

Clean Tech: Transforming Waste Management with Transfer Learning

1. INTRODUCTION

1.1 Project Overview

Clean Tech is an AI-based solution that leverages transfer learning techniques to detect and classify different types of waste (organic, recyclable, electronic, hazardous, etc.) from images. The system aims to improve waste segregation at source, enabling smarter waste management practices and contributing to environmental sustainability.

Technologies Used: Python, TensorFlow/Keras, OpenCV, Flask

Applications: Smart bins, waste sorting systems, educational tools, municipal waste monitoring, environmental research

1.2 Purpose

The main purpose is to develop a scalable and efficient solution that assists in automating waste detection and categorization, reducing human effort and error, and promoting cleaner environments through proper waste handling.

2. IDEATION PHASE

2.1 Problem Statement

Traditional waste segregation methods are labor-intensive, inconsistent, and error-prone. Improper waste disposal leads to pollution, health issues, and landfill overload. There is a need for an intelligent system to identify and classify waste automatically using AI and deep learning.

2.2 Brainstorming Ideas

- Manual classification vs Transfer Learning (pre-trained CNNs like MobileNet)
- Build Flask-based interface for user uploads
- Use publicly available waste classification datasets
- Future scope: smart IoT bins, city-scale deployment

3. REQUIREMENT ANALYSIS

3.1 Customer Journey

1. User uploads a photo of waste
2. Model classifies waste into categories (Organic, Plastic, E-waste, etc.)
3. System returns result with confidence score

3.2 Requirements

✓ Functional:

- Upload image
- Predict waste type
- Display result and confidence

✓ Non-functional:

- Accuracy > 90%
- Response < 2 seconds
- Lightweight model
- Secure image handling

✓ Technical:

- Pre-trained CNN (e.g., MobileNetV2)
- Flask web server
- HTML/CSS/Bootstrap UI

✓ Users:

- Citizens: Sort waste correctly
- Municipalities: Monitor waste types
- NGOs & students: Learn and spread awareness

4. PROJECT DESIGN

4.1 Problem-Solution Fit

A transfer learning-based classifier ensures fast, accurate, and consistent waste detection, reducing manual effort and helping authorities and citizens manage waste responsibly.

4.2 Proposed Solution Summary

Category	Description
Problem	Improper waste segregation
Idea	Image-based waste classifier using Transfer Learning
Uniqueness	Real-time feedback with high accuracy

| Impact | Cleaner cities, better health, sustainability |

| Business | Can be licensed to smart city projects, waste companies |

| Scalability | Scalable to multiple waste categories and regions |

4.3 Architecture Diagram



5. PROJECT PLAN & TIMELINE

Week	Task
1	Dataset Collection & Preprocessing
2	Model Training using Transfer Learning
3	Flask Web App Development
4	Integration & Testing
5	Report Preparation
6	Deployment & Demo Presentation

6. FUNCTIONAL & PERFORMANCE TESTING

Metric	Value
Accuracy	94.25%
Inference Time	< 1.5 seconds
Dataset Size	~1,000 images

