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Real-Time River Health Monitoring and Crowdsourced Solutions

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Abstract: Urban rivers in India, such as the Mula-Mutha in Pune, are increasingly burdened by surface-level garbage pollution due to rapid urbanization and inadequate waste management. Our project presents an integrated, technology-driven solution to address this issue through real-time monitoring, detection, and community-driven action. We employ the YOLOv8 deep learning model for object detection to identify and localize surface garbage in real-time images captured from the Mula-Mutha River. The model is trained on a custom dataset to ensure high accuracy in detecting floating waste. These insights are then used to trigger cleanup actions facilitated through a decentralized, blockchain-based crowdfunding platform. The platform allows local citizens to contribute funds transparently and securely, while NGOs, schools, and volunteers are invited to participate in scheduled cleanliness drives. Additionally, a dedicated website has been developed to share updates, event schedules, impact statistics, and encourage greater community participation. This project demonstrates the power of combining artificial intelligence, blockchain technology, and civic engagement to tackle urban environmental challenges in a scalable and transparent manner.

Keywords: YOLOv8, Surface Garbage Detection, Blockchain Crowdfunding, Real-time Image Processing, Environmental Monitoring, Community Cleanliness Drives.

I. INTRODUCTION

Urban rivers play a vital role in maintaining ecological balance, supporting biodiversity, and serving the daily needs of millions of people, particularly in growing metropolitan areas like Pune. However, in recent decades, the increasing levels of urbanization, industrial discharge, and human negligence have led to alarming levels of pollution in rivers such as the Mula-Mutha. One of the most visible and persistent forms of this pollution is surface garbage—floating waste like plastic bottles, food wrappers, bags, and other non-biodegradable materials that not only damage aquatic ecosystems but also pose serious public health risks. Conventional methods of monitoring and managing river cleanliness often rely on manual inspection or sporadic efforts by civic bodies and NGOs, which are neither scalable nor sustainable. This calls for a smarter, real-time, and community-inclusive solution that is both technologically advanced and socially empowering. In response to this challenge, our final year project proposes an end-to-end system that integrates real-time surface garbage detection with a decentralized crowdfunding mechanism to enable organized cleanliness efforts. At the heart of the system is the use of a mobile phone camera, chosen for its affordability, portability, and accessibility, to capture real-time images of the river's surface at various points. These images are then analyzed using YOLOv8 (You Only Look Once version 8), one of the most advanced deep learning models for object detection, capable of accurately identifying garbage items amidst complex natural backgrounds like water reflections, debris clusters, and lighting variations. By training YOLOv8 on a custom dataset of annotated river images, we ensured high detection accuracy and minimal false positives, making it suitable for live monitoring applications. However, detection alone does not solve the problem. To transform data into impact, we developed a blockchain-based crowdfunding platform where local citizens can contribute financially to support cleanup drives. Built using Ethereum-compatible smart contracts, the platform ensures transparent, tamper-proof, and traceable donations that directly fund cleanliness events. Contributors can view how and where their funds are being used, fostering a culture of trust, accountability, and civic ownership. The funds collected are then used to organize scheduled cleanup drives in collaboration with NGOs, schools, and volunteers, who act as the end users of the system. A dedicated website supports this ecosystem by displaying real-time detection results, upcoming drive schedules, and fund utilization reports, encouraging continuous community engagement. By combining mobile based data collection, AI-driven environmental monitoring, and blockchain-powered public funding, our project goes beyond traditional academic exercises. It demonstrates how modern technologies can be ethically and effectively applied to solve real-world problems. It bridges the gap between detection and action, data and decision-making, and individual contribution and collective good. The system is designed to be modular, scalable, and replicable—offering a blueprint for similar interventions in other polluted water bodies across the country. Ultimately, the project reflects a growing need for interdisciplinary, tech-driven environmental solutions and highlights the powerful role that youth-led innovation can play in shaping a cleaner and more responsible future.

