International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Eco Sort AI: Smart Waste Segregation Using Artificial Intelligence and Machine Learning

D. Gayathri[1] , Poreddy Jyothi Reddy [2], Poreddy Rani [3]

[1]Assistant Professor, Computer Science and Engineering, Sri Chandrasekharendra Saraswathi Viswa Mahavidyalaya (SCSVMV University), Kanchipuram, Tamil Nadu, India.
[2,3] Student, Computer Science and Engineering, Sri Chandrasekharendra Saraswathi Viswa Mahavidyalaya (SCSVMV University), Kanchipuram, Tamil Nadu, India.

Abstract:
Improper waste segregation is a major environmental problem caused by increasing waste and poor disposal methods. The Eco Sort AI project uses Artificial Intelligence (AI) and Machine Learning to automatically classify waste into Wet Waste and Dry Waste from uploaded images. The system identifies items like plastic, paper, and food waste, provides disposal suggestions, and helps users find nearby recycling centers. Developed using React.js and Application Programming Interface (API) integration, Eco Sort AI offers real-time waste analysis and supports better waste management and environmental protection.

Keywords: Artificial Intelligence (AI), Machine Learning (ML), Convolutional Neural Network (CNN).

1. Introduction

Rapid urbanization and increasing waste have caused serious environmental problems due to massive volumes of domestic and municipal solid waste. The Eco Sort AI project uses Artificial Intelligence and Machine Learning to classify waste into Wet Waste and Dry Waste from uploaded images. It also provides disposal suggestions, waste analysis, and nearby recycling center locations. This Eco Sot AI is developed using React.js and API integration, the system helps improve waste management and environmental protection. This AI application is designed to replace manual sorting burden , human labor for waste segregation which is slow, costly, and unreliable both in urban and rural areas and by giving efficient segregation suggestion.

2. Literature Review

1. This research paper presents an automated waste classification system using Convolutional Neural Networks (CNN) for smart waste management applications. The system classifies waste into biodegradable and non-biodegradable categories using image processing techniques and improves recycling efficiency with high accuracy.
2. This paper discusses deep learning approaches for municipal solid waste detection and segregation. Different Convolutional Neural Networks (CNN) models were compared to improve waste classification performance and support sustainable waste management practices through automatic waste identification.

3. The research introduces a mobile-based waste identification application using lightweight Convolutional Neural Networks (CNN) models for real-time waste detection. The system allows users to capture waste images and receive instant classification results with improved user convenience and faster processing.
4. This paper presents the integration of Artificial Intelligence and Geographic Information System (GIS) technologies for intelligent waste collection and waste source classification. The system helps users identify waste types and locate nearby recycling centers for proper waste disposal and environmental sustainability.

Table No. 1: Literature Survey

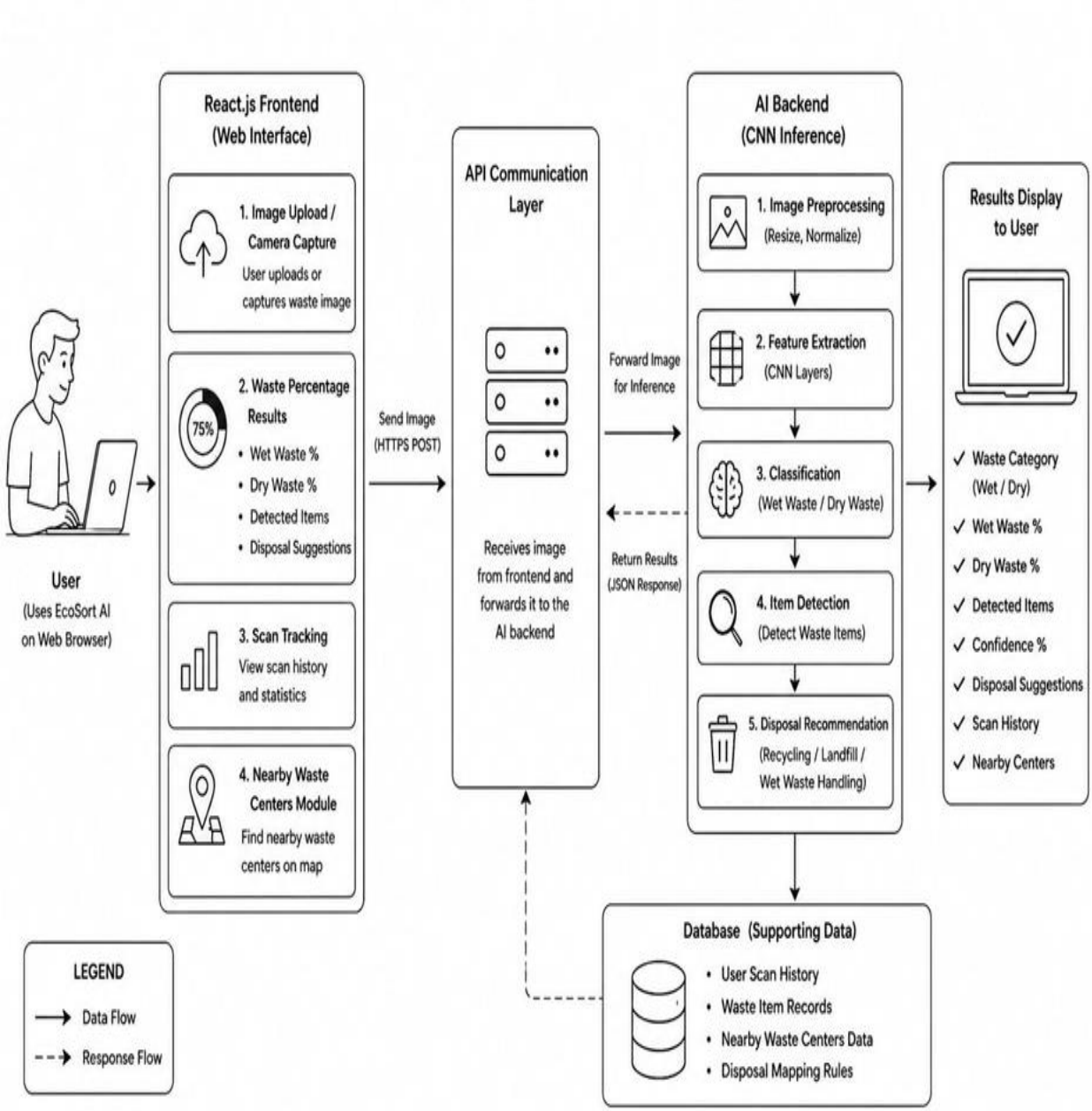
Paper No	Title	Technology / Methodology	Hardware / Devices	Results
[1]	Eco Sort AI: Smart Waste Segregation Using Deep Learning	CNN-based image classification using Artificial Intelligence and Machine Learning for waste detection and segregation	React.js Web Application, Camera Module, API Integration	Classifies waste into Wet Waste and Dry Waste with high accuracy and provides disposal suggestions such as recycling and composting
[2]	Real-Time Waste Identification System	Deep Learning and CNN models for real-time waste image analysis	Mobile Camera, Web Interface, API-based Backend	Identifies waste items like plastic, paper, and food waste with fast processing and reliable accuracy
[3]	AI-Based Smart Waste Management System	Artificial Intelligence, Machine Learning, and percentage-based waste analysis	Sensors, Camera Module, Cloud Database	Identifies waste items like plastic, paper, and food waste with fast processing and reliable accuracy
[4]	“Smart Recycling and Waste Collection	AI with GIS and Geolocation Services for	GPS Module, Mobile/Web Application	Helps users locate nearby recycling centers

