JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

ECO – BIN: INTELLIGENT FOOD WASTE MANAGEMENT SYSTEM.

Dr. Punith Kumar M B, Kempegowda S P, Mahantesh P, Shashank Swaroop G, Surya Kashyap K P
Department of Electronics and Communication Engineering
PES College of Engineering, Mandya, INDIA

Abstract: ***The Eco-bin project addresses food waste management and resource scarcity through IoT- enabled smart bins and a food redistribution platform. Key features include real time waste tracking, food donation facilitation, and incentives for community participation. It integrates IoT sensors, cameras, and machine learning for food recognition and categorization, with a cloud-based dashboard for monitoring. Additional features involve converting waste to bioenergy, reducing landfill impact, and enabling sustainable practices. The system fosters environmental sustainability and social equity by ensuring efficient food utilization, minimizing waste, and promoting a circular economy, while also engaging communities through user-friendly platform send reward mechanisms.***

I. INTRODUCTION

The rapid urbanization and rising demand for resources make effective waste management essential, particularly in addressing food waste and resource scarcity. The "Eco-bin: Intelligent Food Waste Management System" tackles this issue by redistributing surplus food to those in need, including individuals, NGOs, and community kitchens, ensuring that nutritious food reaches those who need. At its core, the system utilizes IoT- enabled smart bins to track and gather data in real time, allowing for optimized collection and more efficient waste handling. This data-driven approach provides critical insights into waste patterns, enabling proactive waste management that supports environmental sustainability. The project includes a platform for clothes collection and distribution, allowing community members to donate wearable items, which are then redistributed to underprivileged communities such as orphans, old age homes, needy people thereby reducing textile waste and meeting essential needs. To foster community involvement, participants earn rewards for their waste reduction and donation activities, building a sense of shared responsibility and strengthening community connections. As a secondary goal, the project explores converting unavoidable food waste into bio energy or organic manure, promoting a circular economy that reduces landfill waste and contributes to renewable resources. This multi-faceted system exemplifies how electronic and communication engineering can drive sustainability and social impact, addressing the pressing environmental, social, and economic challenges of waste management in an impact and practical way.

Key Features of the Eco-bin: Intelligent Food Waste Management System.

[1] IoT-Enabled Smart Bins The system features IoT-enabled smart bins that facilitate real-time tracking and monitoring of waste. These bins assess their fullness levels and send automated notifications to waste collection teams when they need servicing. By utilizing sensors and data analytics, the smart bins provide insights into waste generation patterns, allowing for optimized route planning and resource allocation. This enhances operational efficiency, reduces costs, and minimizes carbon emissions associated with waste collection, enabling targeted waste reduction strategies.

[2] Food Redistribution Platform A core component of the system is the food redistribution platform,

which connects surplus food from restaurants, caterers, and households to individuals and organizations in need. This platform ensures that nutritious food reaches local community kitchens, food banks, and NGOs serving underprivileged populations. By facilitating these connections, the system alleviates hunger and fosters community solidarity. The user-friendly platform allows donors to easily list available food and recipients to request items, ensuring efficient and timely distribution.

[3] Food Waste-to-Bioenergy Conversion (Secondary Feature) The system also explores converting unavoidable food waste into bioenergy, such as biogas, or repurposing it as organic manure. This secondary feature promotes a circular economy, transforming waste into renewable energy for cooking or heating and nutrient-rich fertilizer for agriculture. By diverting waste from landfills, this approach reduces greenhouse gas emissions and supports sustainability, high- lighting the project's commitment to environmental stewardship.

[4] Environmental and Social Impact Overall, the "Eco-bin: Intelligent Food Waste Management System" adopts a comprehensive approach to address waste management, food insecurity, and resource scarcity. By integrating technology with community engagement and sustainability initiatives, the system tackles both environmental and social challenges. It cultivates a collaborative environment where community members actively participate in reducing waste and supporting one another, contributing to a healthier environment and a more equitable society.

II. RELATED WORK

[1] Food waste management using modern technology and resources. An article by Madiha Saba in July 2022.

The paper represents the website to reduce food wastage by providing that to those who are in need. In today's world people are wasting more food than consuming, which is a huge problem. India ranks 2nd in food waste, about 68.8 million tons of food is wasted per year. This proposal is to overcome the food wastage problem. It will work as requested and respond from Restaurants and NGOs. The quantity and lifetime of the food should be mentioned by the restaurants. NGOs should collect the leftovers from Restaurants before the lifetime of food and distribute them among those in need. And the restaurants can post the food donated details.

[2] Food Waste Management System An article by Dr. D. Kavitha, D. Srilatha, M. Gayathri and G. Amrutha. Publication date: November 2022

A large amount of food has been thrown out by restaurants and function halls. This food can be distributed to the people in need through NGOs. The existing systems are not aware of collecting that food and distributing it to needy people. It is the best way to deliver food to those who are starving for food.

