SMART DUSTBIN WITH FOOD DETECTION FOR WASTE REDUCTION

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Abstract: *In large events like weddings, itˆ as common to see guests leaving uneaten food on their plates. This leads to a lot of food waste, which is an ongoing concern for event organizers and environmental advocates. To tackle this issue, we are proposing a "smart dustbin system" that helps reduce food waste by detecting significant food leftovers on plates before they are thrown away. Here as how it works the smart dustbin is equipped with a real-time camera and uses image processing technology to monitor the contents of plates as they approach the bin. When someone tries to dispose of their plate, the system scans it and evaluates whether there is a substantial amount of food left on it. If there is, the dustbin will temporarily stay closed, prompting the person to reconsider discarding that much food. This way, guests are encouraged to be more mindful about what they throw away, and event staff can also track the amount of leftover food more easily. By preventing food from being discarded irresponsibly, this smart dustbin helps reduce waste and promote more sustainable practices at large events*.

Keyword: *Smart Dustbin System, Food Waste Reduction, Event Sustainability, Image Processing Technology, Real-time Food Detection, Sustainable Event Planning, Leftover Food Detection*

I.INTRODUCTION

This project aims to tackle food waste at large events by implementing an AI-powered smart dustbin system equipped with real-time camera technology and sensors. The system's primary function is to monitor the amount of food left on plates before it reaches the disposal stage. When a user approaches the bin, a camera captures an image of the plate and uses machine learning algorithms to analyze the quantity and type of food present.

If the system detects a significant amount of uneaten food, it prevents the bin from opening and displays a friendly reminder, encouraging guests to be mindful about wasting food. Guests are provided with options to either take the plate back to consume more or place the leftovers in a designated section for redistribution or composting, if available.

The bin's functionality extends beyond individual awareness. It collects data on the volume and type of food waste generated, enabling event organizers to track waste patterns and gain insights into consumption habits. This data is invaluable for planning future events, allowing organizers to adjust food quantities, menu items, and serving sizes to better match attendees' preferences and reduce waste. Additionally, the smart dustbin system can integrate with a mobile or web-based dashboard, giving organizers real-time access to waste metrics. The dashboard can generate detailed reports, including graphs showing peak waste times, most discarded food types, and overall event waste, facilitating data-driven decision-making.

II.LITERATURE SURVEY

1. M. D. Chavhan, V. N. Thakare, "smart Dustbin Management System Using IoT and Image Processing," [1] 2021 - This study explores a smart waste management system using image processing to detect waste types and assess waste levels in bins. It leverages IoT to monitor bin status and notifies disposal units, aiming to enhance waste management and reduce overflow issues.

2. R. S. Gade, S. D. Bhide, "Food Waste Management and Control System Using IoT and Image Processing," [2] 2020 ˆa This research presents a food waste control system that uses IoT and image processing to detect food leftovers. The system sends notifications when significant food waste is detected, helping reduce food waste in cafeterias and large gatherings by promoting more responsible disposal.

3. S. A. Sharma, M. T. Meena, "AI-Based Food Waste Detection System for Events and Gatherings," [3] 2019 - This paper discusses an AI-driven model for detecting food waste at large events. Using machine learning algorithms, it identifies and categorizes leftover food on plates to monitor waste trends and improve awareness among attendees.

4. J. Kim, H. Park, "Smart Bin System for Sustainable Food Waste Management Using Computer Vision," [4] 2022 - This study proposes a smart bin system that uses computer vision to analyze food leftovers and determine the amount of waste on plates. The system encourages users to reduce waste by temporarily restricting bin access when significant food waste is detected.

5. L. S. Wong, D. Y. Chan, "Real-Time Waste Monitoring System Using Edge Computing and Image Analysis," [5] 2021 - This research introduces a real-time waste monitoring system that uses edge computing and image analysis to evaluate food waste at events. It processes images of plate waste and calculates the remaining food volume, aiming to improve awareness and reduce waste generation.

6. A. B. Jadhav, N. V. Naik, "Automated Food Waste Detection and Prevention System for Social Gatherings," [6] 2022 -This paper details an automated system to detect and prevent food waste at social gatherings. Utilizing image recognition and AI, the system scans plates as they approach the bin, discouraging users from discarding large amounts of uneaten food by alerting them of potential waste.

III.METHODOLOGY

- Requirement Analysis and Feasibility Study: Identify and assess the feasibility of all system requirements to meet user and operational needs.
- System Design and Architecture: Develop a design and architecture that integrate hardware and software components for seamless operation.
- Image Processing and Machine Learning Model Development: Build and optimize a machine learning model to accurately detect food leftovers in real time.
- Hardware Integration and Prototyping: Assemble hardware components and create a prototype to test functionality and integration.
- Software Development: Develop the software for image processing, user interface, and data tracking for effective system performance.

