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Smart Waste Management System using IoT (Internet of Things)

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Abstract: *Effective waste management is a major issue in crowded urban areas. In many developing countries, it is common to see garbage left on streets and in public spaces. This situation harms the environment and creates unsanitary conditions. Both developed and developing countries face challenges in managing waste for sustainable development. This paper looks at how automation can improve waste management systems in terms of cleanliness and hygiene.*

To tackle these problems, the Smart Netbin concept has been introduced. It combines hardware and software solutions by adding a Wi-Fi network to regular trash bins. This setup offers users free internet access for a limited time. The technology encourages users to keep their surroundings clean, which helps with effective waste management in their neighborhoods. The Smart Netbin uses various technologies: it measures the amount of trash added, tracks the movement of waste, and sends necessary signals while connecting users to the Wi-Fi network. The proposed system uses a client-server structure. It supports a clean environment, public health, and a pollution-free community.

Keywords: Load cell, Internet of Things(IoT), load detection plate, Arduino, Wi-Fi, Internet

I. INTRODUCTION

In developing nations, the concept of waste management and awareness is becoming increasingly important. The daily volume of waste generated by industries and households is rising at a concerning pace, largely due to the growing consumption of packaged goods, textiles, paper, food, plastics, metals, glass, and more. As a result, effectively managing this waste has become a vital aspect of our daily lives. Many developed countries utilize various efficient methods for proper waste management; however, in some developing nations, the public's neglect towards maintaining clean environments, combined with issues such as inadequate regulations on biodegradable materials, insufficient environmental policies, and a lack of laws regarding sustainable development, contribute to the dire consequences of waste management. The mounting waste has led to public bins overflowing, resulting in neighborhoods cluttered with garbage, which creates foul-smelling streets and poses a negative threat to public health and the environment.

Waste management is a major global issue, especially with more people moving to cities and population density increasing. Unreliable waste collection leads to full trash bins. This causes people to throw their garbage in public areas, which results in pollution and health hazards. Piles of waste attract pests, rodents, and stray animals, spreading diseases like typhoid, malaria, and respiratory infections. Hazardous waste and plastic litter threaten marine ecosystems. An overflowing garbage crisis impacts tourism, spoils the beauty of cities, and harms economic opportunities. Currently, the world produces more than 2 billion tons of waste each year. This amount is expected to rise to 3.4 billion tons by 2050. Effective and inventive waste management is crucial for protecting public health, preserving the environment, and supporting sustainable city growth.

The internet captures the world's attention today. Almost everyone can access the internet through their phones, tablets, or laptops. Many believe that moving forward in the modern world is tough without connectivity. However, connectivity issues or busy schedules can sometimes block access to the internet. This creates a strong interest in free Wi-Fi. Providing free Wi-Fi in exchange for proper waste disposal could help with the waste problem. It would also offer internet access and encourage people to use this service, promoting cleanliness in the community.

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II. PROPOSED SYSTEM

The Smart Netbin is a regular trash bin fitted with an Arduino Uno microcontroller. It has a load sensor and a Wi-Fi module. There are two main parts: the mechanical components and the electronic components. The mechanical parts include a shredder and a load sensing plate. The electronic parts consist of several items, such as the Arduino, load cell, LCD display, IR sensor, amplifier, relay module, and Wi-Fi router.

When someone throws waste into the bin, the shredder cuts it down to size. The shredded materials collect on the load sensing plate inside the bin. A load sensor on this plate measures the weight of the waste. Once the weight hits a set limit, the password for the router appears on the LCD screen, but the router stays powered off. After the password is displayed, the user must remove the plate so the collected trash can fall into the bin. The IR sensor detects the falling waste and activates when it senses motion.

