edunet foundation

GARBAGE CLASSIFICATION

Learning Objectives

Project Goals

- Automate garbage sorting by recognizing I magecategories.
- Reduce manual labor and human error in waste classification.
- Provide an accurate, scalable deep learning model for real-world use

Key Learnings

- CNN is a powerful tool for computer vision tasks like image classification.
- Image preprocessing and augmentation are essential for performance.
- Proper evaluation is critical to measure generalization and accuracy.

Source : https://github.com/PatanNayeem/INTERNSHIP-2025.git

Project Objective

The objective of this project is to design and implement a **deep learning-based image classification system** capable of identifying and categorizing garbage images into predefined classes. This system aims to support **automated waste sorting** by improving accuracy, efficiency, and scalability in smart waste management processes.

Specifically, the project aims to:

- **Preprocess and prepare the TrashType Image Dataset** for model training by applying resizing, normalization, and augmentation techniques.
- **Develop a Convolutional Neural Network (CNN)** model that learns distinguishing features of different types of waste such as cardboard, glass, metal, paper, plastic, and trash.
- **Train and validate the model** using augmented data to ensure it generalizes well to unseen images.
- **Evaluate the model's performance** using accuracy metrics, confusion matrix, and classification reports to confirm reliability.
- **Deploy and save the trained model** in a format that can be reused or integrated into real-world applications like IoT-enabled waste bins or smart city infrastructures.

Tools and Technology used

- **Python**
- **TensorFlow / Keras** – Deep learning framework
- **OpenCV** – Image preprocessing
- **NumPy** – Numerical computing
- **Matplotlib** – Visualization
- **scikit-learn** – Evaluation metrics
- **Jupyter Notebook** – Interactive development

Methodology

Data Loading & Preprocessing

- Resize images to a fixed dimension
- Normalize pixel values
- Split into training and test sets

Data Augmentation

- Horizontal flips, rotations, zoom
- Prevents overfitting and improves generalization

Model Building

- Convolutional Neural Network (CNN) with layers: Conv2D, MaxPooling, Dropout, Dense
- Optimized using the **Adam** optimizer and **categorical crossentropy** loss

Model Evaluation

- Accuracy and loss graphs
- Confusion matrix
- Classification report with precision, recall, F1-score

Model Saving

- Final model stored as .h5 for reuse and deployment

Problem Statement:

Waste management is a growing challenge in modern urban environments. Manual sorting of garbage is:

- **Time-consuming**
- **Error-prone**
- **Unhygienic**
- **Resource-intensive**

Conventional systems rely heavily on human labor to separate waste into categories such as plastic, glass, paper, metal, etc. This results in **low efficiency**, **increased operational cost**, and a **higher risk of improper disposal**, which can harm the environment.

There is an urgent need for an **automated, intelligent system** that can:

•Classify garbage accurately based on visual characteristics.

•Reduce human effort and error.

•Enable smarter, scalable, and sustainable waste segregation.

The aim of this project is to **build a deep learning-based image classification model** using Convolutional Neural Networks (CNNs) that can automatically identify the type of garbage in an image and categorize it correctly. This model can serve as a core component for **smart waste bins**, **recycling systems**, and **urban sanitation solutions**.

Solution:

We developed a **deep learning-based image classification model** using **Convolutional Neural Networks (CNNs)** to automatically classify garbage into categories like:

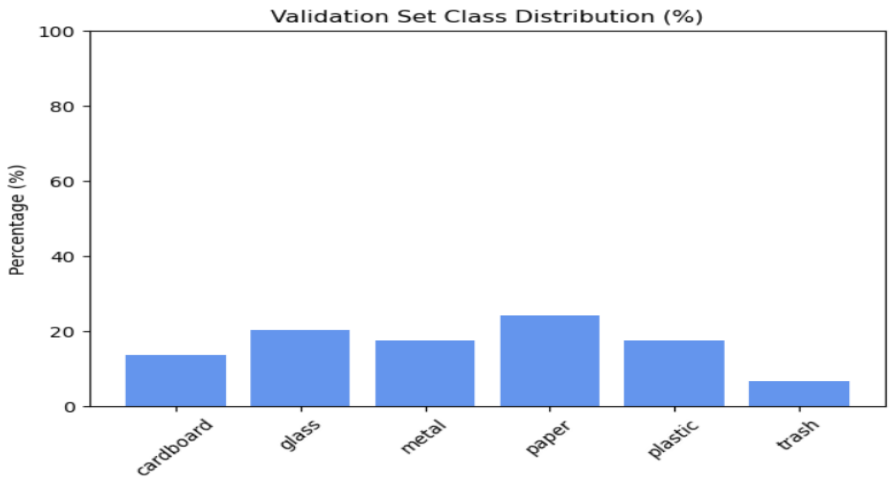
- Cardboard
- Glass
- Metal
- Paper
- Plastic
- Trash