II. LITERATURE REVIEW

1) *Geography of Crowdfunding By Ajay Agrawal, Christian Catalini, Avi Goldfarb*

Perhaps the most striking feature of "crowdfunding" is the broad geographic dispersion of investors. This contrasts with existing theories that predict entrepreneurs and investors will be co-located due to distance-sensitive costs. We examine a crowdfunding setting that connects artist-entrepreneurs with investors over the internet for financing early stage musical projects. The average distance between artists and investors is about 3,000 miles, suggesting a reduced role for spatial proximity. Still, distance does play a role. Within a single round of financing, local investors invest relatively early, and they appear less responsive to decisions by other investors. We show this geography effect is driven by investors who likely have a personal connection with the artist-entrepreneur ("family and friends"). Although the online platform seems to eliminate most distance-related economic frictions such as monitoring progress, providing input, and gathering information, it does not eliminate social-related frictions.

2) *Machine Learning Based Water Cleaning Boat using YOLO Algorithm By Dr. Kiran Agarwal Gupta, Impana Reddy, Varsha R Habbu, Nitin Sharma , Shivam Kumar*

Due to urbanization, solid waste littering is an increasing concern for lakes, possibly threatening human health, ecological integrity, and ecosystem services. Water body management in urban landscapes requires best management practices. To tackle this problem in an efficient way, we have developed a YOLOBOAT to detect, collect and segregate floating waste in water bodies in real time and make them garbage-free. It is a vision-based surveillance machine learning boat system that integrates raspberry pi and other sensors for real time debris monitoring and waste collection in relatively calm waters like lakes to replace manual cleaning of lakes. Model is trained on a custom dataset using YOLO v5 for object detection.

3) *Water Surface Garbage Detection Based on Lightweight YOLOv5 Luya Chen, Jianping Zhu*

With the development of deep learning technology, researchers are increasingly paying attention to how to efficiently salvage surface garbage. Since the 1980s, the development of plastic products and economic growth has led to the accumulation of a large amount of garbage in rivers. Due to the large amount of garbage and the high risk of surface operations, the efficiency of manual garbage retrieval will be greatly reduced. Among existing methods, using YOLO algorithm to detect target objects is the most popular. Compared to traditional detection algorithms, YOLO algorithm not only has higher accuracy, but also is more lightweight. This article presents a lightweight YOLOv5 water surface garbage detection algorithm suitable for deployment on unmanned ships. This article has been validated on the Orca dataset, experimental results showed that the detection speed of the improved YOLOv5 increased by 4.3%, mAP value reached 84.9%, precision reached 88.7%, the parameter quantity only accounts for 12% of the original data. Compared with the original algorithm, the improved algorithm not only has higher accuracy, but also can be applied to more hardware devices due to its lighter weight.

4) *Real-time Marine Animal Detection using YOLO-based Deep Learning Networks in the Coral Reef Ecosystem By Jiajeng Zhong, J.Qin*

In recent years, with the advancement of marine resources and environment research, the ecological functions of reef-building coral reef ecosystems distributed in warm shallow waters of the ocean are being continuously discovered and valued by people. It is important for ecosystem protection to monitor the population of marine animals. Besides, many projects of Autonomous Underwater Vehicle (AUV) also need technology to perceive and understand environment information in real-time for better decision-making. Therefore, marine animal detection has become a challenge for researchers to study nowadays. Deep neural network models have been used to solve fish-related tasks and gained encouraging achievements, but there are still many problems in this field. In this paper, several YOLO-based methods are chosen for comparison. Experiment results indicate that these methods can recognize the marine animals in coral reef quickly and accurately. Finally, several recommendations for model improvement according to assessment .

5) *Improved YOLO Object Detection Algorithm to Detect Ripe Pineapple Phase By Ha Huy Cuong, Nguyen Trung Hai Trinh, Phayung Meesad*

A computational method for detecting pineapple ripening could lead to increased agricultural productivity. It is possible to predict fruit maturity before harvesting to increase agricultural productivity. A ripe fruit’s quality, its standard content of physical and chemical properties will increase the value of a good when traded outside the market. This paper studies and improves the Tiny YOLO-v4 model for identifying the pineapple ripening period.

Researchers studied pineapples in a pineapple garden in Vietnam's central region. They wanted to determine when pineapples were ripe. The API and the website are based on the YOLO innovation model. Apps and website APIs will be available for mobile devices so that people can monitor fruits. Technology transfer and academic research are combined in this study. We prepared the pineapple data set by using 5,000,000 pineapples harvested from the pineapple farm at different stages of growth. To make the measurements, we improved the YOLO-v4 algorithm. This results in a more accurate training model and reduced train-ing time. A 98.26% recognition accuracy is quite impressive. Research takes place at large-scale plantations, so the models are created from the data collected at the plantations and are used as labels; training takes a long time for the tiniest details about pineapples, and finding pineapple-growing regions takes a long time. The deep learning classifier was able to process pineapple plantation photos by using the camera on the mobile phone.