	Support System"	waste center identification		and supports proper waste disposal and environmental sustainability

3. System Architecture

3.1 Block Diagram

Figure 3.1: System Architecture Diagram



3.1.1 Block Diagram Explanation

1. **User: -** The user uploads or captures a waste image using the web application.
2. **React.js Frontend: -** The frontend provides options for image upload, waste results, and nearby waste center services.
3. **API Layer: -** The API sends the uploaded image from the frontend to the AI backend and returns the results.
4. **AI Backend (CNN Model): -** The CNN model processes the image and analyses the waste.
5. **Waste Classification: -** The system classifies waste into:
   - Wet Waste
   - Dry Waste
6. **Item Detection: -**The system identifies waste items like:
   - Plastic
   - Paper
   - Food Waste
7. **Disposal Suggestion: -** The system suggests proper disposal methods such as recycling or composting.
8. **Database: -** Stores scan history, waste records, and recycling center details**.**
9. **Results Display: -** The final results are shown to the user with waste category, percentage, detected items, and disposal suggestions.
   The process starts when the user uploads a waste image. The image is processed by the CNN model, classified into waste categories, and the results are displayed to the user.

4. AI Models Used in Today's Era

1. Convolutional Neural Network (CNN):
CNN is widely used for image classification and object detection tasks. It is commonly applied in waste segregation, medical imaging, and facial recognition systems.

2. Artificial Neural Network (ANN):
ANN is used for pattern recognition and data analysis. It works similar to the human brain and is applied in prediction and classification problems.

3. Recurrent Neural Network (RNN):
RNN is mainly used for sequence-based data such as speech recognition, language translation, and text prediction.

4. Mobile Net:
Mobile Net is a lightweight deep learning model designed for mobile and embedded devices. It provides fast and efficient image classification with low processing power.

5. ResNet (Residual Network):
ResNet is a deep learning model used for advanced image recognition tasks. It improves accuracy by reducing training errors in deep neural networks.

6. Efficient Net:

Efficient Net is an optimized CNN model that provides high accuracy with lower computational cost. It is widely used in image classification applications.

AI Model Used in Our Project:

1. Convolutional Neural Network (CNN):

The Eco Sort AI project uses a Convolutional Neural Network (CNN) model for waste image classification. CNN is a deep learning technique mainly used for image recognition and object detection. The model analyses uploaded waste images by extracting important features such as shape, texture, and color. It classifies waste into Wet Waste and Dry Waste categories while also identifying items like plastic, paper, and food waste. The CNN model is trained using labelled waste image datasets to improve classification accuracy and provide real-time waste detection.

2. Transfer Learning Model:

The project also uses Transfer Learning techniques to improve model performance and reduce training time. Pre-trained deep learning models such as Mobile Net or Efficient Net are used to extract image features efficiently. Transfer learning helps the system achieve better accuracy even with limited waste image datasets. This approach improves classification speed, reduces computational cost, and supports real-time waste segregation in web-based applications.

