Introduction

•Because of more people and more cities, the world today has big problems with waste management.
•Two of the main reasons why traditional systems often fail are poor separation and low public participation.
•When you throw things away the wrong way, you get bad recycling, health risks, and pollution of the environment.
•Smart technologies like AI and IoT are being used to improve how garbage is handled these days.
•A Smart Dustbin is a creative way to automate sorting and throwing away trash.
•It uses sensors and AI (YOLO model) to sort trash into three groups: organic, paper, and plastic.
•The system encourages users by giving them UPI cashback or reward points for throwing things away correctly.
•This gamification encourages families and individuals to live in a way that is good for the environment.
•The idea supports programs like the Swachh Bharat Mission and smart city projects.

Review of literature

S.No	Author Name, Journal, Publication Year	Research/ Methodology	Performance Metrics	Advantages	Disadvantages
1.	Sharma et al., *IEEE Access*, 2022	YOLOv5-based waste classification using real-time camera input and sensor fusion	Accuracy (92%), Classification Speed	Fast detection, scalable model, adaptable to urban bins	Sensitive to lighting and image quality
2.	Li & Zhang, *Sensors*, 2021	IoT-enabled smart bins with fill-level monitoring and remote alerts	Sensor reliability, Data latency	Real-time monitoring, reduced overflow incidents	Requires stable network, sensor calibration issues
3.	Kumar et al., *Sustainable Cities and Society*, 2020	Incentive-based waste segregation using mobile app and QR code tracking	User engagement rate, Reward redemption	Encourages citizen participation, gamified experience	Risk of reward misuse, requires app literacy
4.	Al-Mashaqbeh et al., *Journal of Cleaner Production*, 2023	Integrated AI-IoT system for municipal waste analytics and predictive maintenance	Prediction accuracy, System uptime	Enables proactive bin servicing, data-driven decisions	High initial setup cost, complex integration with legacy systems

Observations from the Literature Review

1. AI helps with more accurate trash separation and identification.
2. IoT enables real-time monitoring and management of waste bins.
3. Providing rewards or points motivates people to properly dispose of their trash.
4. The Raspberry Pi and Arduino are among the parts that keep the system affordable.
5. Mobile apps make it simple for users to keep track of their environmentally friendly activities and rewards.

Limitations from the Literature Review

1. When used extensively, smart bins can be expensive.
2. Dirty or mixed waste may result in less accurate waste detection.
3. If rewards are too little or come too late, people might become disinterested.
4. For optimal operation, a steady power source and internet are required.
5. It is necessary to perform routine maintenance, which can be challenging in public areas.

Problem Statement / Scope of the Project

Problem Statement: Improper waste segregation in urban areas leads to inefficient recycling and environmental harm. To address this, we propose a Smart Waste Segregation System that uses sensor-enabled bins and AI to classify waste and assign reward points for correct disposal. This incentivizes responsible behavior, improves recycling efficiency, and supports data-driven municipal planning.

Proposed Methodology:

- **Hardware:** Smart dustbin with sensors, camera, Raspberry Pi/Arduino.
- **Software:** YOLOv5 AI for classification, IoT for real-time monitoring, UPI for rewards, mobile app for gamification.
- **Approach:** waste disposal → classify waste instantly → reward if correct disposal → collect real-time data → scale to smart cities.
- If the bin is full, alert collection teams.

Proposed Idea / Solution

- The smart dustbin uses IoT and AI to automatically detect and classify waste into plastic, paper, or organic.
- It has sensors and a camera with YOLOv5 AI model for accurate segregation.
- When a user disposes of waste correctly, they get UPI cashback or reward points credited to their account.
- The rewards are tracked through a mobile app, which also shows the user's eco-impact, reward history, and leaderboards.
- The system gamifies waste disposal, encouraging families and individuals to participate actively.
- This helps cities reduce littering, improve recycling rates, and support programs like Swachh Bharat Mission and Smart City projects.

Objectives of the Idea / Solution as Design Project

1. Build an AI-Enabled Smart Bin for Waste Segregation

Design and implement a dustbin that uses sensors and YOLOv5 image recognition to automatically identify and sort waste into plastic, paper, and organic or categories.

2. Deploy IoT for Real-Time Bin Monitoring

Integrate IoT sensors to track bin fill levels, waste types, and user interactions, enabling timely alerts and data collection for efficient waste management.

3. Launch a Reward System to Encourage Recycling

Develop a mobile app that assigns points to users for correct waste disposal, redeemable for incentives, to boost participation and promote sustainable habits.