[3] Solid Waste Collection as a Service using IoT- Solution for Smart Cities" is authored by Sangita S. Chaudhari and Varsha Y. Bhole from the Department of Information Technology at A. C. Patil College of Engineering, Navi Mumbai, India

The paper presents an IoT-based solution to tackle the growing issue of solid waste management in urban areas. As solid waste generation increases with population growth and urbanization, current waste collection systems face significant inefficiencies, especially in the context of smart cities. The proposed system equips garbage bins with ultrasonic sensors to monitor waste levels and GPS modules for location tracking. This real-time data is transmitted to a cloud-based platform, al- lowing municipal authorities and waste collection drivers to access the status of bins through a mobile application. The system optimizes waste collection by dynamically scheduling routes for trucks based on real-time bin statuses, reducing fuel consumption and improving efficiency. The solution was successfully implemented and tested, leading to better resource management, cost reduction, and time savings. Additionally, the paper suggests future enhancements such as smell sensors and solar- powered modules to further improve the sustainability and effectiveness of the waste management system.

[4] Fady E. F. Samann's paper titled "The Design and Implementation of Smart Trash Bin," published in 2017.

This paper highlights that the system successfully presents a cost-effective, user- friendly smart waste container suitable for small-scale applications, such as university campus or small parks. Unlike previous works that utilized the Internet of Things (IoT), this solution sends SMS alerts without requiring internet connectivity, significantly reducing costs. Tests showed that the system performed well, particularly in terms of power efficiency due to the use of a solar panel. How- ever, there are opportunities for improvement, such as replacing the GSM module with a Wi-Fi module to further decrease costs and

eliminate mobile network fees. Additionally, some challenges were noted, including the power bank's automatic shutdown and the PIR sensor's sensitivity under sunlight, indicating areas for future refinement.

[5] Youthika Chauhan's paper titled "Food Waste Management with Technological Platforms: Evidence from Indian Food Supply Chains," published on October 2, 2020,

The paper "Food Waste Management with Technological Platforms: Evidence from Indian Food Supply Chains" highlights that technological platforms play a significant role in reducing food wastage in supply chains. The study shows that automated systems like Programmable Logic Controllers (PLCs), Enterprise Resource Planning (ERP), and Machine-to-Machine (M2M) communication improve operational efficiency, visibility, and process control, leading to reduced wastage. While technological platforms generally help prevent food wastage, the results also revealed that in certain cases, manual processes or innovative approaches, such as converting waste into by- products, also contribute to reducing food loss. The paper emphasizes that food supply chains, especially in developing economies like India, can benefit from technological integration, which has policy implications for improving food security and addressing hunger.

[6] Haque, Khandaker Foysal, et al. "An IoT Based Efficient Waste Collection System with Smart Bins." 2020 IEEE 6th World Forum on Internet of Things (WF- IoT), IEEE, 2020.

The IoT-based waste collection system with smart bins proposed in this paper efficiently monitors waste levels, VOC levels, temperature, and humidity in real time. The system enables optimized waste collection by determining which bins need to be emptied, reducing unnecessary collections. Additionally, the use of an optimized navigation system significantly reduces travel distances, thereby lowering fuel consumption and operational costs. This approach enhances the overall efficiency of waste collection while minimizing human labor and resource use, making it a highly effective solution for smart city waste management.

III. PROPOSED WORK

a) Methodology:

The proposed system utilizes the Raspberry Pi 4B (2GB) as the central processing unit, orchestrating the operation of various connected modules and sensors. Upon initialization, the Raspberry Pi loads the necessary software stack—including Python scripts, machine learning models, and network configurations—from a 32GB SanDisk MicroSD card. A stable 5V/3A power supply ensures uninterrupted system functionality. Users, acting as donors, interact with the system via a push button, which activates the camera after they deposit food waste into the bin. A Load Cell integrated with an HX711 ADC module captures the weight of the deposited food in real-time and transmits the data to the Raspberry Pi. Simultaneously, the Raspberry Pi V2 Camera Module captures an image of the food waste, which is then processed using the Gemini 1.5-flash AI model. This model classifies the type of food and assesses its suitability for redistribution. The resulting classification, along with weight and location details, is transmitted over Wi-Fi to a web-based dashboard. This dashboard provides real-time updates on bin status, food availability, and donor contributions. Furthermore, the system supports dynamic tracking and management of food donations, continuously updating the data to facilitate efficient redistribution and timely notifications to associated NGOs.

b) System design approach:

Fig 1: Block diagram.

c) Proposed workflow:

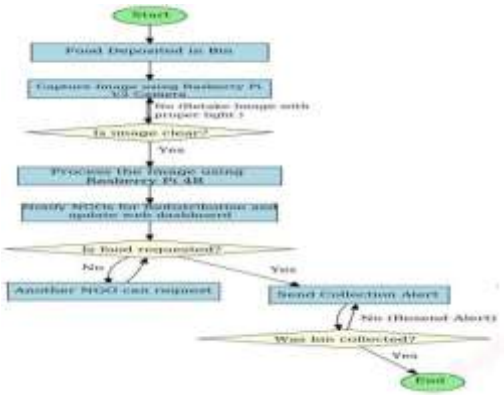

Fig 2: Flow chart.