Benefits of the suggested system:

- Low implementation costs
- Simple module
- Easy-to-use functionality

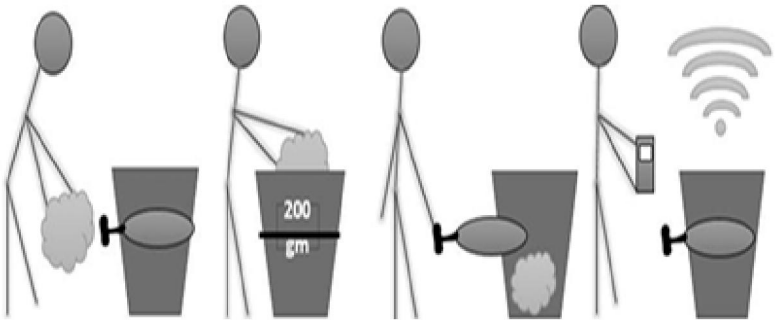

Fig.1.Proposed System

III. SYSTEM ARCHITECTURE

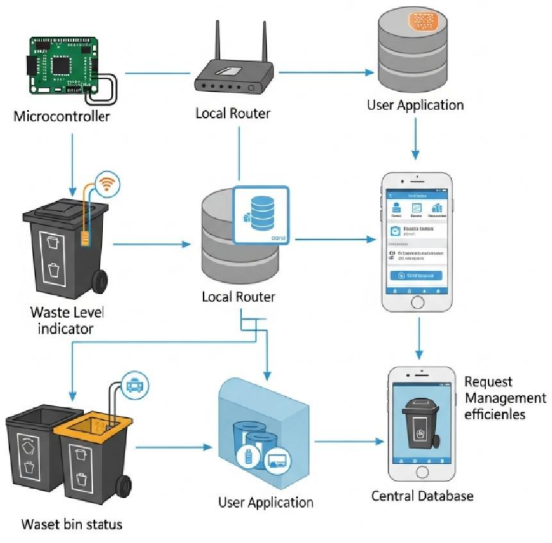

Fig. 2. System Design

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The system is composed of following components:

The Dustbin:

A standard trash bin made from plastic or metal can hold all its components. This includes the mechanical shredder located at the top and the load sensing plate positioned in the middle. All the IoT devices will be placed at the bottom.

Sensors:

The sensing unit will primarily be composed of two kinds of sensors: the load sensor and the infrared sensor. The load sensor measures the weight of the waste deposited into the dustbin and is mounted on the underside of the load-sensing plate. The IR sensor detects the downward movement of trash when the load-sensing plate is pulled out and the waste falls into the bin.

Wi-Fi Network:

It includes the router, which gives the user access to the internet so they can dispose of their trash in bin.

Microcontroller:

The Arduino will serve as the embedded system's processing unit at the bins. It will be utilized for information transmission and sensor control.

IR Sensor:

An infrared sensor is an advanced electronic device that senses the presence, movement, or thermal signature of objects nearby by either emitting or detecting infrared radiation. IoT systems frequently use these sensors for object tracking, motion detection, and proximity sensing.

Range of Operating Voltages 3.6–5 VDC
Average Current Usage (mA) 0.06
Distance Measuring Range 2 ~ 30 cm
Detection Angle 35 Â°

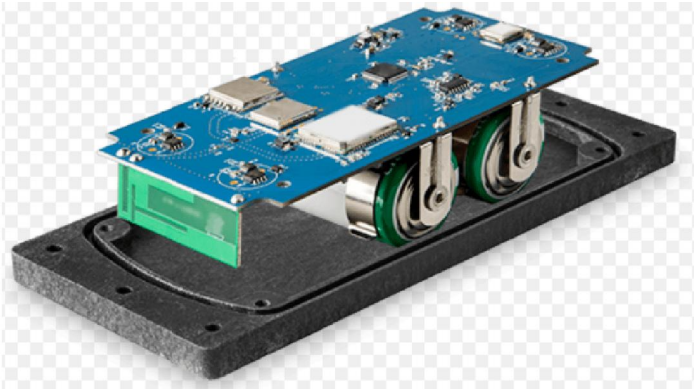

Fig. 3. IR Sensor

Load Cell:

The weight of the shredded waste gathered on the sensing plate is determined by the load cell, a force measurement tool. It uses strain gauge technology to function. Processing requires amplification of this signal, which is proportional to the applied weight.