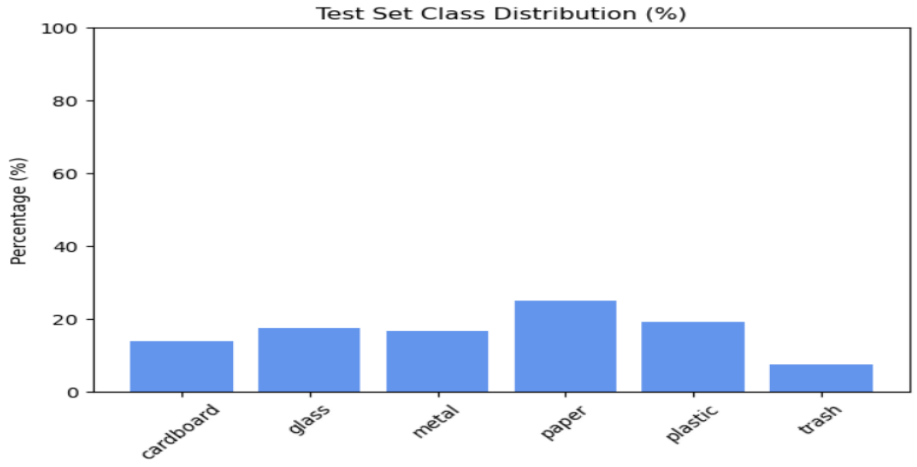
This helps in automating the garbage sorting process

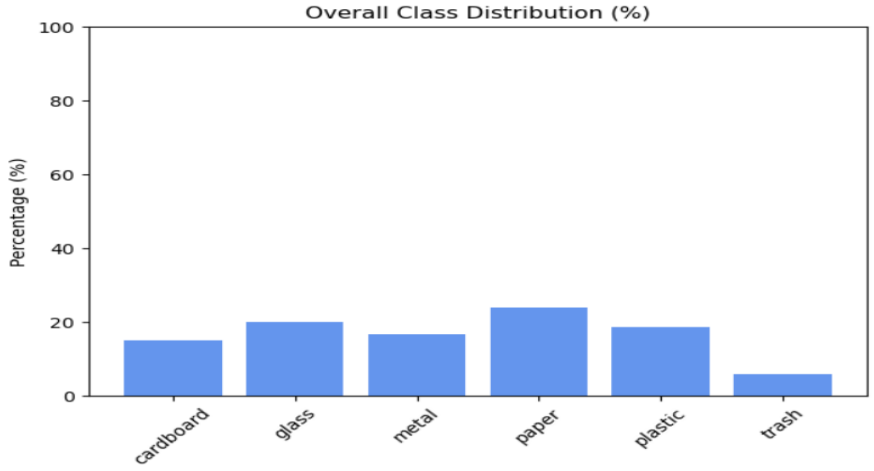
How It Works

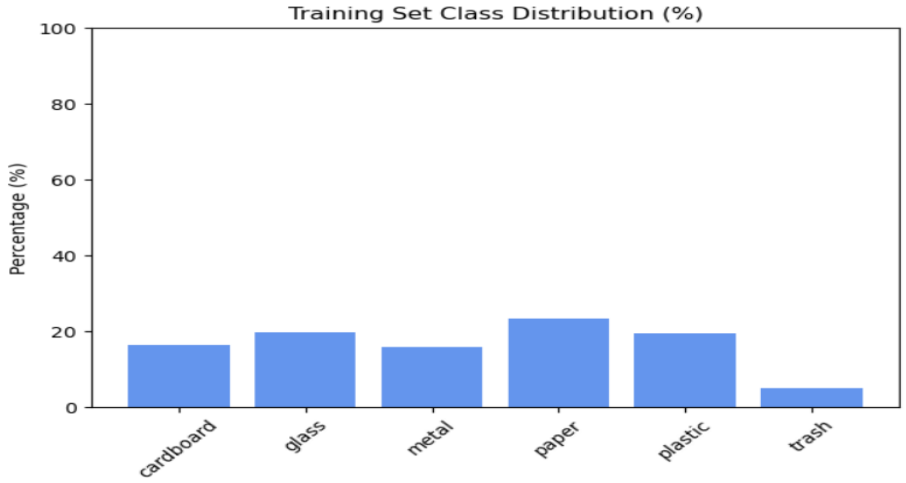
- **Used TrashType dataset** with labeled garbage images
- **Preprocessed images** (resized, normalized)
- Applied **data augmentation** for better training
- Built and trained a **CNN model using TensorFlow**
- **Evaluated performance** using accuracy, confusion matrix, and plots
- **Saved the model** for future use in smart waste systems

