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Solar Powered Smart Dustbin

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***Abstract* - In response to the growing challenges of urban waste management, this paper proposes an innovative solution leveraging IoT technology and renewable energy sources. The IoT-based solar-powered smart dustbin presented here aims to enhance the efficiency and sustainability of waste collection processes in urban areas. The system incorporates ultrasonic sensors that continuously monitor the garbage level within the dustbin. Once the garbage level exceeds a predefined threshold, a real-time message is automatically transmitted to the municipal authorities, prompting timely garbage collection. This proactive approach minimizes overflow and littering, thereby improving overall cleanliness and sanitation in urban environments. Central to the functionality of the smart dustbin is its utilization of solar power for energy supply. Solar panels integrated into the design harness sunlight to generate electricity, ensuring continuous operation without reliance on traditional power sources. This not only reduces operational costs but also significantly diminishes the system's carbon footprint, contributing to environmental sustainability. Moreover, the implementation of IoT technology enables remote monitoring and management of the smart dustbins across multiple locations. Municipal authorities can access real-time data on garbage levels, collection schedules, and system performance through a centralized dashboard. This enhances operational efficiency, allowing for optimized resource allocation and proactive maintenance.**

***Keywords* - ESP32, Ultrasonic sensor, IFTTT, Smart city**

I. INTRODUCTION

In our nation, the improper disposal of waste remains significant concern even among the educated populace, there is a tendency to discard garbage outside designated bins, often exacerbated by irregular cleaning of these receptacles, The repercussions become particularly pronounced when these bins overflow emitting strong Odors, especially prevalent during the rainy season. Consequently, this situation accelerates the spread of diseases in neighbouring areas. Ensuring the proper maintenance is essential for the efficient removal of the generated waste [9]. Irregular garbage removal can lead to excessive occupancy in the dustbin, hindering effective waste management. The potential dangers of this scenario include ecological factors like hazardous pollution and its subsequent impact on the well-being humanity [8]. Cities lack and organised and effective system for managing garbage disposal. The absence of a well-structured controlled mechanism contributes to the current challenging in handling waste. Efficient waste management possess a significant challenge in urban areas globally, requiring the implementation of well organised clearance system to uphold environmental sustainability [10]. The respective programmed logic is written in Arduino IDE and interfaced with ESP32 to detect the filling level of the dustbin through the ultrasonic sensor and sends a notification when it reaches a pre-defined threshold, signalling the need for disposal. IoT comprises interconnected physical entities assessable via internet, where the 'THING' refers to tangible devices equipped with sensors, enabling them to transmit data via IFTTT platform and communicate autonomously with a central station.

The integration of solar powered system holds immense potential for innovative projects such as a smart garbage system. Harnessing energy from sun not only aligns with sustainable practices but also enhances the efficiency and reliability of the waste management infrastructure. By incorporation solar technology, this system can operate autonomously, reduce dependency on conventional power sources and contributing to environmentally conscious solution for urban waste disposal.

II. LITERATURE SURVEY

[1] S.S Navghane, M.S Killedar, Dr.V.M Rohokale, presented smart dustbin that aims to minimize human involvement in waste management, streamlining the process to save costs and reduce pollution. By enhancing and simplifying waste management procedures, it will contribute to overall efficiency and environmental sustainability.

Numerous studies advocate for the collection of comprehensive data on garbage generation,

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including the quantification of various types of waste. This data serves as a foundation for in-depth analysis, facilitating the development of resource-efficient management systems. By understanding the volumes and types of garbage produced, decision-makers can optimize waste management processes for greater effectiveness and sustainability

[2] [3] [4] [5]. [6] M. Z. Harith, M. A. Hossain, Ahmedy, I. Idris, M.Y.I. Soon, and T.K. Noor, they presented that In current systems, municipal authorities typically schedule regular trash collection using manual methods, leading to various challenges. These include uncertainty regarding the condition of specific sites, employees' lack of awareness about the demand for waste collection in particular areas, inefficiency in maintaining city cleanliness, and the necessity of assigning dedicated vehicles for trash removal. These challenges highlight the need for more advanced and efficient waste management solutions.

A proposed solution involves implementing ultrasonic sensors to monitor real-time fill levels of bins, enabling data storage for future use in tasks such as optimizing collection routes and analyzing waste generation trends. Additionally, the bin design includes a feature where the lid automatically closes when the bin reaches full capacity, and a proximity sensor detects the presence of an employee for waste collection, as outlined in the design proposed by Aksan Surya Wijaya et al. This integrated approach enhances efficiency and effectiveness in waste management operations [7].

