CLOUD BASED WASTE MANAGEMENT SYSTEM USING IOT

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Abstract - This research paper presents the design and implementation of a Cloud-Based Waste Management System aimed at revolutionizing waste management processes through the integration of cutting-edge technologies. The system leverages ultrasonic sensor technology, Blynk Cloud as the cloud platform, and Node MCU ESP8266 as the microcontroller, all developed within the Arduino IDE framework. The primary objective of this innovative system is to enhance waste management efficiency by enabling real-time monitoring and effective utilization of collected data. The ultrasonic sensor serves as the cornerstone component for measuring the fill levels of waste bins, providing continuous and accurate data regarding waste accumulation. The NodeMCU ESP8266, programmed using the Arduino IDE, functions as the central hub for data collection and processing. It establishes a seamless connection to the Blynk Cloud, facilitating the transmission of collected data to the cloud platform for further analysis and decision-making.
Keywords: NodemcuESP8266, Ultrasonic Sensor, Internet of Things, Alert Notification.

1 INTRODUCTION

In the bustling landscape of India, where population growth surges and environmental concerns loom large, the issue of waste management has emerged as a critical challenge. As urbanization accelerates, so does the accumulation of garbage, exacerbating environmental degradation and pollution. Dustbins, traditionally utilized as receptacles for waste collection, often overflow, spilling refuse into the surroundings and contributing to heightened pollution levels. The repercussions of such negligence extend beyond mere inconvenience, as air pollution emanating from overflowing dustbins harbors bacteria and viruses, posing grave health risks to communities.

In response to these pressing environmental woes, a paradigm shift is underway—a fusion of technology and innovation aimed at addressing the shortcomings of conventional waste management practices. Introducing the smart dustbin, a beacon of hope in the fight against waste proliferation and pollution.

Equipped with state-of-the-art ultrasonic sensor technology and powered by the NODEMCU ESP8266 microcontroller, thisintelligent solution heralds a new era of cleanliness and efficiency. By detecting objects tossed into the bin and automatically opening its lid with the assistance of a motor, this IoT-based research and project offer a transformative approach to waste disposal.

This innovative device not only streamlines the process of waste management but also embodies a cleaner, smarter way of living. From electronic gadgets to wrappers, the smart dustbin accommodates various types of waste, ensuring a hygienic environment for households. Its intuitive design, featuring automated lid opening and closing based on proximity, not only enhances convenience but also fosters a culture of cleanliness and sustainability. In essence, the smart dustbin symbolizes a beacon of progress, offering a glimpse into a future where technology converges with environmental stewardship to create cleaner, healthier communities.

The goal of implementing an IoT smart garbage collector project in real-time is to solve the growing problem of waste management and its effects on the environment. Ineffective waste management techniques and improper disposal of garbage can result in a variety of environmental issues, such as pollution, health risks, and climate change. Waste management may be optimised and made more effective with the use of an Internet of Things smart garbage collector.

2 RELATED WORK

A method is implemented to efficiently manage waste in large cities without requiring manual, round-the-clock part monitoring. Here, the issue of disorganised and haphazard rubbish collection is resolved by creating an embedded Internet of things system that would

keep track of the quantity of waste placed in each dumpster on an individual basis. Here, a technology for automatically separating dry and moist garbage is available. Wet and dry waste can be separated mechanically into different containers; in this case, wet and dry can be separated using sensors. [1]

Garbage monitoring systems are intended for use in bus stops, colleges, hospitals, and smart buildings. The idea behind the garbage monitoring system is to upgrade the standard dustbin by utilising sensors to make it more intelligent. A garbage monitoring system is a novel invention that uses ultrasonic sensors to detect the level of waste in a bin, show the quantity of waste, and send a message to the department head in charge, updating the bin's status via a GSM modem.[2]

In an environmental context, the use of RFID (radio frequency identification) and load cell sensor technology can be employed for not only bringing down waste management costs, but also to facilitate automating and streamlining waste (e.g., garbage, recycling, and green) identification and weight measurement processes for designing smart waste management systems. In this paper, we outline a RFID and sensor model for designing a system in real-time waste management.[3]

3 METHODOLOGY

1. Installation of Equipment:
   - Bins are equipped with ultrasonic sensors, Node MCU microcontrollers, and LED lights.
   - Ultrasonic sensors are securely attached to the lid of the waste container.
   - Connection between Node MCU board and ultrasonic sensor is established using connecting wires.
   - The entire system includes an ultrasonic sensor, Node MCU board, and power supply (USB cable).

2. Data Transmission:
   - When waste containers reach a capacity of over eighty or ninety percent, signals are transmitted wirelessly through the Wi-Fi network.
   - Signals are sent to a centralized database hosted on the Blynk cloud platform, an internet-based software application

3. User Registration:
   - Authorized users' information is registered in the system to facilitate access and notification services.

