International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 07 | July 2024 www.irjet.net p-ISSN: 2395-0072

Smart Waste Management using IoT

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***Abstract*—This paper proposes a novel smart waste man- agement system using Internet of Things (IoT) technologies to address the challenges of waste segregation, collection, and monitoring. The system employs ultrasonic sensors to detect dustbin fullness, and rain sensors to categorize waste into dry and wet fractions. Real-time bin location and fullness data are trans- mitted wirelessly to a central monitoring system via Bluetooth, enabling efficient waste collection and overflow prevention. The Android app visualises bin location and fullness level on a map, facilitating efficient waste collection and promoting transparency The proposed system offers a cost-effective and scalable solution for smart waste management in urban environments.**

***Index Terms*—Waste Segregation, IoT, Android App, LocationTracking, Bluetooth**

I. INTRODUCTION

Garbage bins in current management systems are emptied at regular intervals by cleaners, leading to various drawbacks:

A. Some bins fill up faster, causing overflow onto streets, pollution, and breeding grounds for pathogens. B. Slow waste production in certain areas results in semi-filled bins upon collection, leading to fuel wastage and increased transportation costs. With household garbage and municipal waste increasing daily, even small improvements in collection operations can yield significant cost savings. To address these challenges, proper garbage monitoring is essential. A proposed solution involves an IOT-based smart garbage monitoring and disposal system. This innovative technology aims to optimize waste management processes and alleviate the negative impacts of inefficient garbage disposal practices.

Furthermore, The proposed smart garbage monitoring sys- tem will automatically send SMS notifications to authorized personnel when a dustbin reaches full capacity, facilitated through Bluetooth and an Android application. Additionally, the system will utilize Google Mobile Services to pinpoint the exact location of the full dustbin on Google Maps, ensuring prompt action by authorities. Furthermore, waste segregation between wet and dry waste will be monitored using a rain sensor, allowing for efficient categorization and disposal of waste types. This comprehensive approach aims to enhance waste management efficiency and reduce costs associated with solid waste collection and disposal.

II. LITERATURE SURVEY

The future IoT-based smart waste management system uses sensors to monitor waste levels in urban dustbins. An accom- panying Android application provides real-time informationon bin levels across different locations. When a bin is full, it sends notifications with its location to truck drivers forcollection. Higher officials can monitor employees, and the system is powered by solar panels for sustainability. Using Zig-Bee IoT technology, it can efficiently collect and transmit data, enabling dynamic supervision of waste collection through cloud integration. The IOT community has designed a system that is powered by a solar panel which is also a means of renewable energy resources.[1][2][3][5][6][9]

The system utilizes IoT sensors to monitor waste levels in urban dustbins. An Android app provides real-time infor- mation and alerts drivers when bins are full. Solar-powered and cloud-connected, it optimizes garbage collection efficiency and enables remote monitoring by higher officials.[2] Voice Controlled Automatic Dustbin (VCAD) responds to specific voice commands via an Android device.

Upon command recognition, the microcontroller opens the lid when garbage is detected, aiding elderly and disabled users.[3]

Using transfer learning to classify and recognize garbage, adapting the Inception V3 model from ImageNet. Data augmentation and convolutional neural networks are utilized, achieving high training and test accuracies. The model accurately identifies common garbage, showing promise for intelligent waste classification.[4] the significant issue of air pollution caused by solid waste garbage, emphasizing its impact on human health. By proposing a cloud-based solution utilizing sensors and AWS Kinesis, it aims to monitor and process garbage odor data, crucial for mitigating pollution in crowded cities.[7]

III. PROPOSED SYSTEM

The Smart Garbage Monitoring System is an innovative solution that combines various sensors and communication technologies to revolutionize waste management. This system employs rain sensors for detecting the type of garbage (wet or dry) a console for displaying the result of segregation, ul- trasonic sensors for distance measurement, Global Positioning System (GPS) for location tracking. The Global Systems for Mobile Communications (GSM) is used for sending location messages which are in-built into raspberry pi, and Bluetooth for transmitting sensor data to an Android app for real-time tracking.

A. Components

The system consists of the following components:

1) Rain Sensor: Rain sensors are integrated into the garbage bins to detect the presence of moisture. These sensors differentiate between wet and dry garbage based on the level of humidity or rainwater infiltration.

2) Ultrasonic Sensor: An ultrasonic sensor is placed in the trash can to measure the distance between the sensor and the trash can. As the waste level increases, the distance will decrease and the system will be able to monitor collection conditions.

Fig. 1. Ultrasonic Sensor.

3) Bluetooth: Bluetooth technology is employed to transmitsensor data (rain, ultrasonic, GPS) from the garbage bins to a connected Android app. Application: The Android app serves as a centralised platform for monitoring all garbage bins. Users, including waste management authorities and citizens, can access real-time data on garbage levels, types, and loca- tions.

4) Raspberry Pi: Raspberry Pi 4 Model B is a one-of-a-kind computer developed by the Raspberry Pi Foundation. It's a credit card-sized computer that can be used for a variety of tasks, including work, media, and homework. 1.5GHz 64-bit quad-core ARM Cortex-A72 processor, built-in 802.11ac Wi- Fi, Bluetooth 5, full Gigabit Ethernet (unlimited), two USB 2.0ports, two USB 3.0 ports, 1, 2, 4, or 8 Supports two monitors with up to 4K resolution on GB RAM and two micro HDMI (HDMI Type D) ports.