Product Name: Load Cell
Maximum Load Capacity: 10Kg /22lb
Rated Output: 1+/-0.15mV/V
Recommend Excitation Voltage: DC 5V; Max Excitation Voltage: DC 10V

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Type: Strain Gauge-based

Fig.4. Load Cell

Power supply:

The power supply provides electricity to run the microcontroller, shredder, and router.It keeps the system working smoothly.

Shredder:

Mechanical Horizontal Two-Shaft Shredder machine helps reduce the size of different materials. It has steel blades, a loading box, a box bracket, and a power system.

Specifications:

Voltage: 200-300V
Power: 4-15 kW
Capacity: 80-800

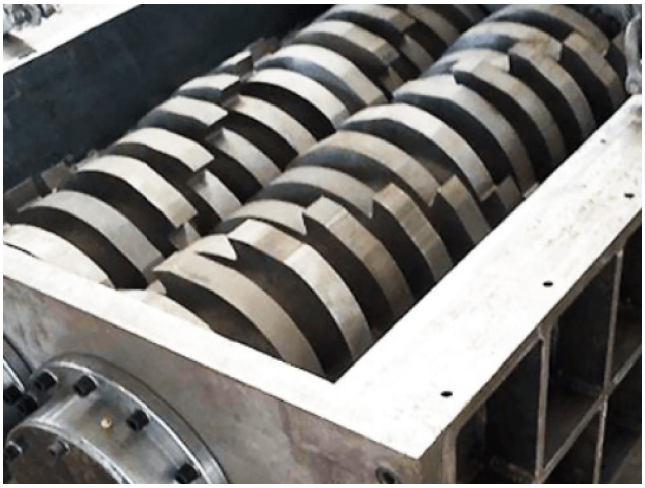

Fig. 5. Mechanical Shredder

Load Sensing Plate:

This plate is designed to fit the dustbin's size and can be made of plastic, wood, or metal.

Features:
Material: Plastic, wood, or metal
Sensor: Measures the weight of dumped waste

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Holes: Allow sand, soil, and mud to pass through, preventing their weight from being counted and reducing the plate's overall weight.
Placement: Installed at 1/4th of the dustbin's height from the top.

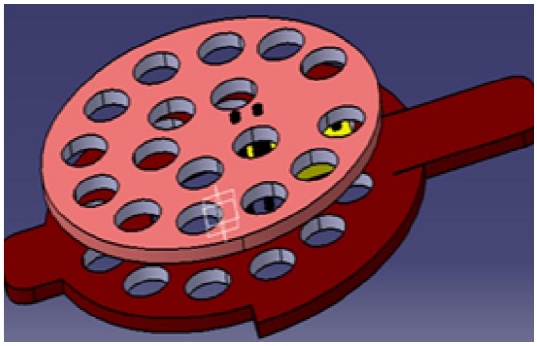

Fig. 6. Load Sensing Plate

HX711 Amplifier:
The HX711 is a high-precision, 24-bit analog-to-digital converter (ADC) designed for weight measurement applications using load cells.
Specifications:
Differential Input Voltage: +/-40mV (supports full-scale input)
Operating Voltage: 2.7V to 5V DC
Current Consumption: Less than 10mA

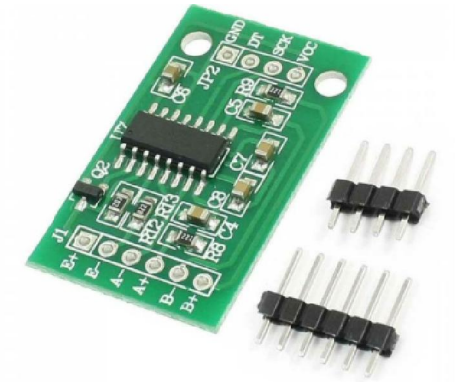

Fig. 7.HX711 Amplifier

IV. EASE OF USE

Waste disposal is made easy and hassle-free with the Smart Netbin.
1. Just Drop & Go: Simply place waste in the bin, and it will handle the rest, including weighing, shredding, and controlling internet access.
2. LCD Display: When the bin is full, the LCD display provides the Wi-Fi password and clear instructions.
3. Auto Detection: No buttons or apps are required; sensors identify waste and initiate the process.
4. Self-Resetting: The system resets itself after every use, ready for the next user.
5. Free Wi-Fi Bonus: Promotes appropriate waste disposal by providing internet access.
6. Low Maintenance: Simple and robust parts require little care.
7. Simple Repairs: It's simple to replace parts like the shredder and sensors.