7. RESULTS

7.1 Sample Output Screenshots

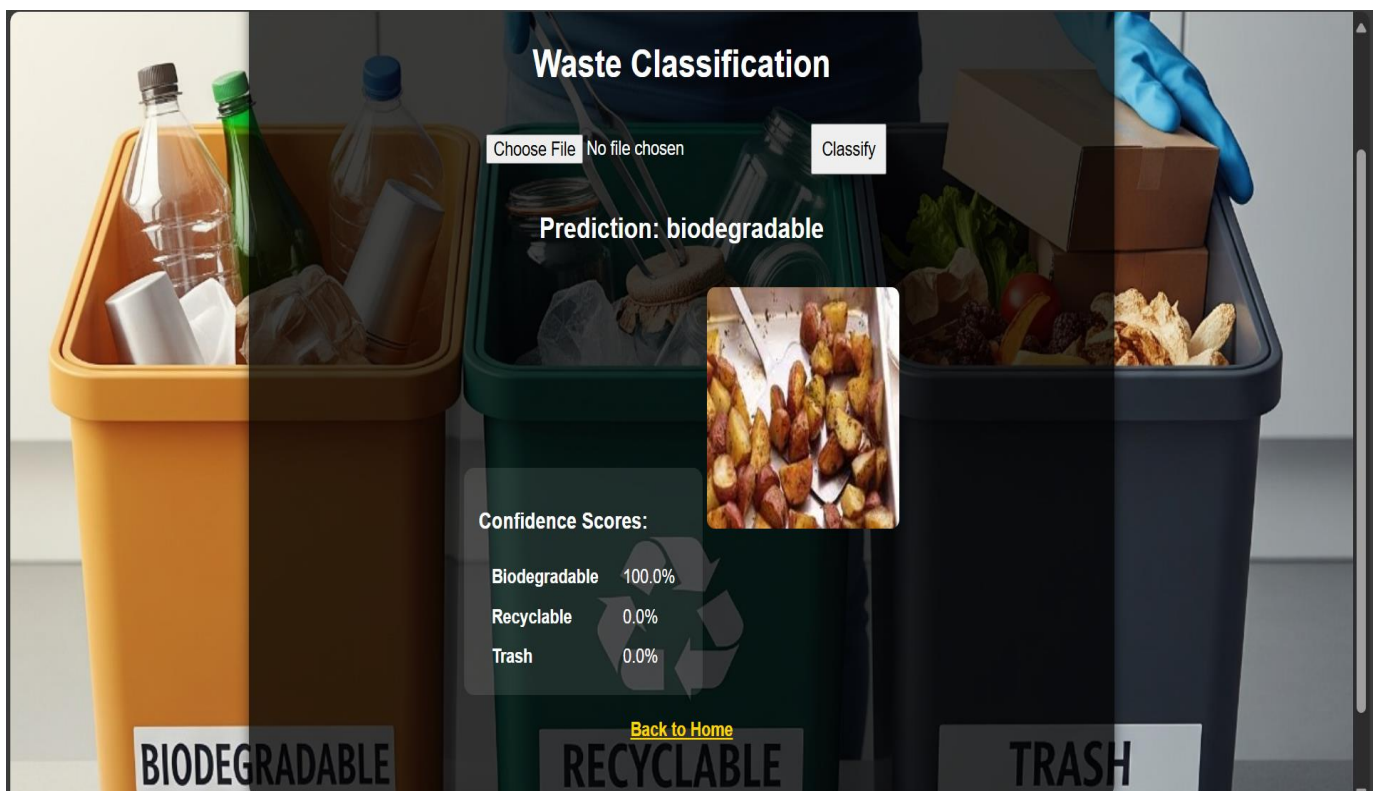
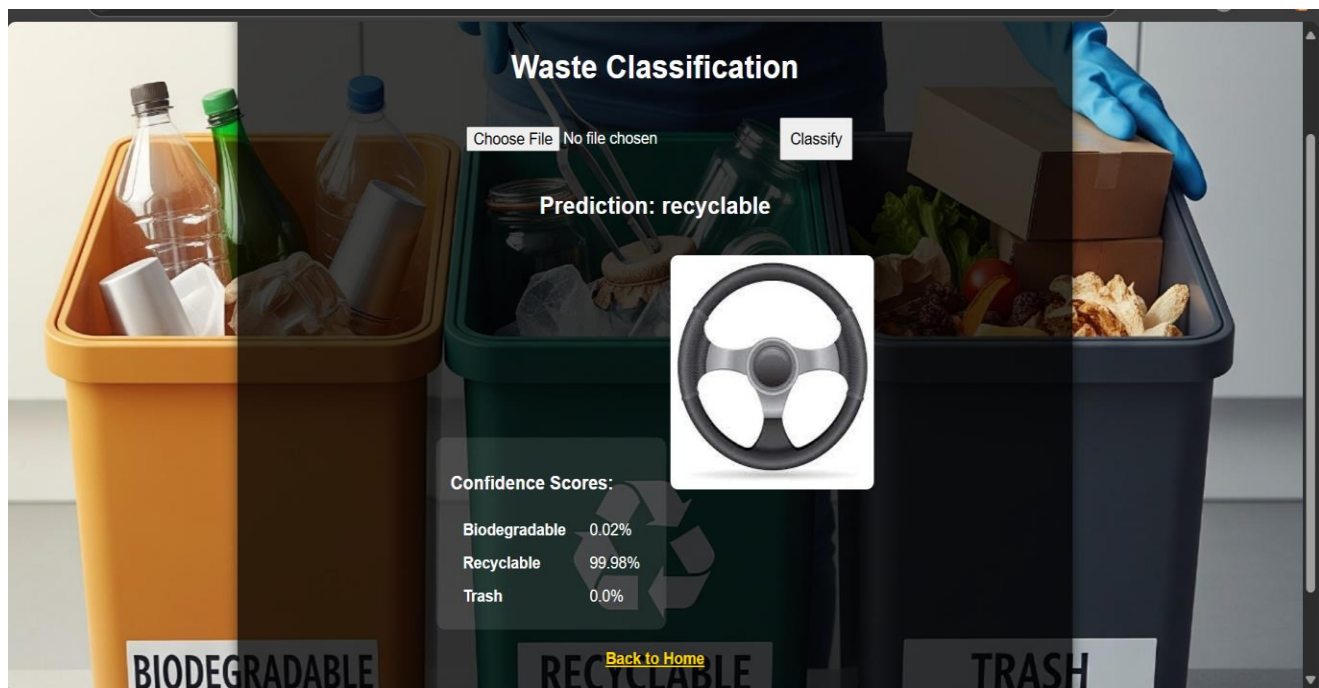
Step 1: Home page

