A Mini Project Report on

Material Classification for Sustainable Waste Management

by

Yalka Dimple Reddy	Jogganagari Sathrika	Abdul Ateeb
HT No: 217021026011	HT No: 217021026022	HT No: 217021026144

Under the Guidance of

Mahesh Kumar
Head of the Department

Department of Computer Science

Vishwa Vishwani Institute of Systems and Management
Boston House, Thumkunta (Post),
Shamirpet Road, Via-Hakimpet,
Hyderabad-500078.

2021-2025

ABSTRACT

Every day, large amounts of waste are generated from homes, factories, and other places. As this waste keeps increasing, it creates serious problems for the environment, including pollution and the overuse of landfills. Properly sorting waste into categories like plastic, metal, glass, and paper is essential for recycling and reducing these issues. However, manual waste sorting is slow, prone to errors, and cannot handle the growing volume efficiently. This highlights the need for an automated system that can quickly and accurately classify waste to support better recycling practices and reduce environmental damage.

Traditional waste management facilities often rely on human labour for sorting different types of waste. Workers manually separate recyclable materials from waste streams based on visual inspection. Although this method is widely used, it is time-consuming, prone to human error, and inefficient in handling large-scale waste sorting demands. Most systems do not provide user-friendly interfaces or tools that engage the public in proper waste disposal practices. This gap represents a missed opportunity to integrate waste classification technologies into everyday consumer behavior, promoting broader recycling efforts through mobile apps or smart bins.

In this project, we designed and implemented a waste classification system using machine learning models, specifically focusing on convolutional neural networks (CNNs) and transformer-based models. The primary architecture consists of an ensemble approach combining ResNet-152 and Vision Transformer (ViTB/16), which leverages both deep feature extraction and attention mechanisms for classification tasks. The system aims to classify images of waste into seven predefined categories, including Cardboard, E-Waste, Glass, Medical, Metal, Paper, and Plastic. ResNet-152 was chosen for its proven success in image classification tasks, especially on large datasets. ResNet employs residual connections that help to mitigate the vanishing gradient problem in deep networks. The architecture consists of repeated residual blocks that allow the model to learn deeper representations without degradation in performance.

HARDWARE

CPU: Intel i5 12th generation

GPU: Nvidia RTX 3050 4GB

RAM: 8GB

Storage: 50GB

SOFTWARE

Operating System: Windows 11 home

Programming Language: Python

Libraries: Matplotlib, NumPy, Pandas

Frameworks: TensorFlow, Keras, Streamlit

Version Control: GitHub

MODULES

1) Data Processing and Preprocessing:

Collect the dataset, resize all images to a fixed size, and normalize them for compatibility with the model. Apply data augmentation techniques like flipping and rotation to increase model robustness.

2) Model Training Module:

Load pre-trained models (e.g., ResNet, ViT), replace the final layer for waste categories, and train on the processed dataset.

3) Ensemble Learning Module:

Combine predictions from multiple models using ensemble methods (soft, hard, or weighted voting). Evaluate and fine-tune the ensemble for better accuracy and performance than individual models.

4) Deployment Module:

Develop a web application using Streamlit for users to upload waste images for real-time classification. Integrate the trained ensemble model and display the predicted waste type with confidence scores.

5) Evaluation and Testing Module:

Test the system on unseen data and real-world scenarios, logging misclassifications for improvement. Evaluate the system's performance using metrics like accuracy, recall, and F1-score to ensure reliability.