IV. RESULT

The food waste management system integrates both hardware and software components to create an efficient, user-friendly platform aimed at encouraging responsible food disposal and redistribution. The hardware setup features a Raspberry Pi 4B connected to a breadboard, incorporating a Raspberry Pi Camera Module V2 and a push button. A red jumper wire links the GPIO pins of the Raspberry Pi to the breadboard, enabling basic input-output operations such as triggering image capture upon button press. The camera is integrated into a smart bin to automatically capture images of the deposited food waste. These images are then analyzed using the Gemini 1.5 Flash AI model to classify the type of food and assess its suitability for redistribution. On the software side, the web application offers a clean and intuitive interface with key sections including Home, Report Waste, Collect Waste, and Rewards. Users can report food waste, manage collection tasks from hotels and restaurants, and track their participation through a point-based reward system. For example, collection entries from institutions like PES College of Engineering and Vijayaram Nagar Campus include food type, quantity, location, timestamp, and verified status. The Rewards section transparently displays the user's point balance and recent transactions, supporting gamified engagement. Altogether, the system fosters community-driven sustainability by combining real-time hardware interaction, intelligent food classification, and an engaging digital platform.

Fig 3. User dashboard

Fig 4. Food collection interface

Fig 5: Hardware implementation.

V. CONCLUSION AND FUTURE SCOPE

The Eco-bin: Intelligent Food Waste Management System provides a smart and practical solution to reduce food waste and support people in need. By using IoT-enabled smart bins the system tracks food waste in real time and helps waste collection teams work more efficiently. It also includes a food redistribution platform that connects extra food from homes, restaurants, and events to nearby NGOs, community kitchens, and hungry individuals. This helps reduce food waste while feeding those who lack regular meals. The system also turns leftover, non-edible food into bioenergy or natural fertilizer, which helps protect the environment and supports farming. People who take part in food donation and waste reduction activities can earn rewards, which encourages more community involvement.

In the future, the project can be expanded with advanced AI models for more accurate food classification, integration of GPS-enabled logistics for real-time NGO coordination, mobile app interfaces for broader accessibility, and blockchain for transparent tracking of food redistribution. The system can also scale across urban and rural areas, creating a robust, data-driven network for sustainable food waste management and equitable food distribution, empowering smart cities, promoting circular economy practices, and fostering long-term community-driven environmental and social impact.

VI. ACKNOWLEDGEMENT

We gratefully acknowledge the assistance and facilities provided by the Project Lab Department of ECE, PESCE, Mandya during the project work leading to this publication. The use of Raspberry pi kits, Software tools, communication trainer kits, enabled us to complete the project work.

VII. REFERENCE

[1] Ali, Tariq, et al. "IoT-based smart waste bin monitoring and municipal solid waste management system for smart cities." Arabian Journal for Science and Engineering 45 (2020).

[2] Sreejith, S., et al. "Smart bin for waste management system." 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS). IEEE, 2019.

[3] Mithinti, Shashank, et al. "IoT Based Smart Bin for Smart City Application." 2019 International Conference on Intelligent Computing and Control Systems (ICCS). IEEE, 2019.

[4] Noiki, Ayodeji, et al. "Smart waste bin system: a review." IOP Conference Series: Earth and Environmental Science. Vol. 655. No. 1. IOP Publishing, 2021.

[5] Yusof, N. Mohd, M. Faizal Zulkifli, M. Yusof, and A. Afififie Azman. "Smart waste bin with real-time monitoring system." International Journal of Engineering & Technology 7, no. 2.29 (2018): 725-729.

[6] Ravi, V. R., et al. "Smart bins for garbage monitoring in smart cities using IoT system." IOP Conference Series: Materials Science and Engineering. Vol. 1055. No. 1. IOP Publishing, 2021.

[7] Manikandababu, C. S., et al. "Webpage Portal for Crowd Sourcing on Food Waste Management." Sentimental Analysis and Deep Learning: Proceedings of ICSADL 2021. Springer Singapore, 2022.

[8] Gayathri, N., et al. "IOT based smart waste management system." 2021 7th inter- national conference on advanced Computing and communication systems (ICACCS). Vol.1. IEEE, 2021.