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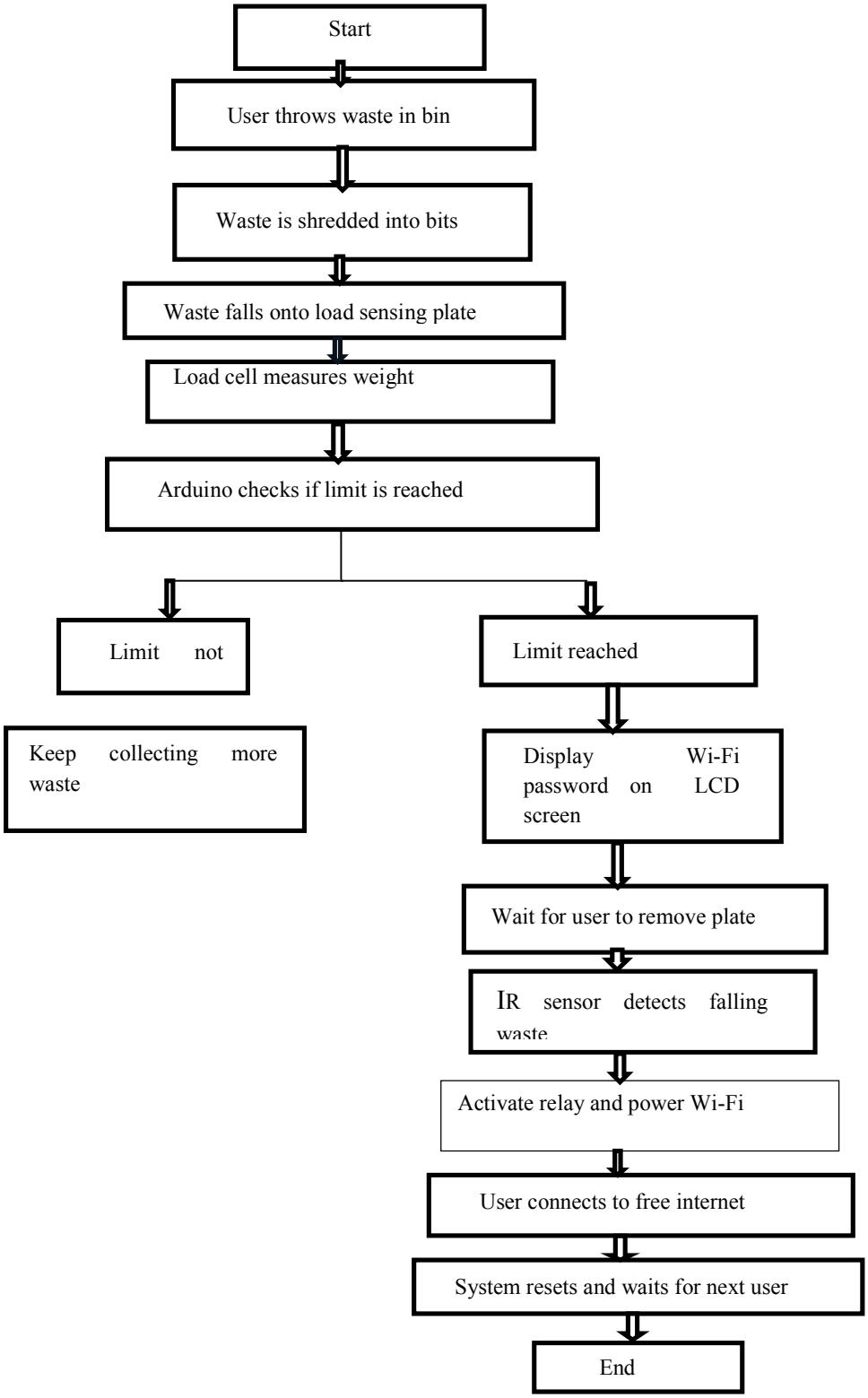
V. METHODOLOGY



