CleanTech: Transforming Waste Management with Transfer Learning Project Report

1. INTRODUCTION

1.1 Project Overview

The Smart Waste Classifier is a Clean Tech solution that uses machine learning and image processing to automatically classify waste into recyclable and non-recyclable categories. The project aims to promote environmental sustainability by enabling accurate segregation at the source.

1.2 Purpose

The purpose of this project is to reduce manual effort in waste segregation, minimize human error, and increase recycling efficiency using artificial intelligence.

2. IDEATION PHASE

2.1 Problem Statement

Improper waste segregation leads to environmental damage and inefficient recycling processes. There is a lack of affordable, smart systems to automate classification at household and community levels.

2.2 Empathy Map Canvas

Think & Feel: Wants to help the environment, but finds waste segregation confusing.
Hear: Messages about global warming, pollution.
See: Overflowing garbage bins, mixed waste.
Say & Do: Discards waste without classifying due to lack of knowledge.
Pain: Confusion, inconvenience.
Gain: Easy, automated waste segregation.

2.3 Brainstorming

- Waste image classification using AI
- Smart bin integration
- Dashboard for viewing results
- Performance tracking
- Web-based or mobile interface

3. REQUIREMENT ANALYSIS

3.1 Customer Journey map

Stage	Action	Emotion	Pain Point
Awareness	Learns about the Smart Classifier	Curious	Trusting the technology
Onboarding	Uploads waste image	Hopeful	Confusion on usage
Usage	Views classification result	Satisfied	Occasional misclassification
Outcome	Separates waste accurately	Confident	Needs feedback option

3.2 Solution Requirement

- Upload image functionality
- TensorFlow-based classifier
- Dashboard to view results
- User login (optional)
- Feedback form

3.3 Data Flow Diagram

Refer to diagram section or attached image for detailed flow.

3.4 Technology Stack

- Frontend: HTML, CSS, JavaScript
- Backend: Flask or Node.js
- ML Framework: TensorFlow / Keras
- Dataset: Waste images
- Hosting: Localhost / GitHub Pages

4. PROJECT DESIGN

4.1 Problem Solution Fit

Current waste disposal systems lack classification support. A real-time classifier bridges the gap between waste generation and proper recycling.

4.2 Proposed Solution

An image-based waste classification model trained to identify organic, plastic, metal, and other waste types. Integrated with a web interface for end-user accessibility.

4.3 Solution Architecture

1. Image upload from frontend
2. Image sent to backend/model
3. Model processes and classifies
4. Result displayed in dashboard

5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning

Refer to the Product Backlog and Sprint Schedule for breakdown by sprint.

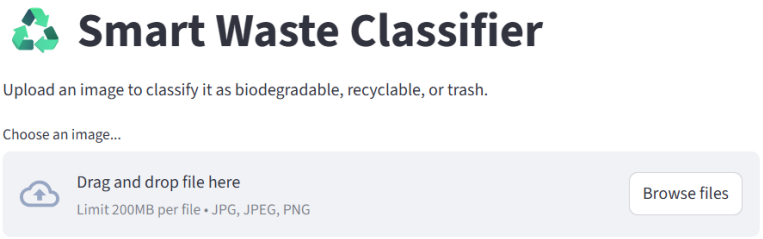
6. FUNCTIONAL AND PERFORMANCE TESTING

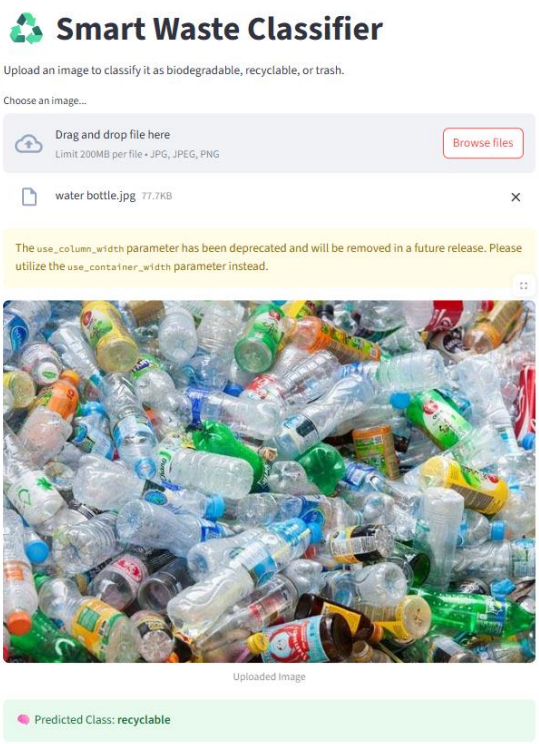
6.1 Performance Testing

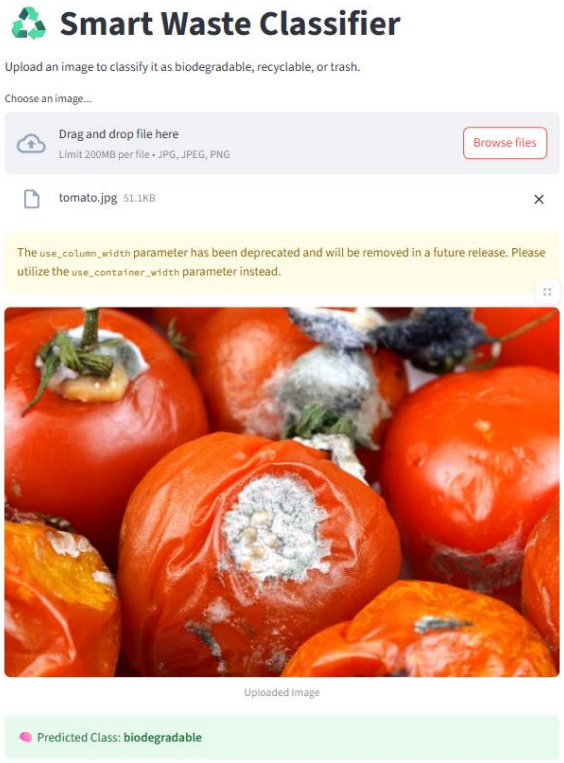
- Accuracy: ~85-90% on validation set
- Test cases: Uploaded images vs ground truth
- Time to respond: < 3 seconds per image
- Stress test: Multiple uploads handled sequentially

7. RESULTS

7.1 Output Screenshots







8. ADVANTAGES & DISADVANTAGES

Advantages:
- Automates waste segregation
- Environmentally impactful
- Easy to use interface

Disadvantages:
- May misclassify poorly lit or blurry images
- Requires internet/computer access
- Limited to trained categories

9. CONCLUSION

The Smart Waste Classifier simplifies the segregation process through AI, making recycling easier and more effective. It demonstrates the power of technology in addressing environmental challenges.

10. FUTURE SCOPE

- Integration with smart bins
- Voice commands for accessibility
- Mobile app version

- Larger dataset for more categories
- Real-time IoT implementation

11. APPENDIX

Dataset Link: https://www.kaggle.com/datasets/elinachen717/municipal-solid-waste-dataset
GitHub & Project Demo Link: https://github.com/Vanithavasa/CleanTech-Transforming-Waste-Management-with-Transfer-Learning-