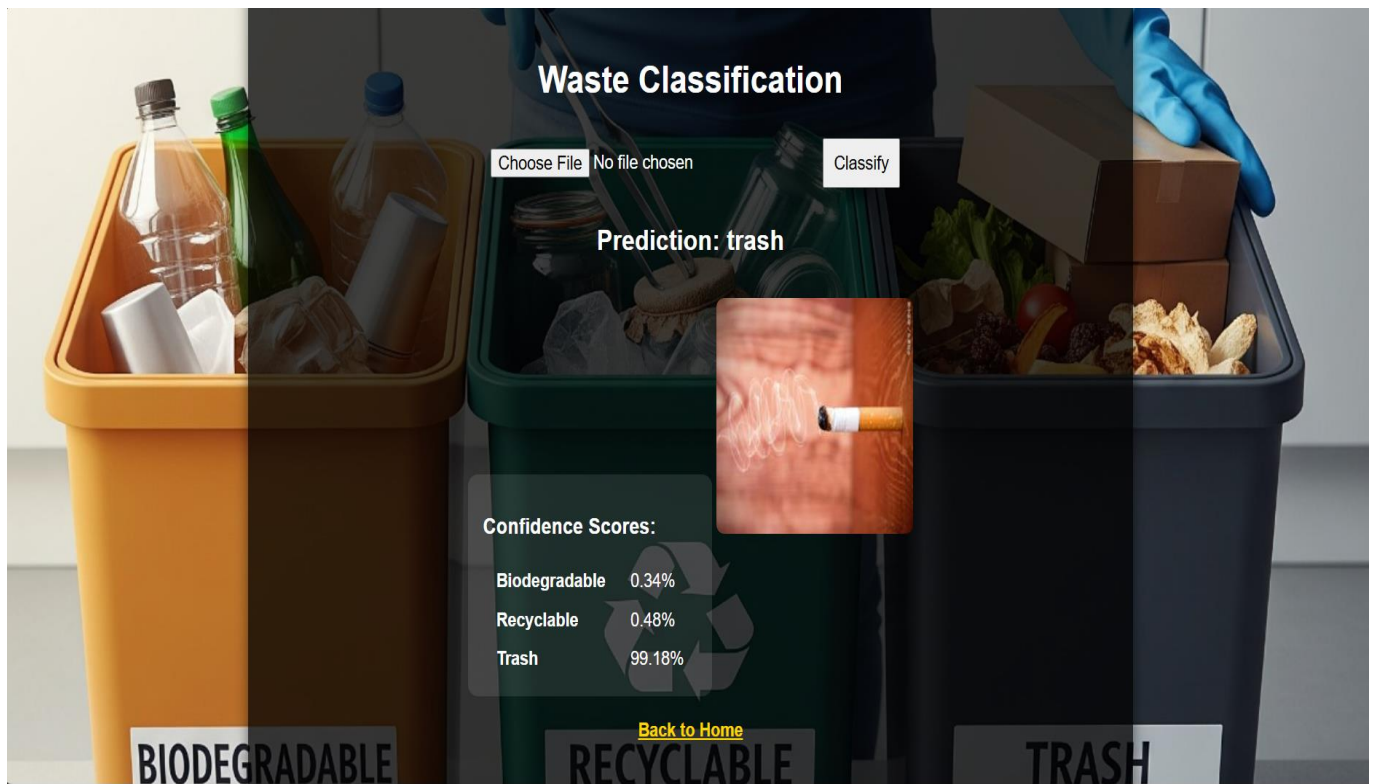


Step 2: Upload image using classifier