III. PROBLEM STATEMENT

When garbage overflows, citizens face a myriad of challenges that disrupt their daily lives and compromise their well-being. Firstly, the unpleasant odor emanating from the overflowing garbage becomes pervasive, permeating the air and causing discomfort to nearby residents, diminishing the quality of life for all inhabitants. This foul stench not only affects the immediate vicinity but can also spread to surrounding areas, detracting from the beauty of the environment and diminishing property values. Moreover, the accumulation of waste becomes a breeding ground for pests like flies and rodents, further exacerbating the problem, posing health risks and creating a sense of unease and insecurity among residents. Additionally, the health hazards associated with accumulated garbage cannot be understated, as disease-carrying organisms thrive in such environments, increasing the risk of illnesses and infections among residents, from respiratory issues to gastrointestinal problems. Similarly, the widespread adoption of renewable energy sources faces challenges such as technological limitations, economic barriers, regulatory constraints, and societal acceptance issues, hindering its full realization and integration into mainstream energy systems. Overcoming these hurdles requires innovative solutions, policy reforms, investment incentives, and public awareness campaigns to facilitate the transition towards a sustainable energy future, accelerating the global shift towards a low-carbon, resilient, and equitable energy system.

IV. OBJECTIVE

The objective of implementing a solar-powered IoT-based smart dustbin system is to efficiently manage waste disposal, preventing overflow, and addressing the challenges citizens face when garbage accumulates. By monitoring garbage levels in real-time and automatically alerting authorities when the dustbin reaches capacity, the system aims to minimize unpleasant odors, aesthetic degradation, and health hazards associated with accumulated waste, ultimately enhancing citizen satisfaction and well-being by maintaining clean and hygienic surroundings. Similarly, objectives for renewable energy sources focus on promoting their widespread adoption to tackle energy challenges and mitigate environmental impacts. This includes increasing the share of renewable energy in the energy mix, enhancing energy security, mitigating greenhouse gas emissions, fostering economic opportunities, and preserving biodiversity. Efforts are also directed towards ensuring timely waste disposal to prevent overflow and maintain cleanliness, through establishing regular waste collection schedules, educating citizens, implementing incentives, and collaborating with stakeholders to improve waste management infrastructure. Overall, the goal is to improve environmental sustainability, public health, and community well-being by integrating solar-powered IoT-based smart dustbins and advancing the adoption of renewable energy sources, fostering a cleaner, more resilient, and sustainable future for all.

V. METHODOLOGY.

The garbage levels in smart trash bin within the defined region is allowed to be monitored by the proposed garbage collection system. Additionally, updates on which bins are full and need to be collected in every round of garbage collection are provided by the system.

- The program code for the smart bin should first be uploaded to the ESP32.
- Measurement of garbage levels is accomplished through the use of the ultrasonic sensor connected to the dustbin.
- It is essential to establish the threshold value for the distance measured by the ultrasonic sensor.

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- When the garbage surpasses the threshold distance of the dustbin, a notification is automatically dispatched to the municipality.
- The seamless execution of this entire process necessitates the presence of an ongoing and unbroken power supply to the system.
- Embedding a solar power supply mechanism as the energy source fulfills the requirement for a continuous power supply to the system.

Fig.1 Overall system

A. Arduino setup:

Before implementation, it is imperative to ensure the proper functioning of any hardware setup. Therefore, direct deployment of the code into the microcontroller is not advisable. Instead, a meticulous software verification process is necessary to scrutinize the code manually. For this purpose, we employed Arduino IDE to validate the code and its output meticulously. This approach enables us to effectively debug any errors that may arise during the verification process.

B. IFTTT Application

We utilized the IFTTT application to send the message to municipality. IFTTT (If This Then That) simplifies automating tasks across various online services and devices through applets—conditional statements linking triggers and actions. By connecting apps, devices, and services, users can orchestrate tasks like backing up files, syncing data, receiving notifications, and controlling smart devices. Its versatility spans popular platforms such as Facebook, Twitter, Gmail, Dropbox, and more.

Accessing IFTTT requires no traditional installation. Users can sign up via web browsers or the mobile app for iOS and Android devices. Once logged in, users connect their accounts for seamless integration. Creating applets involves selecting triggers and actions, setting up desired responses, all through an intuitive interface.

Overall, IFTTT empowers users to streamline digital workflows, saving time and effort in managing online activities and devices. Whether through creating custom applets or utilizing pre-built ones, IFTTT offers a user-friendly solution for automating diverse tasks across the digital landscape.