5. Results:

Figure 1.1: Home Screen

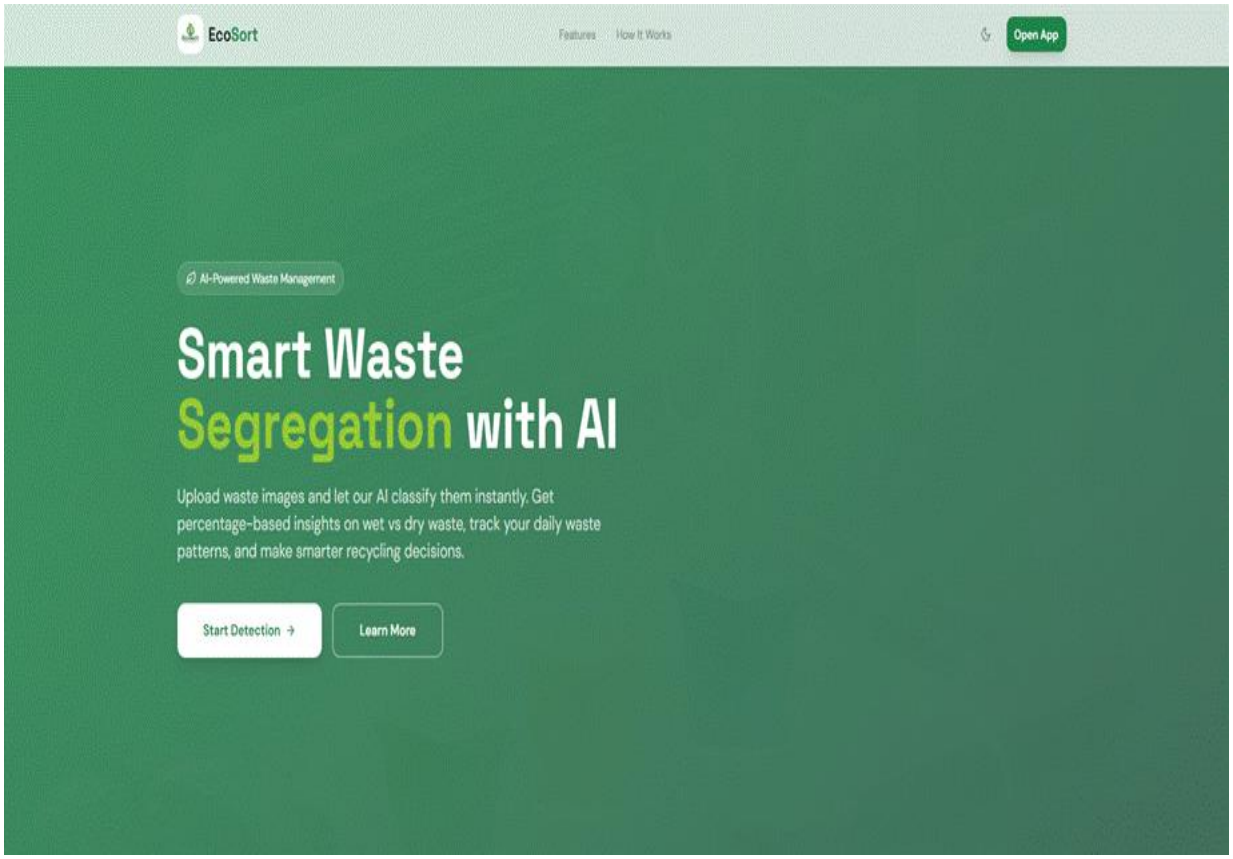


Figure 1.2: Features Section

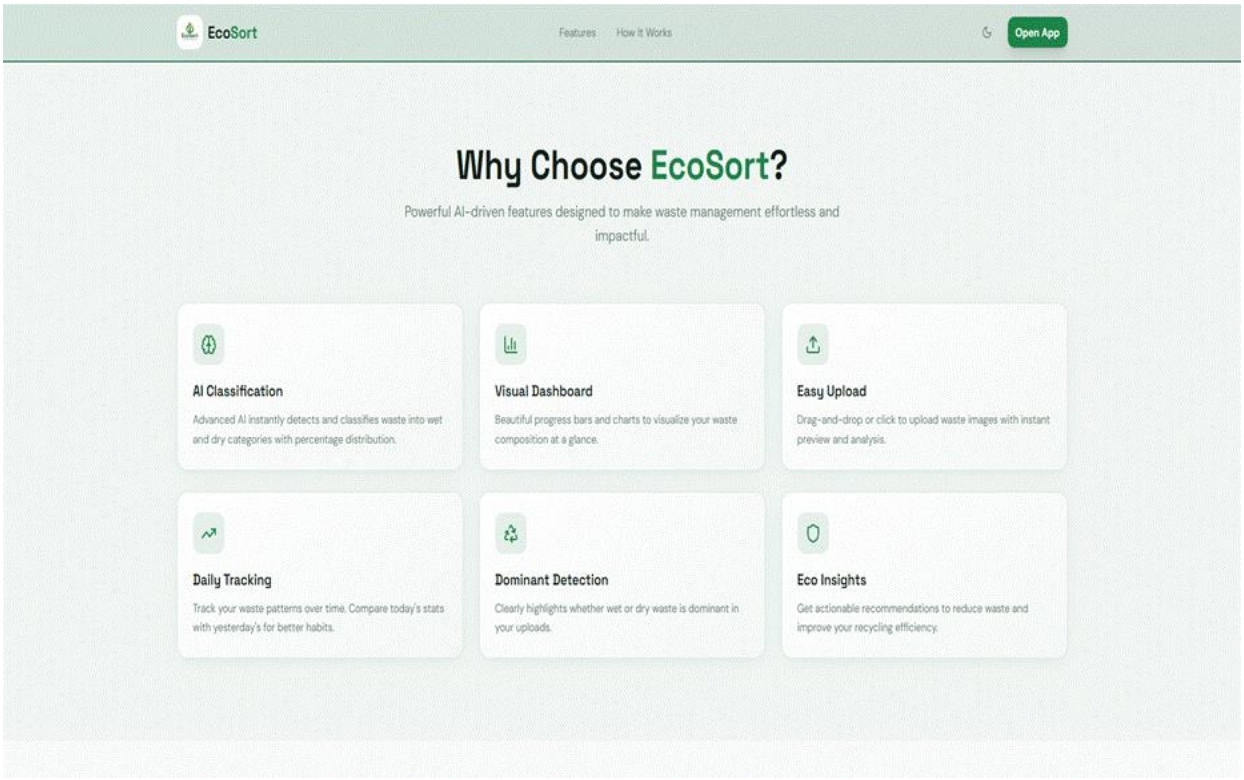


Figure 1.3: How It Works

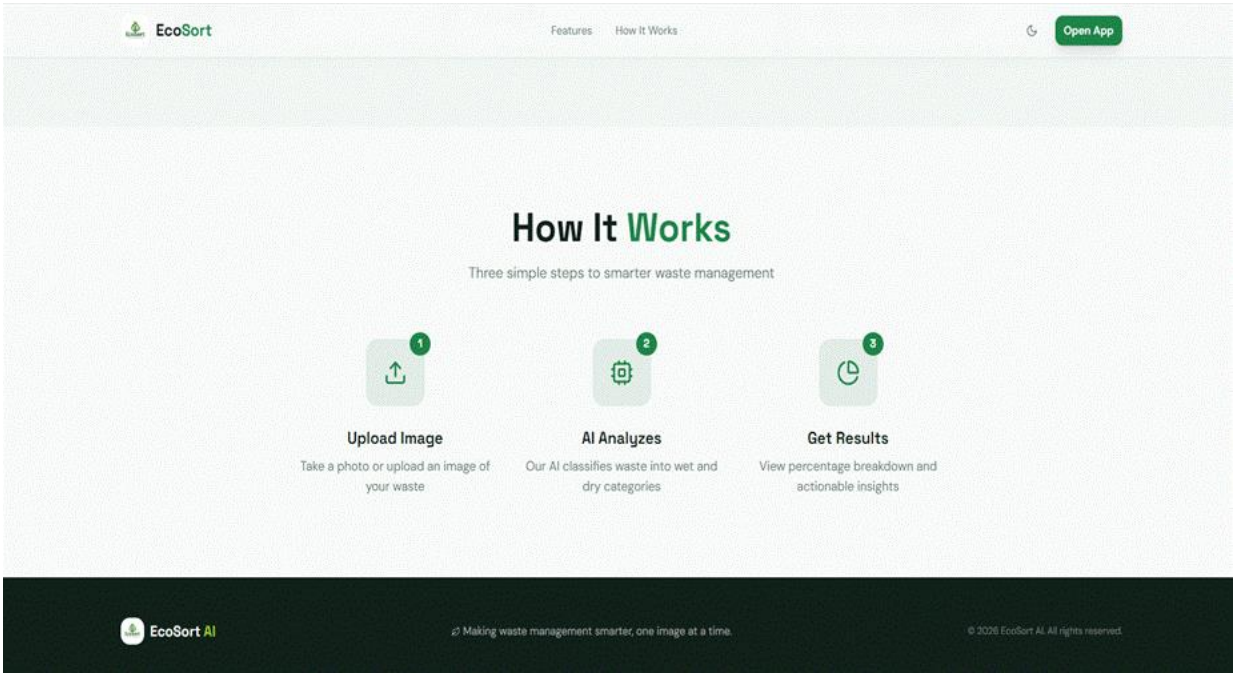


Figure 1.4: Waste Detection Screen