Proposed Research / Methodology

- Study existing waste management systems to find gaps in segregation and recycling.
- Design a smart bin using sensors, camera, and microcontroller.
- Use AI to classify waste and actuators to sort it.
- Connect to IoT for real-time monitoring and user rewards via a mobile app.
- Test the system for accuracy, usability, and efficiency in different environments.
- Aim for a hygienic, automated, and scalable solution that encourages recycling.

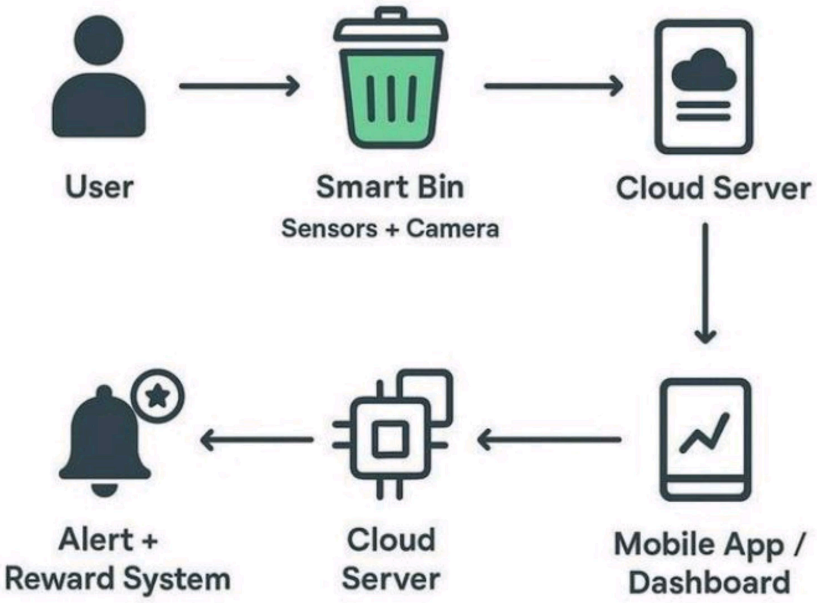
Hardware Requirements

1. **Microcontroller(ArduinoUNO/RaspberryPi):**
   Acts as the central control unit for managing sensors, collecting data, and transmitting it to the cloud.
2. **UltrasonicSensor:**
   Used to measure the distance from the bin lid to the waste surface, helping determine the fill level.
3. **MoistureSensor:**
   Detects the presence of wet or dry waste, assisting in classification.
4. **LoadCell(WeightSensor):**
   Measures the weight of waste deposited, preventing overflow and improving segregation efficiency.
5. **CameraModule:**
   Captures images of waste for AI-based classification using a trained model.
6. **Wi-FiorGSMModule:**
   Provides wireless connectivity for transmitting bin data and alerts to the central system.
7. **PowerSupplyUnit:**
   Ensures continuousoperationof the smart bin and sensors.
8. **LEDIndicatorsandBuzzer:**
   Provide visual and audio alerts to users and maintenance staff when bins are nearly full or malfunctioning.

Software Requirements

1. **Programming Languages:** Python, C/C++, and JavaScript for developing control logic, AI models, and web interfaces.
2. **Microcontroller IDEs:** Arduino IDE or Raspberry Pi OS for coding and uploading sensor control programs.
3. **Database Management:** MySQL or Firebase for storing sensor data, user rewards, and collection history.
4. **Cloud Platform:** Thingspeak, AWS IoT, or Google Cloud for real-time data monitoring and analytics.
5. **Web / MobileDevelopmentTools:** Flask, HTML, CSS, React, or Android Studio for building the user application.
6. **Machine Learning Frameworks:**
   TensorFlow or OpenCV for image-based waste classification.

Process / Flow / Design Diagram



Proposed Modules

Module 1: Waste Detection & Classification

- Uses sensors and camera input
- YOLOv5 AI model classifies waste into categories like plastic, paper, organic.

Module 2: Automated Segregation

- Actuators sort waste into correct compartments based on AI output
- Reduces manual handling and improves hygiene

Module 3: IoT Monitoring & Feedback

- Tracks bin fill levels, usage patterns, and waste type distribution
- Sends real-time alerts and updates to users and authorities

Module 4: Rewards & Data Management

- Mobile app rewards users for proper disposal with points or cashback
- Stores and analyzes data for municipal planning and system optimization

Novelty of the Proposed Idea / Project

•**AI-Powered Classification**: Uses YOLOv5 to identify and sort waste types with high accuracy.
•**Automated Segregation**: Actuators direct waste into correct compartments, removing manual effort.
•**IoT Monitoring**: Tracks bin status and usage remotely for smarter waste collection.
•**User Rewards**: Incentivizes responsible disposal through a point-based mobile app.
•**Sector Adaptability**: Customizable for homes, offices, hospitals, and public spaces.
•**Improved Hygiene**: Reduces human contact with waste, enhancing safety.