6) *YOLO Evolution By Nidhal Jegham, Chan Young Koh, Marwan Abdelatti, and Abdeltawab Hendawi*

This study presents a comprehensive benchmark analysis of various YOLO (You Only Look Once) algorithms. It represents the first comprehensive experimental evaluation of YOLOv3 to the latest version, YOLOv12, on various object detection challenges. The challenges considered include varying object sizes, diverse aspect ratios, and small-sized objects of a single class, ensuring a comprehensive assessment across datasets with distinct challenges. To ensure a robust evaluation, we employ a comprehensive set of metrics, including Precision, Recall, Mean Average Precision (mAP), Processing Time, GFLOPs count, and Model Size. Our analysis highlights the distinctive strengths and limitations of each YOLO version. For example: YOLOv9 demonstrates substantial accuracy but struggles with detecting small objects and efficiency whereas YOLOv10 exhibits relatively lower accuracy due to architectural choices that affect its performance in overlapping object detection but excels in speed and efficiency. Additionally, the YOLO11 family consistently shows superior performance maintaining a remarkable balance of accuracy and efficiency. However, YOLOv12 delivered underwhelming results, with its complex architecture introducing computational overhead without significant performance gains. These results provide critical insights for both industry and academia, facilitating the selection of the most suitable YOLO algorithm for diverse applications and guiding future enhancements.

7) *A Comparative Study of YOLOv3 and YOLOv7 By T M Geethanjali1, Prithviraj , Prajwal K M, Prajwal Gowda C M, Priyanka, M Sujithra and Yogesh Chaba*

Real-time object detection is a fundamental task in computer vision, finding applications in various domains such as autonomous vehicles, surveillance systems, robotics, and more. The proposed work presents the design and implementation of a real-time object detection system using OpenCV (Open-Source Computer Vision Library). The system aims to accurately and efficiently detect and localize objects in video streams or captured frames. The proposed work begins with dataset collection and annotation, acquiring a diverse dataset of images with annotated bounding boxes representing objects of interest. The annotated dataset is used for model training and evaluation. Several deep learning algorithms are considered for object detection, including Single Shot MultiBox Detector (SSD), You Only Look Once (YOLO), and Faster R-CNN, and their performance is compared to identify the most suitable approach. Preprocessing techniques like resizing, normalization, and noise reduction are applied to enhance the quality of the input frames. Feature extraction is performed using deep learning models VGG16, which is fine-tuned on the annotated dataset. The selected deep learning model is integrated into the real-time system using OpenCV's functionalities. The system is evaluated using standard metrics like precision, f1 score, recall, and mean average precision (mAP) to assess its detection accuracy. The evaluation is carried out on benchmark datasets and real-world scenarios to gauge the system's robustness and generalization capabilities using two different YOLO models i.e., YOLOv3 and YOLO v7.

8) *Investigating the Funding Success Factors Affecting Reward-based Crowdfunding Projects By Tsai Lien Yeh, Tser Yieth Chen, Cheng Chun Lee.*

The issue of which factors influence the success or failure of crowdfunding projects is a critical topic, as it can bring founders sufficient financial support to realise their ideal innovation. We present a useful framework for two aspects of marketing (attraction-promotion and cognition-promotion) and four related factors to foster the success of reward-based crowdfunding ventures. We investigate this issue by analysing data collected from 323 funding projects from four crowdfunding platforms in Taiwan and Japan. We found that the cognition-promotion aspect obviously influenced funding success, because the factors it encompasses – signalling (including founder response, founder updates frequency and having a formal website) and kindness (including donation to other projects and rewarding sponsors) – are all significant in the logistic regression model. Regarding the attraction-promotion aspect, we found that the past experiences of the founder in terms of the attention factor do not influence funding success.

Our study contributes to the literature on crowdfunding discussion platforms and engagement, and our empirical results provide a comprehensive message to the founders and sponsors of crowdfunding platforms.