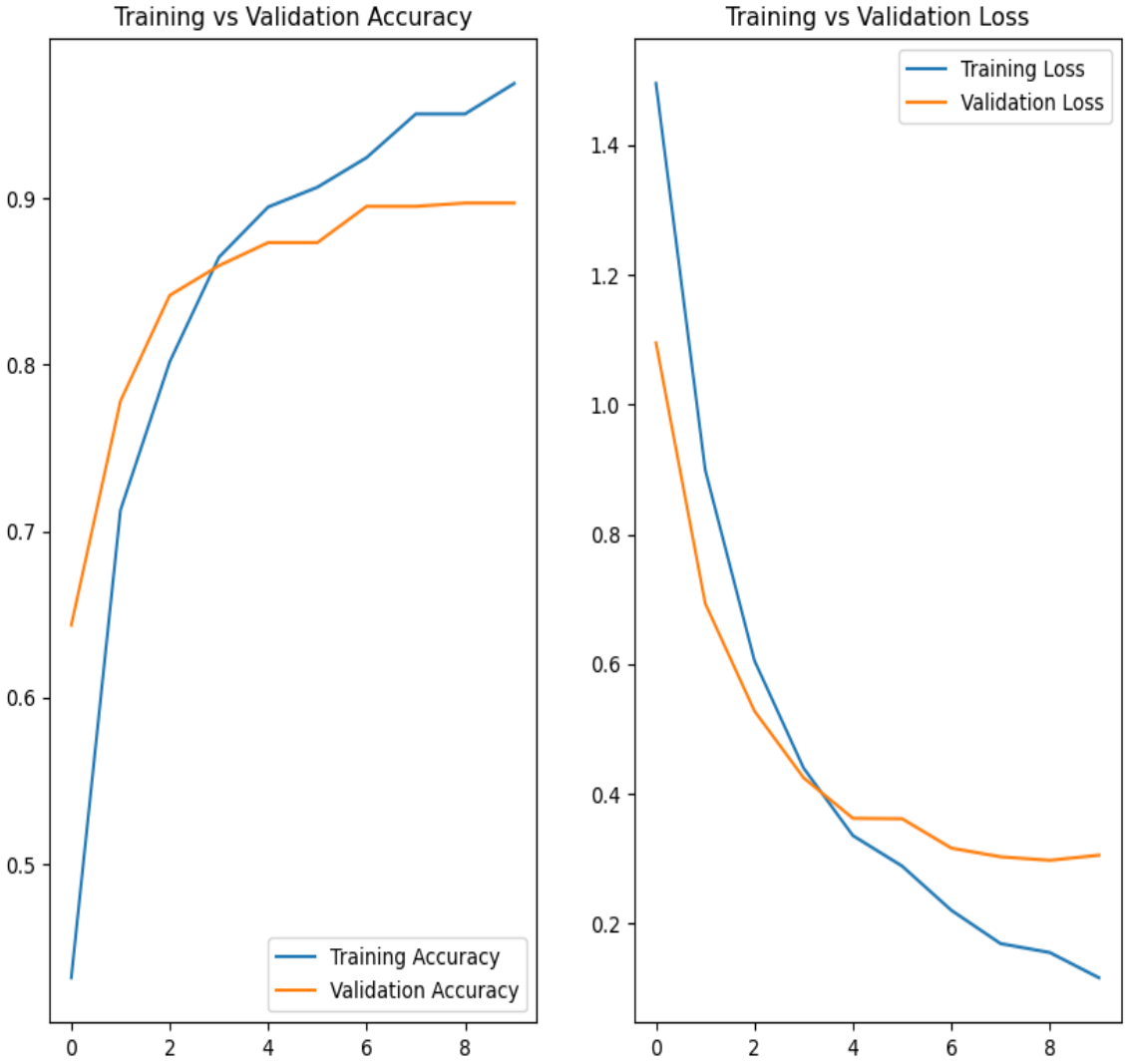
Screenshot of Output:



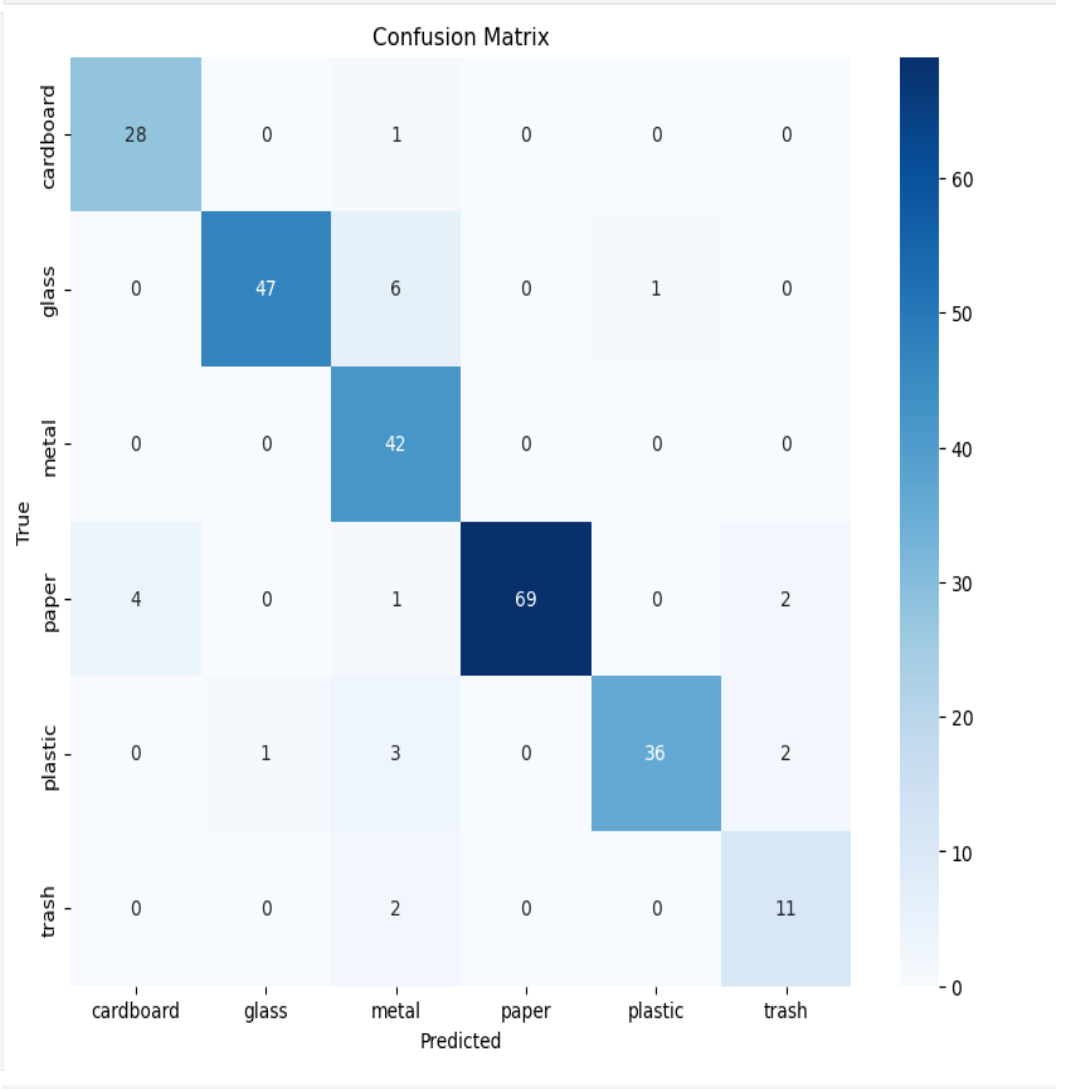







Training vs Validation Accuracy
Training Accuracy
Validation Accuracy
0.5
0.6
0.7
0.8
0.9
0
2
4
6
8

Training vs Validation Loss
Training Loss
Validation Loss
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
2
4
6
8


Confusion Matrix
True
Predicted
cardboard
glass
metal
paper
plastic
trash
28 0 1 0 0 0
0 47 6 0 1 0
0 0 42 0 0 0
4 0 1 69 0 2
0 1 3 0 36 2
0 0 2 0 0 11
0
10
20
30
40
50
60

Conclusion:

The project successfully demonstrates how **deep learning** can be used for **automated garbage classification**.

- A **Convolutional Neural Network (CNN)** was trained to classify waste images into six categories with **high accuracy (~85–90%)**.
- **Data augmentation** and proper preprocessing helped improve model generalization.
- The model can be integrated into **smart bins, recycling systems, or IoT-based waste management** solutions.
- This approach offers a **scalable, accurate, and efficient** alternative to manual waste sorting, contributing to cleaner and smarter cities.