IV.OBJECTIVE

- Requirement Analysis and Feasibility Study: To thoroughly understand user requirements and assess the technical, economic, and operational feasibility to ensure project viability and alignment with user expectations.
- System Design and Architecture: To create a comprehensive and scalable design that integrates hardware and software components effectively, ensuring reliable performance and easy maintenance .
- Image Processing and Machine Learning Model Development: To develop an accurate and efficient image processing model that can detect significant food waste on plates in real time, optimizing for high accuracy and fast response times.
- Hardware Integration and Prototyping: To assemble and test all hardware components within a functional prototype, ensuring that each element (camera, sensors, locking mechanism) works cohesively as a system.
- Software Development: To develop software that accurately processes images, tracks data, and provides user prompts, ensuring ease of use and high functionality in waste management.

V.PROBLEM DEFINATIONS

At large events, such as weddings and corporate gatherings, significant amounts of food waste are generated due to uneaten food left on guests' plates. This not only leads to higher waste management costs but also has adverse environmental impacts by contributing to landfill waste and greenhouse gas emissions. Traditional waste bins are unable to encourage responsible disposal, and event organizers lack effective tools for monitoring and minimizing food waste. The goal is to develop a **smart dustbin system** that leverages real-time image processing and machine learning to detect significant food leftovers on plates, prompting guests to reconsider discarding uneaten food. By encouraging mindful disposal and providing waste data insights to event organizers, the system aims to reduce food waste, support sustainable event practices, and foster environmental responsibility. This solution also needs to be reliable, easy to use, and scalable to accommodate various event sizes and types.

VI.FLOWCHART

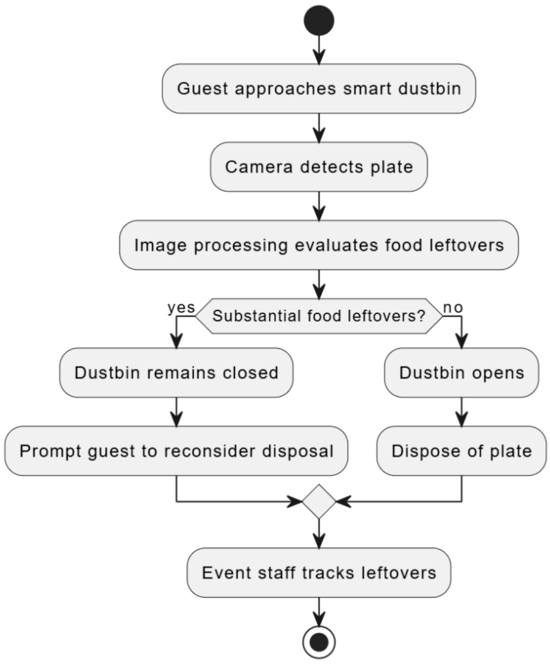

Fig: Flow chart

VII. PROPOSED METHODOLOGY

1. Data Collection and Image Processing

Image Dataset Collection: Collect images of plates with varying amounts of food waste to create a diverse dataset. This dataset should include images from different environments, lighting conditions, and plate types to enhance model robustness.

Data Preprocessing: Normalize and resize images to a fixed dimension for consistency. Use data augmentation techniques, such as rotation and brightness adjustment, to increase model robustness against variations.

2. Food Waste Detection Using Machine Learning

Convolutional Neural Network (CNN) Model: Use a CNN to classify images based on the percentage of leftover food on the plate. Train the CNN on annotated images with labels indicating the percentage of food waste.[1]

Threshold Detection: Define a threshold (e.g., 5-10% food waste) to determine when the bin should remain closed. The model should output an estimate of the percentage of food left on the plate. If the estimated waste is above the threshold, the system prevents the dustbin from opening, encouraging users to reconsider discarding the food.

3. Automated Bin Control System

Servo Motor Control: Attach a servo motor to control the opening and closing of the dustbin lid. The CNN output (above or below threshold) controls the servo motor’s state, automatically locking or unlocking the bin based on waste detection.

Raspberry Pi Integration: Use a microcontroller (Arduino or Raspberry Pi) to interface with the camera and servo motor. The microcontroller will execute the open/close command based on the CNN’s decision.[3]

4. Waste Data Monitoring (Optional)

Data Logging: Log information such as the time of disposal, estimated percentage of waste, and user actions.

This data can help event organizers understand waste patterns and improve portion sizes for future events.

IoT Integration: Use IoT technology to send data to a remote server for real-time monitoring and analysis. The data can be visualized through dashboards, allowing stakeholders to gain insights into waste reduction efforts.