4. Notification System:
   - End-users receive notifications about the nearest available empty bins and directions to reach them.
   - Authorized personnel are alerted about full bins and their specific locations, enabling timely intervention.

5. System Optimization:
   - The Blynk cloud platform displays equipment's capacity, serving as a basis for optimizing waste collection routes.
   - Garbage trucks are directed only to containers that genuinely need to be emptied, minimizing unnecessary trips and fuel consumption.

6. Operational Program:
   - The operational program is loaded onto the Arduino IDE to facilitate the functioning of the system.

7. Power Supply:
   - Power is supplied to the system through a MicroUSB cable, ensuring continuous operation.

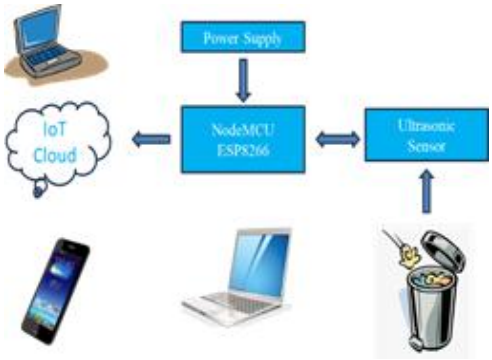

Fig 1. System Architecture

4 PROPOSED ARCHITECTURE

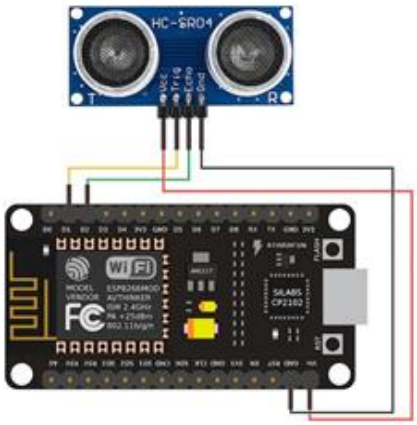

Fig 2 NodeMCU ESP8266

In the realm of our Smart Waste Management System, the NodeMCU ESP8266 emerges as a multifaceted enabler, not only boasting powerful processing capabilities but also equipped with an integrated Wi-Fi module. This built-in Wi-Fi functionality grants the NodeMCU the ability to seamlessly connect to local networks, enabling real-time data transmission and remote monitoring. Exploiting its GPIO (General Purpose Input/Output) pins, the Node MCU offers a plethora of possibilities for interfacing with external devices and sensors. Each GPIO pin serves as a versatile conduit for both input and output operations, allowing for dynamic interactions with the surrounding environment. From D0 to D8, these pins provide the foundation for connecting various peripherals, ranging from sensors to actuators. In our system, GPIO pins D1 and D2 are strategically utilized for interfacing with the ultrasonic sensor, facilitating precise data acquisition. Meanwhile, GPIO pins D3 to D8 remain available for additional sensor integration or output control, further enhancing the system's flexibility and scalability. With its robust Wi-Fi module and GPIO pins, the Node MCU ESP8266 emerges as a central hub in our quest for efficient waste management, enabling seamless communication and control in an interconnected world. As shownn in Fig 2.

Fig 3. Node MCU Esp8266

- **Ultrasonic sensors**

In the realm of ultrasonic sensors, the Echo and Trig pins stand as gateways to precise distance measurement, serving as the conduits through which sound waves are emitted and received. The Trig (trigger) pin acts as the initiator, sending out ultrasonic pulses into the surrounding environment. These pulses, akin to the bat's echolocation, travel outward until they encounter an object, upon which they bounce back as echoes. The Echo pin, on the other hand, serves as the receiver, capturing these echoes and converting them into electrical signals. By measuring the time interval between the emission of the pulse and the reception of its echo, the sensor can calculate the distance to the object with remarkable accuracy. This dynamic interplay between the Trig and Echo pins forms the crux of ultrasonic sensor functionality, enabling precise distance measurement and detection of objects in its vicinity. In our Smart Waste Management System, these pins play a pivotal role in gauging the fill levels of waste bins, facilitating real-time data acquisition and informed decision-making. Through their seamless integration with microcontrollers like the NodeMCU ESP8266, the Echo and Trig pins empower intelligent waste management solutions, driving efficiency and sustainability forward in our ever-evolving world. As shown in Fig 4.