C. Working

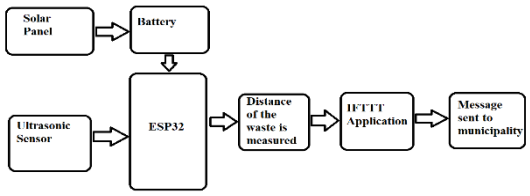

Fig.2 Functional block diagram

The solar panel connection for the Smart Trash Bin harnesses the power of renewable energy to ensure uninterrupted operation and sustainability. Integrated with precision, the solar panels efficiently capture sunlight, converting it into electricity to power the bin's monitoring systems and communication modules. This eco-friendly approach not only reduces reliance on traditional energy sources but also enhances the bin's autonomy and resilience, contributing to a greener and more efficient waste management ecosystem.

the ESP32 typically operates within a voltage range of 2.2V to 3.6V, which can be efficiently supplied by a solar panel system. The solar panel converts sunlight into electrical power, which is then regulated and stored in a battery by a charging module. This stored energy can effectively power the ESP32 and its associated components, ensuring continuous operation even in areas with limited access to traditional power sources.

To elevate the voltage from the battery to the required level for the ESP32, a DC-DC booster is linked to the charging module. The current regulation is achieved through a potentiometer resistor integrated with the voltage booster. Subsequently, this regulated power supply is directed to the ESP32, ensuring optimal performance and stability.

At a specific voltage threshold, the ESP32 initiates its pre-programmed sequence to establish a

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connection with the Wi-Fi network. This firmware, already embedded within the ESP32's memory, enables seamless integration with the designated network, facilitating data transmission and communication functionalities.

The ultrasonic sensor, interfaced with the ESP32, commences the process of gauging the garbage level within the bin. This sensor utilizes sound waves to accurately measure the distance to the surface of the garbage, providing crucial data for determining the fill level of the bin.

D. Circuit diagram

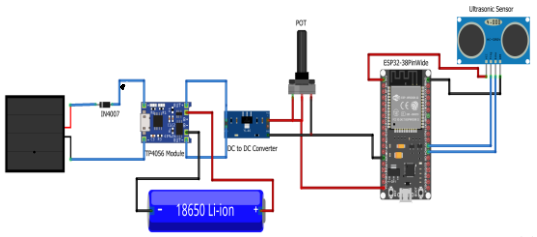

Fig.3 Circuit Diagram

VI. RESULT

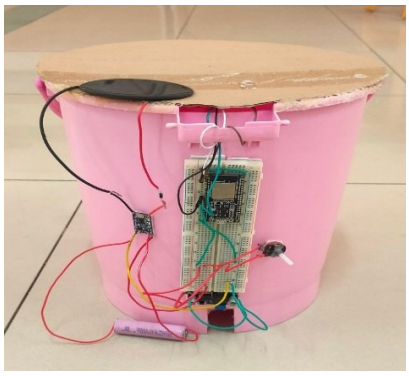

Fig.4 Prototype of the Project

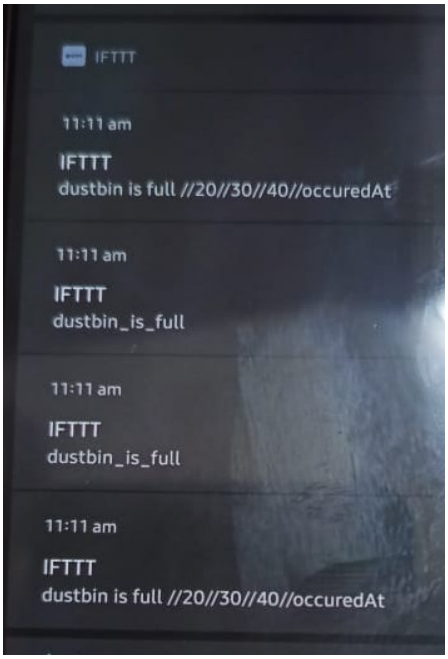

Fig.5 Message Outcome

VII. CONCLUSION

This sustainable approach not only reduces reliance on grid electricity but also promotes eco-friendly solutions for various applications, including the Smart Trash Bin. The Smart Trash Bin epitomizes innovation in waste management, boasting autonomous monitoring capabilities to track its own waste accumulation levels. With an innate ability to discern when it's time for collection, this cutting-edge bin transcends conventional bins by proactively alerting the municipal authorities for timely disposal. Moreover, it seamlessly disseminates real-time data onto designated servers, fostering transparency and facilitating informed decision-making in waste management practices.

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