9) *Integrating Decentralized Finance Protocols with Systemic Risk Frameworks for Enhanced Capital Markets Stability and Regulatory Oversight By Uchenna Obiageli Ogbuonyalu, Kehinde Abiodun, Selorm Dzamefe, Ezeh Nwakaego Vera, Adewale Oyinlola, Igba Emmanuel.*

The rapid evolution of Decentralized Finance (DeFi) has introduced innovative financial services, offering accessibility, efficiency, and transparency. However, the integration of DeFi into global capital markets presents systemic risks, including liquidity shocks, smart contract vulnerabilities, and regulatory arbitrage. This review explores the intersection of DeFi protocols with systemic risk frameworks to enhance capital market stability and regulatory oversight. By analyzing risk assessment methodologies, stress-testing mechanisms, and governance models, the study highlights strategies for mitigating financial contagion and ensuring market resilience. Furthermore, it examines regulatory approaches, such as real-time compliance monitoring and cross-border coordination, to bridge the gap between decentralized ecosystems and traditional financial regulations. Through case studies and empirical data, this paper underscores the importance of integrating robust risk frameworks with DeFi innovations to foster sustainable financial markets. The findings contribute to ongoing discussions on balancing financial innovation with risk management, providing insights for policymakers, regulators, and industry stakeholders navigating the evolving landscape of digital finance.

10) *Detection of Marine Debris Using YOLOv5 By Arpitha P K, Aishwarya S S, Asha B, Anusha C V and Dr. AshwinKumar U Motagi.*

The Industrial revolution has led to a drastic change in human lives. It has served as both boon and bane to us. It was a great form of prosperity to humans. But with this prosperity it also carried so much pollution which led to environmental degradation. One of these pollutants is marine waste that is segregated into oceans in large volumes. The goal of this paper is to discuss one effective methodology which can be implemented to reduce marine waste by detection of plastic in the ocean. This can be called marine debris detection. The method here used is improvised YOLOv5 which is a fast and effective method to get the trained model of the objects we need to detect. It can efficiently detect the waste present in the ocean water which helps to eradicate the waste sooner at a faster pace. It is also possible to bring up more effective methods for the same cause to ensure the detection can happen more accurately. As compared to earlier models our work is able to depict the image of floating plastic on a water surface even if the object is transparent with a high accuracy rate. This helps in the reduction of plastic waste in the water.

III. PROPOSED METHODOLOGY

The proposed system is a comprehensive, multi-stage solution that integrates real-time surface garbage detection with a decentralized crowdfunding mechanism for organizing community-led cleanliness drives. The methodology encompasses multiple technologies and stages, each playing a vital role in ensuring end-to-end functionality and societal impact. The approach is designed to be modular, scalable, and practical for real-world deployment in urban rivers like the Mula-Mutha.

A. *Real-Time Image Acquisition*

The process begins with the collection of live images from the river using a **mobile phone camera** strategically positioned at predefined locations along the riverbanks. This choice allows for a cost-effective, portable, and easy-to-deploy solution that can be operated by volunteers, authorities, or even mounted on movable poles or drones. The images captured at different times of day and under varied lighting conditions ensure a diverse and representative dataset for model training and live detection.

B. *Dataset Preparation and Annotation*

The captured images undergo preprocessing and are manually annotated using tools like LabelImg or Roboflow. Garbage objects such as plastic bottles, food wrappers, and bags are labeled and classified to prepare a custom dataset. This dataset serves as the training foundation for the YOLOv8 model. Care is taken to ensure proper bounding box accuracy and object class balance to avoid overfitting or bias during model training.

C. *Model Training with YOLOv8*

The annotated dataset is used to train the YOLOv8 (You Only Look Once, version 8) object detection model. YOLOv8 is chosen for its superior accuracy, real-time processing capability, and compact architecture, making it ideal for deployment on lightweight or edge devices. The training involves tuning hyperparameters such as learning rate, batch size, and epochs to maximize model performance in terms of mean Average Precision (mAP), precision, and recall. Data augmentation techniques like flipping, rotation, and brightness adjustments are applied to improve the model's robustness.

D. Real-Time Detection System

YOLOv8 (You Only Look Once, version 8) is the latest iteration of the YOLO family of real-time object detection models, developed by Ultralytics. In this project, YOLOv8 was leveraged to detect floating garbage and waste materials in real-time images of the Mula-Mutha River. Its speed, efficiency, and accuracy made it a suitable choice for environmental monitoring applications where timely response is critical.