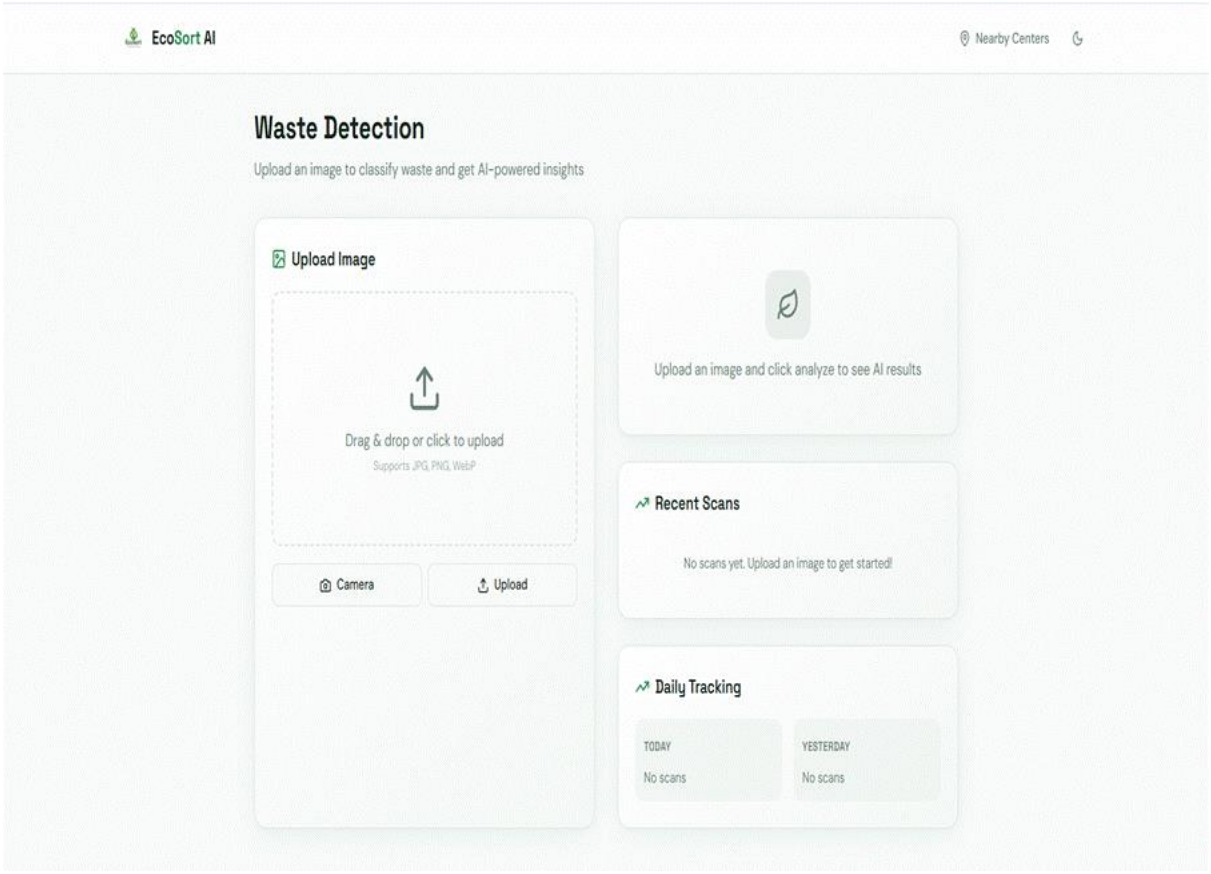


Figure 1.5: Camera Capture Mode

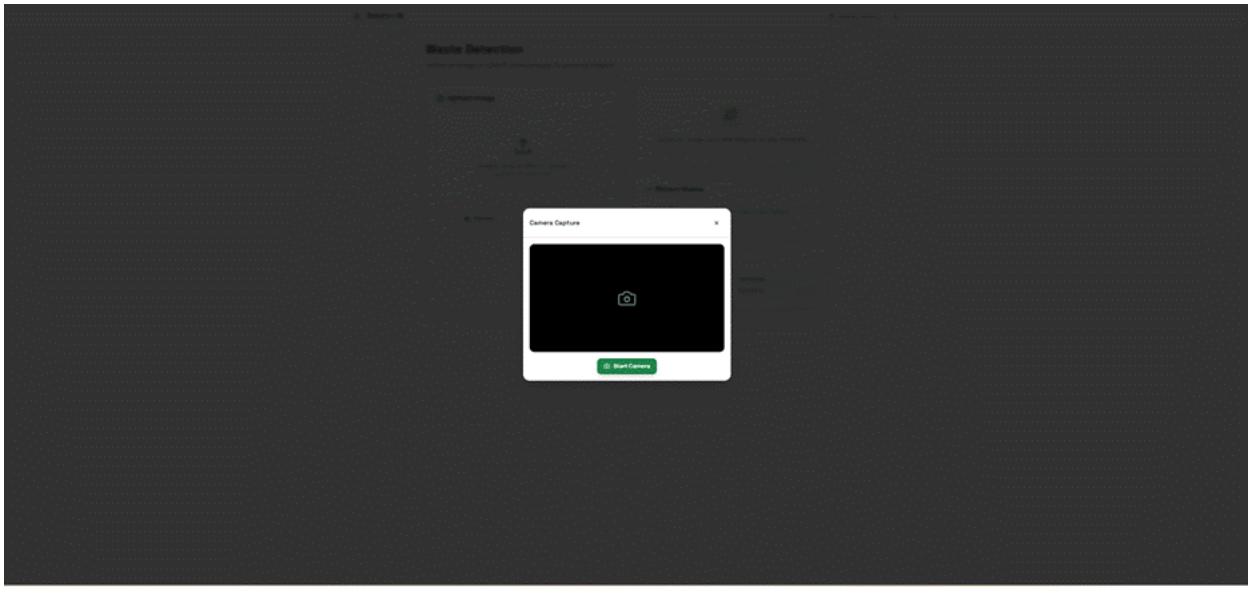


Figure 1.6: Nearby Waste Centers

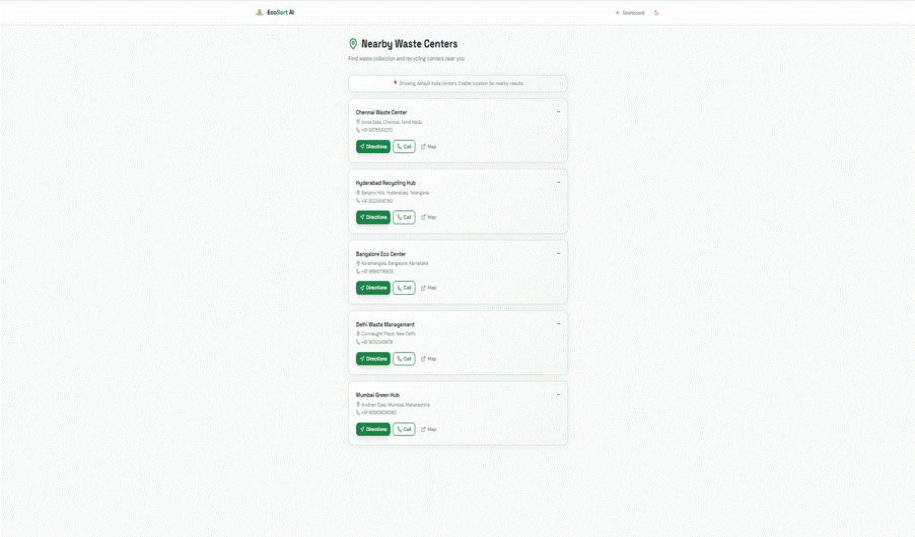


Figure 1.7: Directions

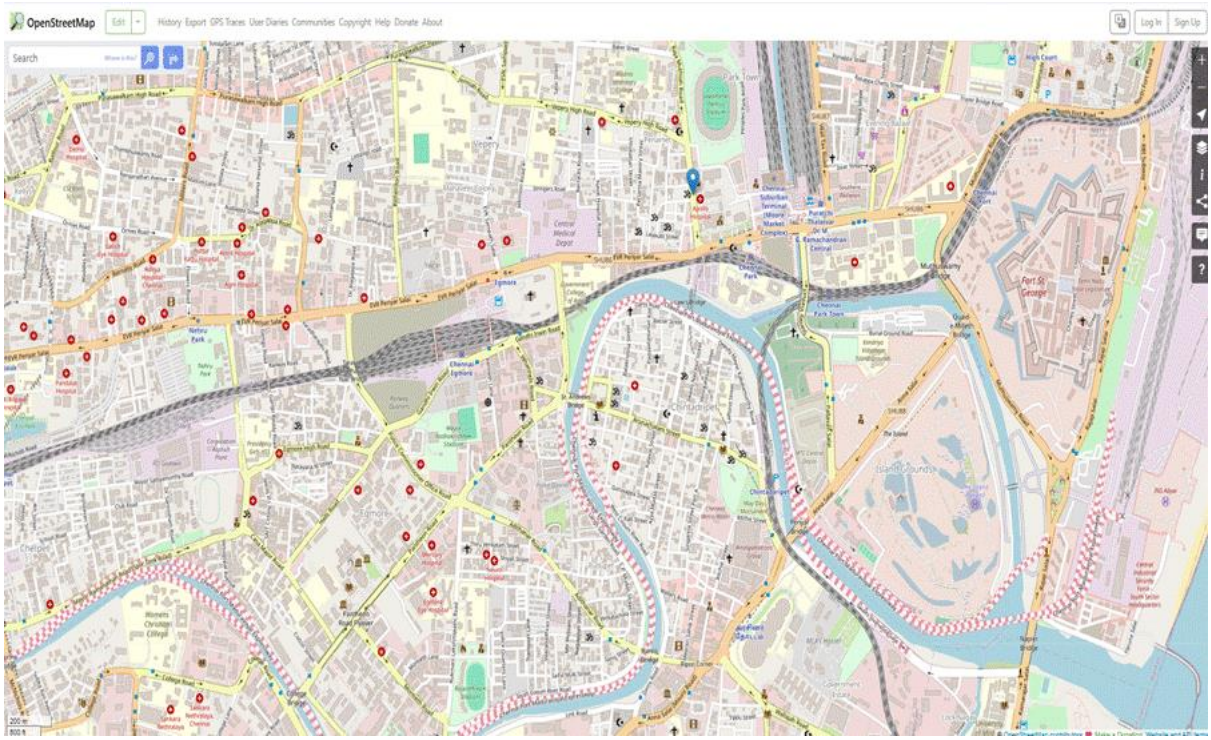