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VI. FUTURE WORK

With some significant improvements, the Smart Netbin can enhance urban waste management. Automatic waste separation is made possible by gas and moisture sensors, and a smartphone app notifies users of bin status and offers incentives for correct disposal. Sustainability is guaranteed by solar-powered components, and waste collection is optimized by AI-driven analytics. Authorities are alerted by GPS (Global Positioning System) and GSM (Global System for Mobile Communication) when bins are full or not working properly. Multilingual support and voice commands improve accessibility, which makes the system more intelligent, environmentally friendly, and effective.

VII. CONCLUSION

Particularly in urban areas, improper waste disposal continues to pose a serious risk to environmental sustainability and public health. The Smart Netbin system combines digital incentives with waste management in a novel IoT-powered solution. In addition to promoting cleanliness, it also encourages civic engagement by promoting responsible disposal through free internet access. The system effectively monitors waste levels, automates monitoring, and guarantees prompt intervention thanks to its sensors, microcontrollers, and connectivity features. This technology has the potential to revolutionize urban waste management on a large scale, improving public hygiene, cutting pollution, and opening the door to smarter, cleaner, and more sustainable cities.

REFERENCES

[1] S. P. Jain, T. Chaudhary, and S. Gajjar, "Design and Development of Smart Waste Management System," 2023 International Conference on Communication System, Computing and IT Applications (CSCITA), Mumbai, India, 2023, pp. 199-203, 10.1109/CSCITA55725.2023.10104960.

[2] P. Suresh, Vijay. Daniel, R.H. Aswathy, Dr. V. Parthasarathy, “A State-of-the-Art review on Internet of Things” International Conference on Science Engineering and Management Research (ICSEMR), IEEE, DOI: 10.1109/ICSEMR.2014.7043637 19 February 2015.

[3] M. Arebey, M. Hannan, H. Basri, and H. Abdullah, "Solid waste monitoring and management using RFID, GIS and GSM", The IEEE Student Conference on Research and Development (SCOReD), 16-18 November 2009, UPM Serdang, Malaysia, 2009 .

[4] S. Longhi, D. Marzioni, E. Alidori, G. Di Buo, M. Prist, M. Grisostomi, et al., "Solid Waste Management Architecture Using Wireless Sensor Network Technology", The 5th International Conference on New Technologies, Mobility and Security (NTMS), 7-10 May 2012, Istanbul, pp. 1-5, 2012. 147.

[5] Parkash, Prabu V “IoT Based Waste Management for Smart City” International Journal of Innovative Research in Computer and Communication Engineering, Vol. 4, Issue 2, DOI: 10.15680/IJIRCCE.2016. 0402029, February 2016.

[6] R. K. Singhvi et al., "IoT-Based Smart Waste Management System: India Prospective," 2019 4th International Conference on Internet of Things: Smart Innovation and Usages (IoT-SIU), Ghaziabad, India, 2019, pp. 1-6, doi: 10.1109/IoT-SIU.2019.8777698.

[7] G. K. Shyam, S. S. Manvi, and P. Bharti, "Smart Waste Management Using Internet-of-Things (IoT)," 2017 2nd International Conference on Computing and Communications Technologies (ICCCT), Chennai, India, 2017, pp. 10.1109/ICCCT2.2017.7972276.

[8] T. Nam and T. A. Pardo, "Smart City as Urban Innovation: Focusing on Management, Policy, and Context," 5th International Conference on Theory and Practice of Electronic Governance (ICEGOV), Tallinn, Estonia, 2011, pp. 185-194.

[9] C. L. Popa, R. Ionel, and I. Silea, “Deep learning for waste classification in smart recycling systems,” IEEE Trans. Ind. Informat., vol. 16, no. 8, pp. 5234–5242, Aug. 2020.

[10]S. Khan, A. Lightwala, N. Naik, and S. Khan, “Smart waste management system using IoT,” Int. J. Adv. Eng. Res. Sci., vol. 4, no. 4, pp. 123–128, Apr. 2017.