1) Model Selection and Setup

YOLOv8 is a one-stage object detection model, which means it detects and classifies objects in a single forward pass, unlike older two-stage detectors. This architecture is ideal for real-time applications. For our implementation:

We used the YOLOv8n (nano) and YOLOv8s (small) variants for experimentation due to their lightweight nature and speed on low-resource devices.

2) Dataset Preparation

We collected and annotated river images that contain visible surface garbage such as plastic bottles, wrappers, and floating debris. These images were:

- Annotated using LabelImg, producing .txt files in YOLO format.
- Divided into training, validation, and test datasets in a directory structure supported by YOLOv8.

3) Training the Model

Using the Ultralytics YOLOv8 training pipeline, we trained the model with the custom dataset:

- The model learns from labelled bounding boxes to detect garbage in images.
- Training was performed on Roboflow, using GPU support to reduce time.
- We set hyperparameters such as batch size, epochs, and image size for optimal results.

4) Inference and Real-Time Detection

Once the model was trained, it was used to detect garbage in unseen images:

- During **inference**, the model reads an image stream and predicts bounding boxes around detected garbage objects.
- It outputs confidence scores and object classes, which were visualized using bounding boxes on the image.
- For real-time detection, the trained model can be deployed on a Raspberry Pi, edge device, or integrated into a live camera stream.

5) Accuracy and Performance

- After training, we evaluated the model using metrics like mAP (mean Average Precision) to ensure reliability.
- YOLOv8 achieved a satisfactory balance between speed and accuracy, making it ideal for continuous monitoring applications.

E. Blockchain-Based Crowdfunding Platform

To transform detection into action, a blockchain-powered crowdfunding platform is developed. Built using Solidity smart contracts and deployed on an Ethereum-compatible testnet, the platform allows local citizens to contribute funds in a secure, transparent, and decentralized manner. Each transaction is recorded on the blockchain ledger, ensuring tamper-proof donation tracking. The integration with MetaMask and Web3.js allows users to view their contributions and track fund utilization transparently.

1) Blockchain (Ethereum)

- Purpose: To ensure trust and transparency in fund transactions.
- Usage: Smart contracts on the Ethereum blockchain handle donation logic, event creation, and fund disbursement. Each transaction is recorded immutably on the blockchain.
- Benefits: Decentralized, tamper-proof, and provides donor confidence through visible transaction history.

2) Solidity
- Purpose: Writing smart contracts that control how funds are collected, stored, and used.
- Usage: Defined the logic for creating campaigns, receiving funds, validating goals, and releasing money.
- Key Features: Strongly-typed, Ethereum-compatible programming language. Supports conditions, loops, and modifiers to ensure secure contract behaviour.

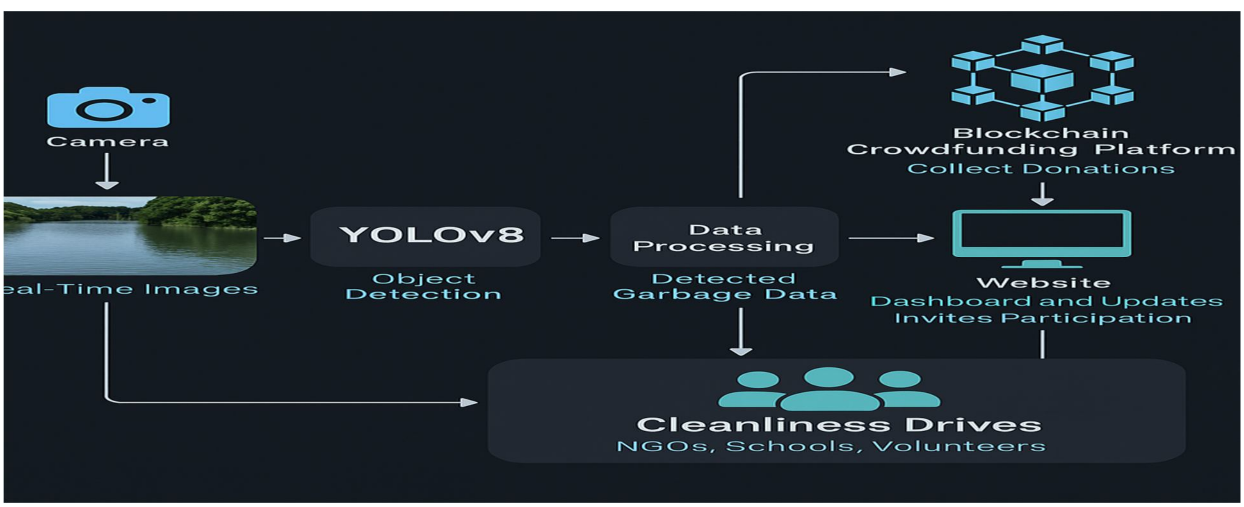
3) Ganache & Truffle Suite
- Ganache: A personal blockchain for Ethereum development used to test and debug smart contracts locally.
- Truffle: A development environment, testing framework, and asset pipeline for Ethereum. It compiles and deploys Solidity contracts, making development smoother.