5. System Testing and Evaluation

Model Evaluation: Assess the CNN's accuracy in detecting food waste through metrics like precision, recall, and F1-score.

Prototype Testing: Test the system at events to evaluate its performance in real-life scenarios. Gather user feedback to make improvements in functionality and usability.

Environmental Impact Analysis: Analyse the data collected to evaluate the system's impact on food waste reduction. Compare food waste data before and after implementing the smart dustbin to quantify its effectiveness.

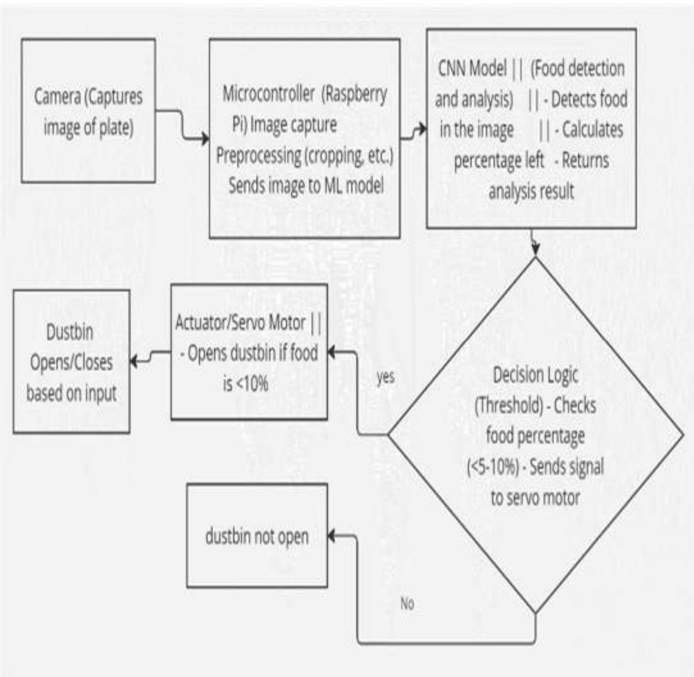

Fig: Proposed System Architecture

VIII.CONCLUSION

In conclusion, the smart dustbin system offers an innovative and impactful approach to tackling food waste at large events. By combining image processing, sensor technology, and machine learning, the system can detect uneaten food on plates and restrict access to the bin if a significant amount of waste is detected. This unique feature promotes mindful disposal and encourages guests to make thoughtful choices about their food consumption, fostering awareness of food waste's environmental impact.

The system benefits event organizers by providing comprehensive waste tracking data. This data-driven approach enables organizers to better understand waste patterns and make informed decisions in future planning, such as adjusting food quantities, improving catering strategies, and implementing more sustainable practices. The insights gained can also support eco-friendly certifications, which are increasingly valued in the events industry.

Moreover, this technology has broad applicability beyond events. It can be adapted for use in restaurants, food courts, public spaces, and workplaces where food waste is a concern. The potential integration with IoT platforms and mobile applications could allow for remote monitoring and real-time analytics, giving users greater flexibility in managing waste across multiple locations.

Despite these advantages, the system has limitations. The initial setup and maintenance costs can be high, and accuracy may vary depending on food types and plate arrangements. However, continuous advancements in image recognition and sensor technology promise to enhance performance and affordability over time.

IX.REFERENCES

(1) M. D. Chavhan and V. N. Thakare, "Smart Dustbin Management System Using IoT and Image Processing," Proc. of International Conference on Computer Science and Information Technology, 2021, pp. 345-350.

(2) R. S. Gade and S. D. Bhide, "Food Waste Management and Control System Using IoT and Image Processing," International Journal of Advanced Research in Computer Science, vol. 11, no. 6, pp. 89-95, 2020.

(3) S. A. Sharma and M. T. Meena, "AI-Based Food Waste Detection System for Events and Gatherings," Proceedings of the International Conference on Artificial Intelligence, 2019, pp. 110-115.

(4) J. Kim and H. Park, "Smart Bin System for Sustainable Food Waste Man Augment Using Computer Vision," Journal of Environmental Engineering Management, vol. 28, no. 3, pp. 233-240, 2022.

(5) L. S. Wong and D. Y. Chan, "Real-Time Waste Monitoring System Using Edge Computing and Image

Analysis," IEEE Access, vol. 9, pp. 657-664, 2021. DOI: 10.1109/ACCESS.2021.3083872.

(6) A. B. Jadhav and N. V. Naik, "Automated Food Waste Detection and Prevention System for Social Gatherings," Journal of Smart and Sustainable Technology, vol. 7, no. 1, pp. 50-55, 2022.