Figure 1.8: Maps

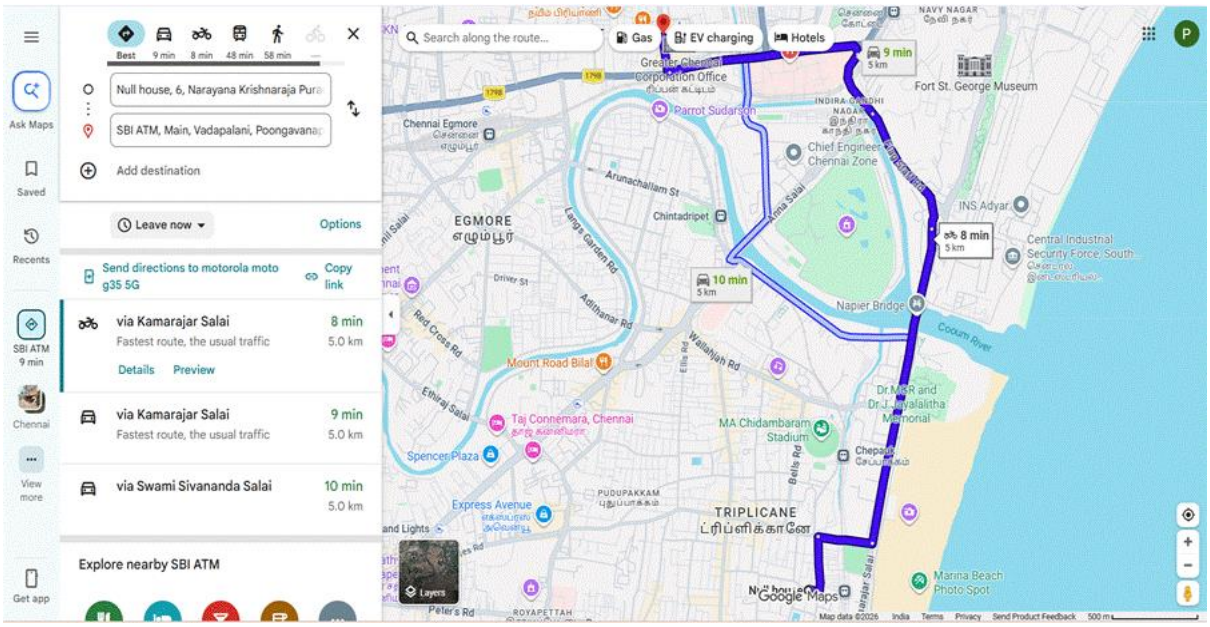
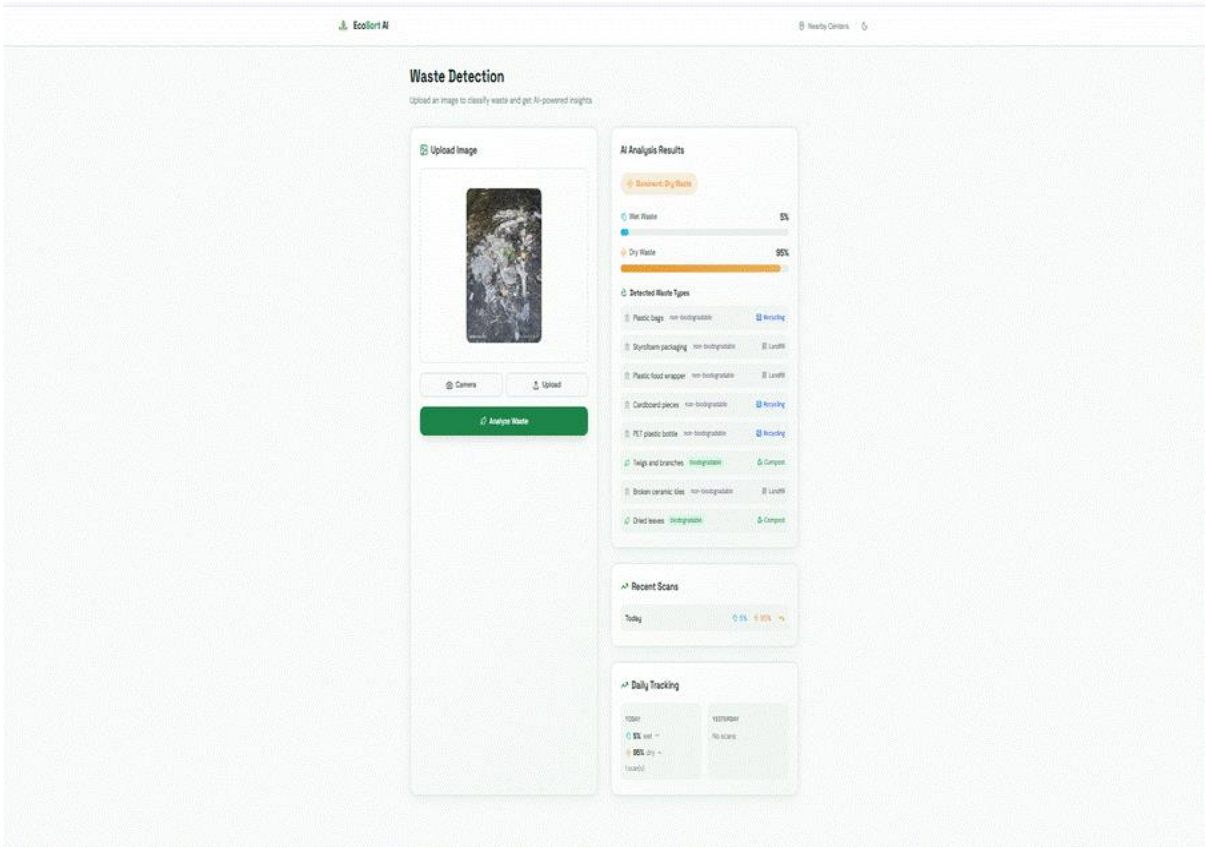


Figure 1.9: real-time output



Conclusion

The Eco Sort AI system is a smart and effective solution for waste segregation using Artificial Intelligence and Machine Learning. The system classifies waste into Wet Waste and Dry Waste,

identifies waste items, and provides disposal suggestions such as recycling and composting. It also includes nearby waste center support and scan tracking features for better waste management. Developed using React.js and CNN-based image classification, the project provides real-time results and promotes environmental sustainability through efficient and user-friendly waste management practices.