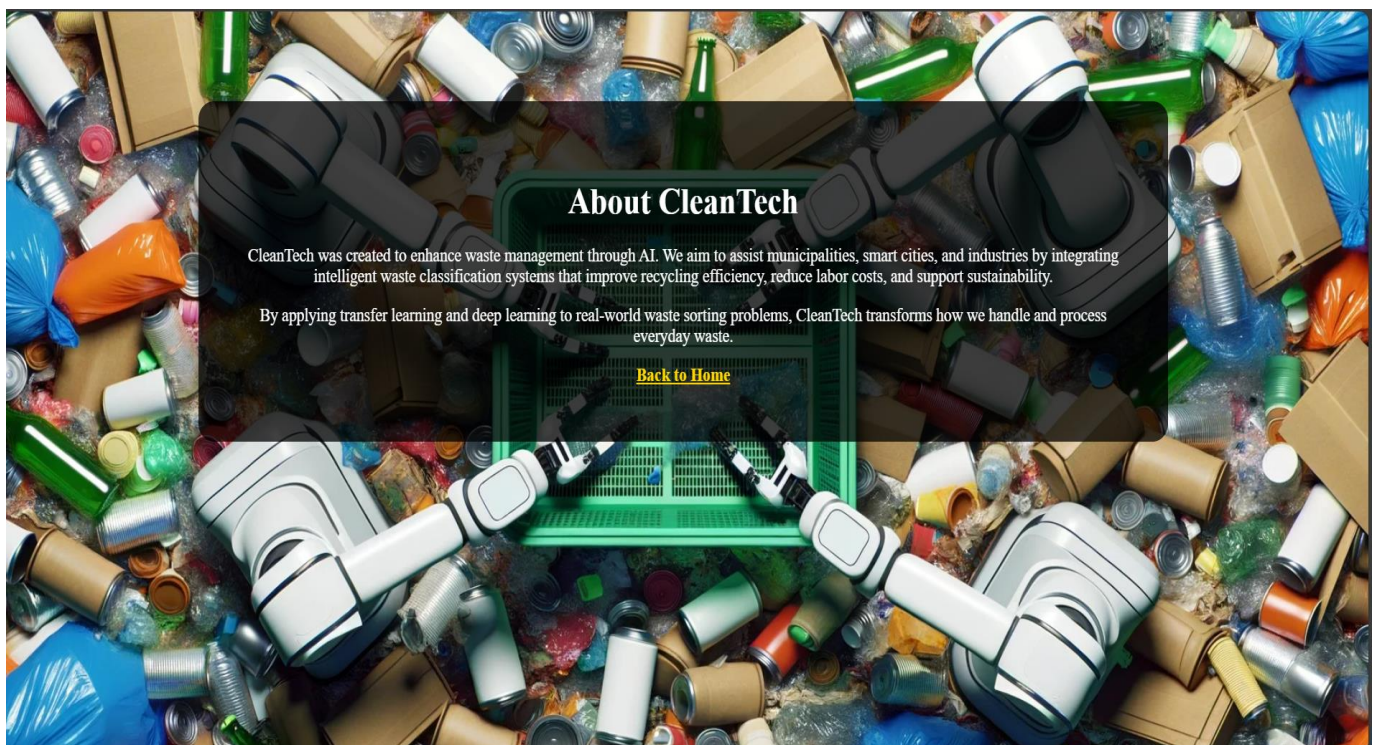


Step 3: Model Predicts(trash,biodegradable,trash)

