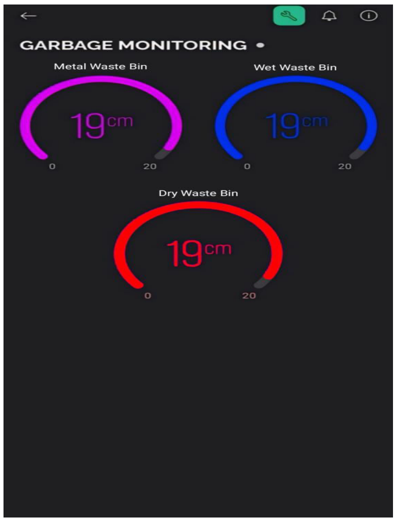

FIGURE 3

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