Conclusion

The proposed AI-powered Smart Dustbin system presents an innovative approach to tackling the growing issue of improper waste segregation in urban areas. By combining artificial intelligence, IoT, and automation, the system ensures efficient sorting of waste into plastic, paper, and organic categories, reducing human intervention and improving recycling accuracy. The integration of a reward-based mechanism through UPI cashback or points encourages citizens to adopt responsible waste disposal habits. This gamified approach not only promotes environmental awareness but also strengthens public participation in maintaining cleaner communities. Overall, the project demonstrates how technology-driven solutions can contribute to sustainable waste management, aligning with initiatives like the Swachh Bharat Mission and Smart City development for a greener, cleaner future.

References

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2. N. Singh and R. Kumar, “Design of IoT-based smart bins for waste monitoring and alert system, ” in Proceedings of the International Conference on Intelligent Sustainable Systems (ICISS), Coimbatore, India, 2019, pp. 258–263.

3. M. Sharma and P. Chauhan, “AI-enabled waste segregation for sustainable cities,” International Journal of Advanced Computer Science and Applications, vol. 11, no. 7, pp. 150–158, Jul. 2020.

4. K. Raj and S. Jha, “IoT-based garbage monitoring and alert system using ultrasonic sensors,” IEEE Access, vol. 9, pp. 11234–11240, Feb. 2021.

5. V. Gupta and T. Patel. (2022, March). “Integration of reward-based mechanisms in waste management systems.” Journal of Environmental Informatics [Online]. vol. 36, issue 4. Available: https://doi.org/10.1016/jei.2022.03.014