Fig 4. Ultrasonic Sensor

- **Blynk Cloud App**

Central to the efficacy of the Blynk Cloud IoT app is its pivotal role in orchestrating a sophisticated Notification and Alerting System, which stands as a linchpin for proactive monitoring and decisive action. Its significance reverberates throughout the IoT landscape, offering users a real-time conduit for staying informed and responsive to critical events and thresholds. This feature represents a vital mechanism for ensuring the integrity and efficiency of IoT deployments, providing users with the means to swiftly address emerging issues and optimize performance. By leveraging the Notification and Alerting System, users can define custom triggers and conditions, enabling the app to deliver timely notifications and alerts tailored to specific scenarios. In our Smart Waste Management System, this functionality is paramount: authorized personnel are promptly notified about full bins and their exact locations, empowering them to intervene promptly and optimize waste collection routes. Meanwhile, end-users receive instant alerts regarding nearby empty bins, ensuring convenient access and contributing to a cleaner environment. Thus, within the Blynk Cloud IoT app, the Notification and Alerting System emerges as an indispensable tool for proactive decision-making, safeguarding operational efficiency, and fostering a seamless IoT experience. Image as shown in Fig 3.

Fig 5. Blynk Interface

5 RESULT AND DISCUSSION

The culmination of our research efforts unveils a paradigm-shifting solution in the realm of waste management: the Cloud-Based Waste Management System. This innovative system, meticulously crafted through the integration of ultrasonic sensors, NodeMCU ESP8266 microcontrollers, and the Blynk Cloud IoT app, heralds a new era of efficiency and sustainability. Our study delves into the intricacies of this system, from its inception to its implementation, and the results speak volumes about its transformative potential.

At its core, the Cloud-Based Waste Management System addresses the pressing challenges of traditional waste management methods by offering real-time monitoring, data-driven insights, and proactive intervention. Through the strategic deployment of ultrasonic sensors, the system accurately gauges the fill levels of waste bins, ensuring timely collection and minimizing the risk of overflow and environmental pollution. When the bin fills to 90% of waste, notifications are triggered to both end-users and municipal drivers, enabling swift intervention and optimized collection routes.

Moreover, the Blynk Cloud's robust Notification and Alerting System serves as a vital lifeline, facilitating proactive decision-making and ensuring the smooth operation of connected devices and systems. The results of our research underscore the transformative impact of the Cloud-Based Waste Management System, offering a glimpse into a future where technology converges with environmental stewardship to create cleaner, healthier communities. As we navigate the complexities of waste management in an ever-changing world, this system stands as a beacon of progress, paving the way for a more sustainable future. Through ongoing refinement and implementation, the Cloud-Based Waste Management System promises to revolutionize waste management practices, driving efficiency and sustainability forward in our quest for a cleaner, greener tomorrow

Fig 6. Working System

Fig 7. LED And NodeMCU ESP8266 Connected

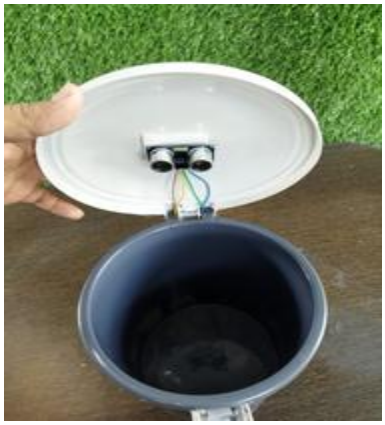

Fig 8. Ultrasonic Sensor Connection

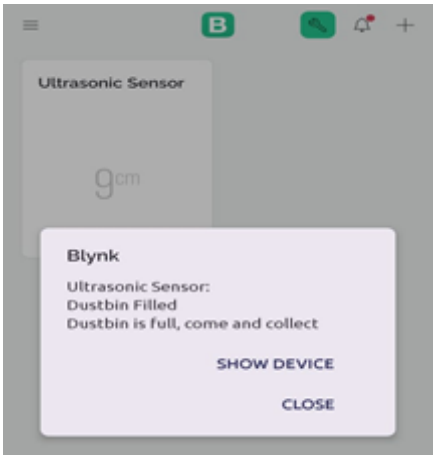

Fig 9. Mobile Notification

6 CONCLUSIONS

The integration of a cloud-based waste management system with Arduino technology represents a significant step towards revolutionizing traditional waste disposal methods. By leveraging the power of the cloud and the versatility of Arduino, this system introduces a range of benefits and efficiencies that contribute to a smarter and more sustainable approach to waste management.

The cloud-based architecture allows for real-time monitoring, data analytics, and remote control of waste bins, providing a comprehensive solution for waste management challenges. Arduino technology, with its cost-effective and adaptable microcontroller platform, enhances the system's capability to interface with sensors, actuators, and communication modules, making it a practical choice for smart waste solutions.

Systems for managing garbage in the cloud are essential for smart buildings. The astute notion of smart city designers is intelligent waste monitoring and management. A novel concept in trash management is cloud-based systems, which employ sensors to detect the quantity of garbage in a dustbin and notify the user when the bin needs to be updated. The dustbin notifies the appropriate authority and displays information on an LCD as soon as it is full.

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