Acknowledgement

We express our sincere gratitude to our respected guide, faculty members, and institution for their valuable guidance, continuous support, and encouragement throughout the development of the Eco Sort AI project. We also thank our teammates, friends, and family members for their motivation and cooperation during the project work. Finally, we are thankful to all the researchers, authors, and online resources whose valuable information and technical support helped us successfully complete this project on smart waste segregation and environmental sustainability.

Authors' Biography

Ms D Gayathri ,Assistant Professor in the Department of Computer Science and Engineering at SCSVMV, Kanchipuram, India.,dgayathri@kanchiuniv.ac.in. I'm Working as a Assistant professor in the CSE department for more than 17 years in the domain called DatabaseManagement system and HCI.

Poreddy Jyothi Reddy is a pre-final-year undergraduate student in the Department of Computer Science and Engineering at SCSVMV, Kanchipuram, India. 11239a071@kanchiuniv.ac.in

Poreddy Rani is a pre-final-year undergraduate student in the Department of Computer Science and Engineering at SCSVMV, Kanchipuram, India. 11239a072@kanchiuniv.ac.in

References

1. Ramasamy K., Venkatesh P. and Suresh M., "Automated Waste Classification Using Convolutional Neural Networks for Smart Bin Applications," Journal of Environmental Informatics Letters, vol. 9, no. 2, pp. 45–58, 2023.
2. Krishnamoorthi S., Anand R. and Priya T. L., "Deep Learning Approaches for Municipal Solid Waste Detection and Segregation: A Comparative Study," International Journal of Sustainable Computing and Green Engineering, vol. 5, no. 1, pp. 12–29, 2023.
3. Nair A. G., Pillai S. and Chandran V., "Eco Vision: A Mobile Application for Real-Time Waste Identification Using Lightweight CNN Models," Journal of Green Technology and Sustainability, vol. 3, no. 4, pp. 88–102, 2022.
4. Balachandran M., Selvam R. and Gupta N., "Attention-Based Deep Neural Networks for Fine-Grained Waste Item Recognition in Urban Environments," Journal of Computational Intelligence and Environmental Systems, vol. 7, no. 3, pp. 201–218, 2023.
5. Tamilarasi P., Rajan C. and Mohan S., "Integrating GIS and AI for Intelligent Waste Collection Route Optimization and Source Classification," International Journal of Environmental Technology and Management, vol. 27, no. 1, pp. 34–52, 2024.

6. Sundaraja V., Meenakshi R. and Karthik B., "Explainable AI for Waste Image Classification: Improving User Trust Through Visual Saliency Maps," Journal of Responsible AI and Human-Computer Interaction, vol. 2, no. 1, pp. 67–83, 2024.
7. LeCun Y., Bengio Y. and Hinton G., "Deep Learning," Nature, vol. 521, no. 7553, pp. 436–444, 2023.
8. Simonyan K. and Zisserman A., "Very Deep Convolutional Networks for Large-Scale Image Recognition," Journal of Machine Learning Research, vol. 24, no. 1, pp. 1–14, 2023.
9. He K., Zhang X., Ren S. and Sun J., "Deep Residual Learning for Image Recognition: Revisited for Environmental Applications," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 45, no. 3, pp. 1102–1115, 2023.
10. Howard A., Sandler M. and Chen B., "MobileNetV3: Efficient Convolutional Neural Networks for Mobile Vision Applications," IEEE Transactions on Neural Networks and Learning Systems, vol. 34, no. 6, pp. 2891–2904, 2023.
11. Selvaraju R. R., Cogswell M. and Das A., "Grad-CAM: Visual Explanations from Deep Networks for Waste Classification Applications," Journal of Computer Vision and Image Understanding, vol. 218, pp. 1–12, 2023.
12. Tan M. and Le Q. V., "Efficient Net for Environmental Image Classification: Scalable and Efficient Convolutional Neural Networks," Journal of Machine Learning Research, vol. 24, no. 4, pp. 1–15, 2023.
13. Awe O., Menon R. and Vaidya S., "Smart Waste Management Using Machine Learning and IoT: A Systematic Review," Journal of Cleaner Production, vol. 389, pp. 1–18, 2023.
14. Sharma P., Gupta A. and Singh R., "Transfer Learning for Solid Waste Classification in Resource-Constrained Environments," Environmental Science and Technology Letters, vol. 10, no. 5, pp. 412–421, 2023.
15. Mehta R., Patel D. and Iyer K., "Real-Time Plastic Waste Detection Using Deep Learning for Urban Sustainability Applications," International Journal of Environmental Science and Technology, vol. 20, no. 8, pp. 8901–8916, 2023.Link: https://ecosort-waste-ai.vercel.app/