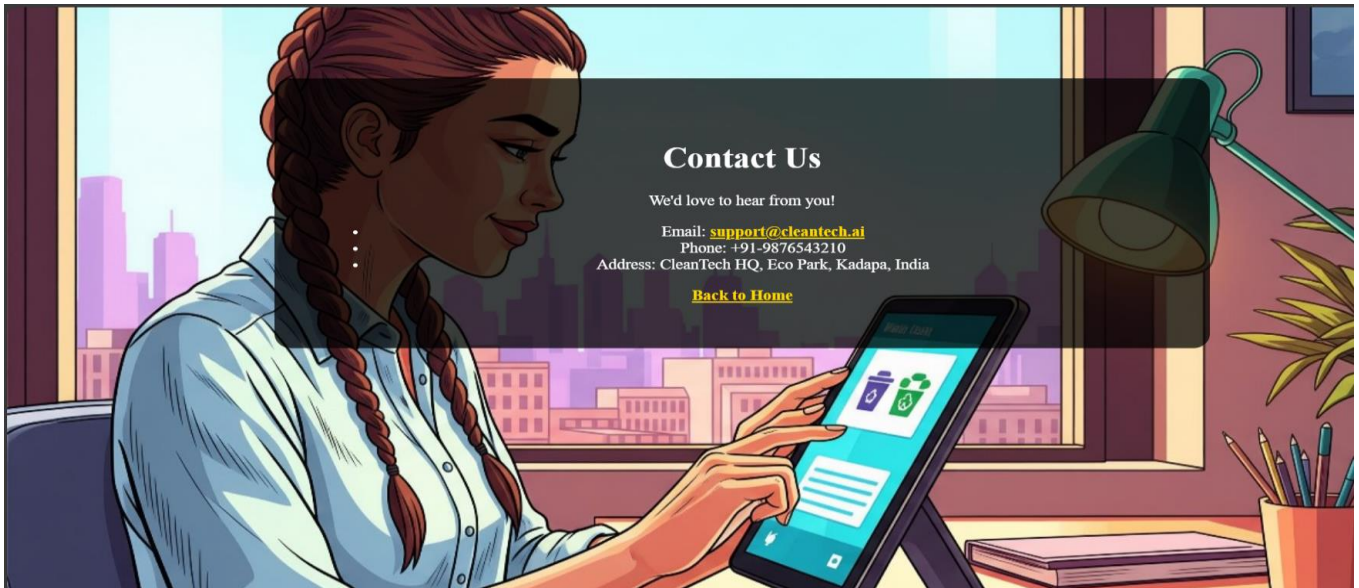




Step 3: About Page



Step 3: Contact Page



8. ADVANTAGES & LIMITATIONS

Advantages:

- Reduces manual labor in waste segregation
- High classification accuracy using transfer learning
- Easy-to-use interface
- Environmentally impactful

Limitations:

- Model depends on image quality
- Requires large, labeled datasets
- Doesn't handle mixed/ambiguous waste types yet

9. CONCLUSION

Clean Tech presents a scalable and innovative solution to modern waste management problems. With deep learning and transfer learning, the system ensures accurate waste classification, supporting both environmental efforts and smart city initiatives.

10. FUTURE SCOPE

- Add real-time video classification
- Extend to more waste types (e.g., industrial, medical)
- Integrate with IoT smart bins
- Multi-language support
- Mobile App version

11. APPENDIX

- Dataset Source: <https://www.kaggle.com/datasets/elinachen717/municipal-solid-waste-dataset>
- GitHub Link: https://github.com/bhuvanasree29/cleantech_flask_app.git
- Demo Video: https://drive.google.com/file/d/1nEHZMsnMnFQjFRZTHUleN0jTxVlZHuSq/view?usp=drive_link