Fig. 2. Bluetooth.

Fig. 3. Raspberry Pi 4B.

5) Infrared Sensor: Infrared emitters vary in wavelength, output power, and response time. The infrared sensor consists of an infrared LED and an infrared photodiode, together called an optocoupler or optocoupler. IR emitters, also known as IR LEDs, look like standard LEDs but emit infrared radiation thatis invisible to the human eye.

6) DC Motor: A direct current (DC) motor is a motor that converts electrical current into electricity. DC motors take electrical energy from direct current and convert this energy into rotating machines. Output torque and speed depend on input voltage and motor design.

IV. METHODOLOGY

System Workflow:

1) Waste is deposited on the designated rain sensor plate for moisture detection.

2) An infrared sensor continuously detects the presence of waste within the designated area, triggering the activa- tion of the rain sensor for subsequent moisture analysis.

3) Upon waste detection, the rain sensor assesses the waste's moisture content. If moisture is present, the mo- tor rotates counter-clockwise, directing waste to the wet waste compartment. Conversely, dry waste is directed to the designated compartment through clockwise motor rotation.

Fig. 4. Infrared Sensor.

Fig. 5. DC Motor.

4) Ultrasonic sensors continuously monitor the fill levels in both wet and dry waste compartments.

5) Upon reaching the pre-set 10cm fill threshold in either compartment, the system proactively transmits an auto- mated SMS alert to registered mobile numbers, ensuring timely collection and preventing overflow.

6) The developed Android application enables live tracking of the bin's location through a map interface based on transmitted coordinates.

7) The HC-05 Bluetooth module facilitates communication between the hardware and software adhering to live location tracking.

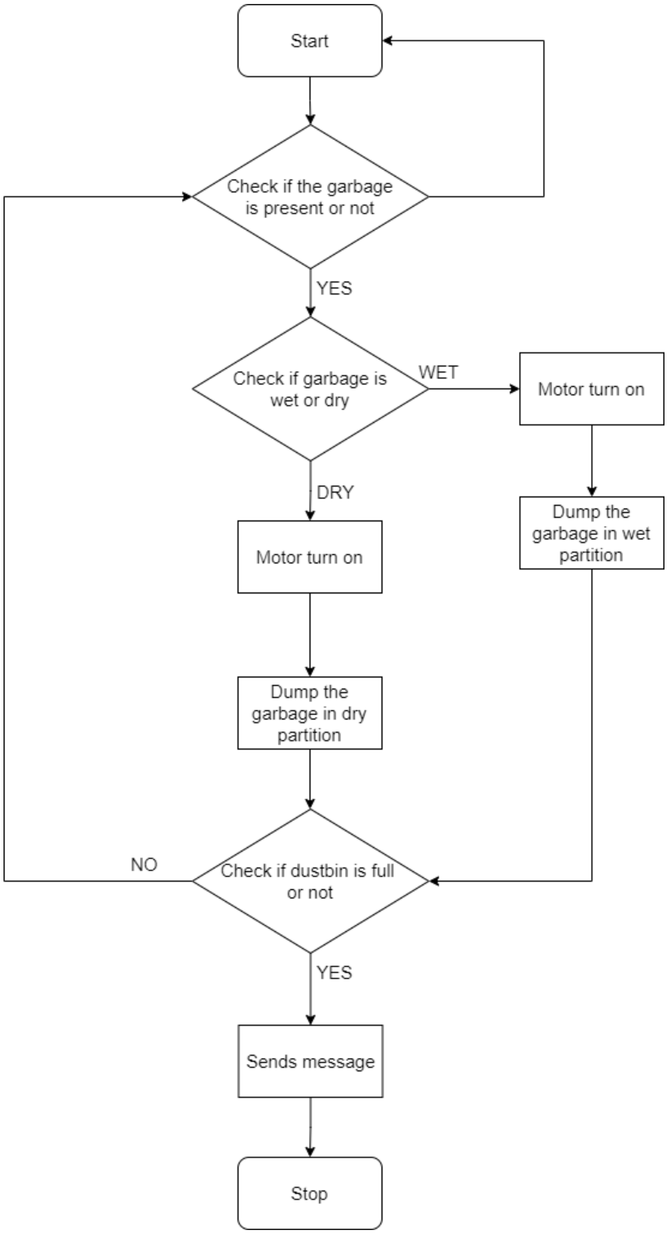

Fig. 6. Flowchart of the Smart Waste Management system.

V. CONCLUSION

In conclusion, our proposed Smart Waste Management Sys- tem stands as a comprehensive solution poised to revolutionize waste management. By seamlessly integrating rain sensors for wet/dry waste detection, ultrasonic sensors for level measure- ment, GPS for location tracking, GSM for location messages, and Bluetooth for real-time data to an Android app, it offers a data-driven approach to optimize collection routes, reduce costs, minimize environmental impact, and enhance trans- parency. The modular design allows for flexible deployment across diverse environments, paving the way for widespread adoption and significant advancements in waste management practices. While further research is crucial to fully unlock its potential, this innovative system holds immense promise for creating a cleaner, more sustainable, and cost-effective future.

While further research is required for future work addition could be done of more segregation parts like metals and non- metals along with dry and wet.

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