NeatF1: An AI-Driven Civic Engagement Platform for Automated Garbage Detection, Reporting, and Gamified Community Cleanup

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***Abstract*—Urban waste accumulation poses serious threats to the environment and public health. Existing municipal reporting mechanisms suffer from delayed response cycles and low citizen participation rates. This paper presents NeatF1, a civic engagement website that leverages computer vision and artificial intelligence to automate the detection of accumulated garbage from user-submitted photographs. Upon successful detection, the system geo-tags the waste location and uploads it to a public feed where users can upvote, downvote, or report the post. Users can subsequently upload video proof of cleaning the garbage and earn points upon admin/moderator approval. Contributors receive 5 points for reporting and 50 points for approved cleanup videos. A public leaderboard displays top contributors along with their social handles. The platform is community-driven; gamification ensures active participation.**

***Index Terms*—citizen science; civic technology; computer vision; convolutional neural networks; environmental monitoring; gamification; garbage detection; smart city.**

I. INTRODUCTION

Due to rapid urbanization, waste generation has increased worldwide. Inadequate reporting of dumped or accumulated garbage persists due to inadequate reporting mechanisms. Traditional approaches rely on citizens calling helplines or filling web forms, which are slow and ineffective. Furthermore, the reports are not made public among citizens so that volunteers or social workers may contribute to cleaning the garbage. Due to the reports being private, accountability is also mitigated. The absence of feedback or recognition reduces civic motivation to report such issues.

Advances in computer vision make it feasible to automatically identify waste accumulation from photographs. Gamification has demonstrated effectiveness in increasing user engagement. This paper introduces NeatF1, a platform that combines AI-based garbage detection, automated geo-tagged reporting, a social-media-like feed, and a gamified leaderboard system.

II. RELATED WORK

A. AI-Based Waste Detection

Computer vision approaches to garbage and litter detection have evolved substantially over the past decade. Vo et al. [1] employed a YOLO-based object detection model trained on urban street imagery to classify litter categories with an mAP of 78.3%. Similarly, Misra et al. [2] demonstrated the use of a ResNet-50 backbone to distinguish organic, recyclable, and hazardous waste from single images captured under variable lighting conditions. These studies confirm the technical viability of automated waste detection but stop short of addressing the civic reporting pipeline.

The NeatF1 platform draws on these advances, employing a fine-tuned detection model integrated into a lightweight web API.

B. Civic Technology and Smart Cities

The app Swacchta is an official app of India which allows the user to click photos of civic issues like garbage dumps and report them to the authorities. However, the platform has two shortcomings: the absence of real-time AI verification, and the friction involved in the bureaucratic process. NeatF1 addresses both by automating detection and requiring visual proof for both reporting and cleanup verification, as

well as disclosing the issue to the public on a social media-style feed.

C. Gamification in Environmental Contexts

Gamification has been applied in many domains as a powerful psychological tool to leverage the psychology of people, especially youth, in order to inculcate good habits. In environmental contexts, studies by Hamari et al. [3] and Johnson et al. [4] found that leaderboards, points, and social visibility are the most effective motivators for sustained pro-environmental behaviour. Crucially, public recognition on the leaderboard was found to be a very strong motivating factor—in some cases even stronger than monetary incentives for voluntary civic action [4]. NeatF1's design reflects these findings by centering the leaderboard on public visibility and community acknowledgment rather than financial reward.

III. SYSTEM ARCHITECTURE AND METHODOLOGY

. Platform Overview

NeatF1 is a web application accessible through any device with an internet connection without requiring a native app installation. The system consists of the following core modules:

• Image Capture and Submission Module
• AI Detection Engine
• Geo-Tagging Module
• Feed (with upvote, downvote, and report functionality)
• Point and Leaderboard System
• Admin System

1. Image Capture and Submission Module

Users access the platform via a browser-based interface that allows the user to invoke the device camera using HTML5's camera-input feature. Upon capture, the image is sent to the Flask backend using the Fetch API as raw binary bytes.

2. AI Detection Engine

The detection engine employs a fine-tuned YOLOv8 model, custom-trained to detect accumulated garbage, hosted on a Python Flask server using the TFLite extension. The confidence score required to flag an image as a valid example of garbage accumulation is 60%.

3. Location Logging

Once the AI confirms the presence of accumulated garbage, the image is accurately geo-tagged using the browser's inbuilt navigator.geolocation.getCurrentPosition() function. The latitude and longitude of the location are previewed before the post is added to the Feed. Image data is also stored in a local JSON file.

4. The Feed

The feed is publicly visible to all users of the website and includes all verified posts. Each post consists of:

• Upvote button — allows positive engagement, increasing traction.
• Downvote button — allows negative engagement, reducing traction.
• Report button — allows users to flag potentially fraudulent posts.
• Clean button — allows users to upload a cleanup video to earn points upon moderator/admin verification.

5. Point and Leaderboard System

The point and leaderboard system creates a sense of drive among users to report and clean accumulated garbage. A user gains 5 points for successfully reporting garbage and 50 points for cleaning one. The top contributors are displayed on the publicly available Leaderboard page, which shows the username, Twitter handle, Instagram handle, and bio of each user.

6. Admin System

The admin has the privilege to delete posts and verify proof-of-cleaning videos submitted by users.

IV. GAMIFICATION AND INCENTIVE MODEL

A. Points and Verification Mechanism

The gamification layer is designed around three core principles drawn from self-determination theory [5]: competence (users develop and demonstrate civic skill), relatedness (shared community goals), and autonomy (voluntary participation). Points are awarded as follows: 5 points for a verified garbage report (AI confidence ≥ 0.60); 50 points for a verified cleanup submission. Cleanup verification requires the submitter to upload a short video which is manually verified by moderators and admins.

B. Leaderboard and Social Recognition

The public leaderboard ranks users by cumulative points. The leaderboard entry displays the user's display name, point total, and social media accounts.

Research supports the hypothesis that visible social recognition in leaderboards produces stronger sustained engagement than anonymous or private reward systems [4]. By making contributions publicly legible, NeatF1 creates reputational incentives that complement intrinsic environmental motivation.

V. LIMITATIONS AND FUTURE WORK

Several limitations of the current implementation merit discussion. First, the YOLOv8 model's performance degrades under challenging conditions such as nighttime imagery, heavy rain, or extreme camera angles. Furthermore, the backend could be made more scalable with a relational database such as PostgreSQL. A donation system could also be set up, where funds would go toward improving the AI model, the website, and providing monetary rewards for top leaderboard contributors.

VI. CONCLUSION

This paper has presented NeatF1, an AI-driven civic engagement platform that unifies automated garbage detection, geo-tagged reporting, social media dissemination, and gamified community cleanup into a single coherent system. The platform addresses key limitations of existing waste reporting mechanisms — namely high participation friction, slow response cycles, and absent feedback — by leveraging computer vision to remove the manual reporting burden and gamification to create compelling social incentives.

NeatF1 demonstrates that the convergence of AI, civic technology, and behavioural science can yield scalable, low-cost approaches to urban environmental management.

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