Partial Implementation

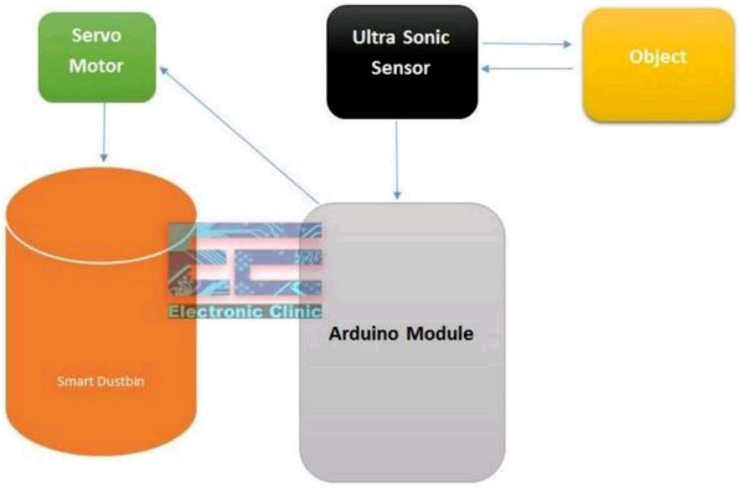
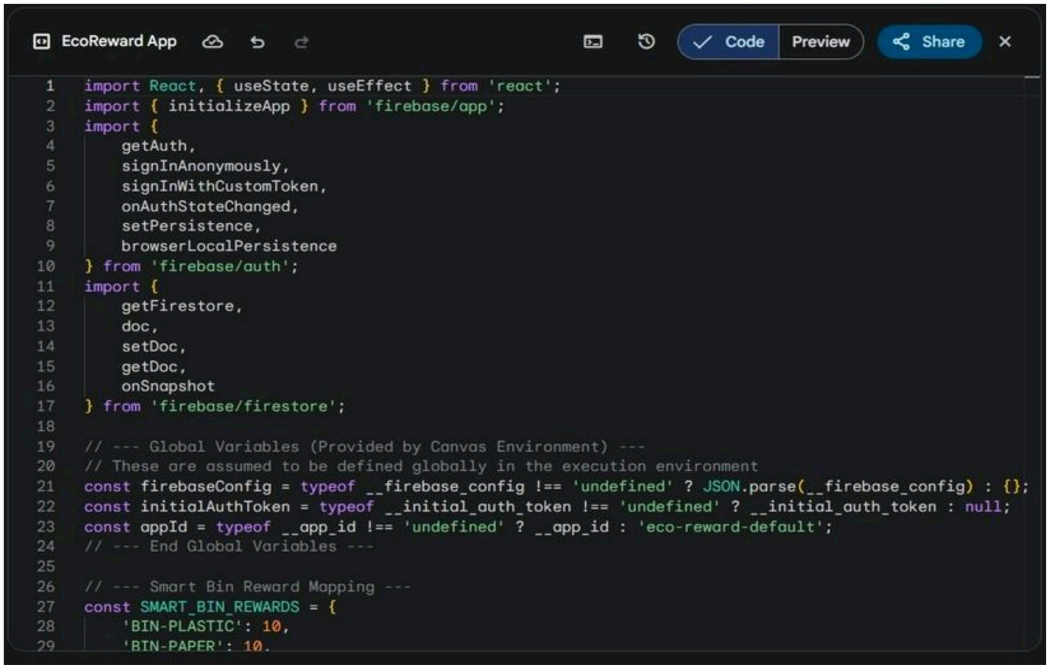
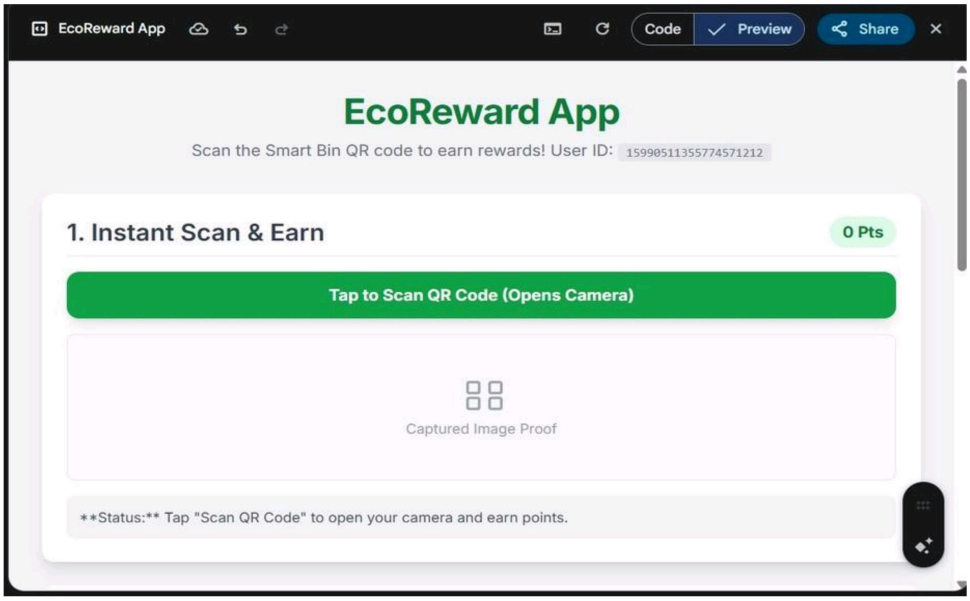


Fig. 1: Block diagram

Code:


EcoReward App
Code
Preview
Share
import React, { useState, useEffect } from 'react';
import { initializeApp } from 'firebase/app';
import {
getAuth,
signInAnonymously,
signInWithCustomToken,
onAuthStateChanged,
setPersistence,
browserLocalPersistence
} from 'firebase/auth';
import {
getFirestore,
doc,
setDoc,
getDoc,
onSnapshot
} from 'firebase/firestore';
// --- Global Variables (Provided by Canvas Environment) ---
// These are assumed to be defined globally in the execution environment
const firebaseConfig = typeof __firebase_config !== 'undefined' ? JSON.parse(__firebase_config) : {};
const initialAuthToken = typeof __initial_auth_token !== 'undefined' ? __initial_auth_token : null;
const appId = typeof __app_id !== 'undefined' ? __app_id : 'eco-reward-default';
// --- End Global Variables ---
// --- Smart Bin Reward Mapping ---
const SMART_BIN_REWARDS = {
'BIN-PLASTIC': 10,
'BIN-PAPER': 10,

Preview:


EcoReward App
Code
Preview
Share
EcoReward App
Scan the Smart Bin QR code to earn rewards! User ID: 15990511355774571212
1. Instant Scan & Earn
0 Pts
Tap to Scan QR Code (Opens Camera)
Captured Image Proof
Status: Tap "Scan QR Code" to open your camera and earn points.

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