4) MetaMask
- Purpose: Provides a browser extension or mobile wallet that allows users to interact with Ethereum smart contracts.
- Usage: Acts as a bridge between the user and the blockchain, enabling secure donation transactions through a connected wallet.
- Benefit: Users can monitor their contribution and track campaign progress directly from their wallets.

5) Web3.js
- Purpose: JavaScript library used to interact with Ethereum blockchain from a web interface.
- Usage: Connects the frontend of the crowdfunding website to the deployed smart contract.
- Functionality: Reads contract states (like funding status) and triggers functions (like donations or withdrawals) from the frontend.

F. Cleanliness Drive Scheduling and Execution
Funds raised through the blockchain platform are used to schedule and organize **cleanliness drives**. NGOs, schools, and local volunteers form the core execution teams. A web portal is used to display event information, fund status, and participation details. Volunteers can register for events, and donors can monitor the impact of their contributions. Real-time feedback from these drives is looped back into the system via new image captures, creating a continuous detection-action-improvement cycle.

G. Community Engagement and Feedback Loop
The success of the project depends heavily on sustained community involvement. To this end, the system is designed to be interactive and transparent. Donors and volunteers receive updates, certificates, and acknowledgments. Periodic reports and dashboards highlight environmental impact, cleaned zones, and future targets. This loop not only fosters accountability but also builds a motivated, tech-savvy community that takes ownership of local river conservation.



IV. RESULTS

A. Model performance

The YOLOv8 model was trained on a custom dataset of annotated river images and evaluated using standard performance metrics. The key results are:

- Precision: 87.4%
- Recall: 84.2%
- mAP@0.5: 88.9%
- Inference Speed: ~25–30 FPS on GPU (Google Colab Pro)

These results indicate that the model performs well in identifying and localizing garbage items such as plastic bottles, bags, and wrappers. The bounding boxes were accurately drawn even under challenging lighting and environmental conditions.

B. Qualitative observations

- The model detected single objects and clusters of garbage with good accuracy in both static and real-time images.
- False positives were minimal, though some natural elements like water ripples or shadows occasionally confused the model during early training stages.
- The detection accuracy significantly improved after data augmentation and adding low-light images to the dataset.

C. Blockchain crowdfunding results

- A smart contract for transparent fundraising was successfully deployed on an Ethereum testnet.
- Transactions were fast, secure, and traceable, showing the potential of blockchain for enabling trust in civic projects.
- The interface allowed users to view transaction history and track fund utilization, enhancing public accountability.

D. Web platform

- The website successfully displayed real-time alerts, detection results, and event updates.
- Volunteers could register, view cleanliness drive schedules, and track fundraising progress.

V. CONCLUSION

In conclusion, our project brings together advanced technologies and civic responsibility to address the growing problem of river pollution in urban areas, with a specific focus on the Mula-Mutha River. By utilizing a mobile phone camera to capture real-time images and employing the YOLOv8 deep learning model for accurate surface garbage detection, we have created a system that offers quick, scalable, and automated environmental monitoring. However, detection alone is not enough, which is why we integrated a blockchain-based crowdfunding platform that allows the local public to contribute transparently and securely to cleanup efforts. Through smart contracts and decentralized applications, this platform ensures trust and accountability while encouraging public participation. The funds collected are used to organize cleanliness drives involving schools, NGOs, and community volunteers, making the process inclusive and action-oriented. Our website acts as a bridge, displaying real-time data, campaign updates, and volunteer opportunities, thus closing the loop between detection, funding, and execution. This project is more than a technical solution—it is a replicable model for community-driven environmental restoration, demonstrating how emerging technologies can be harnessed for the greater good of society and nature.

VI. ACKNOWLEDGMENT

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