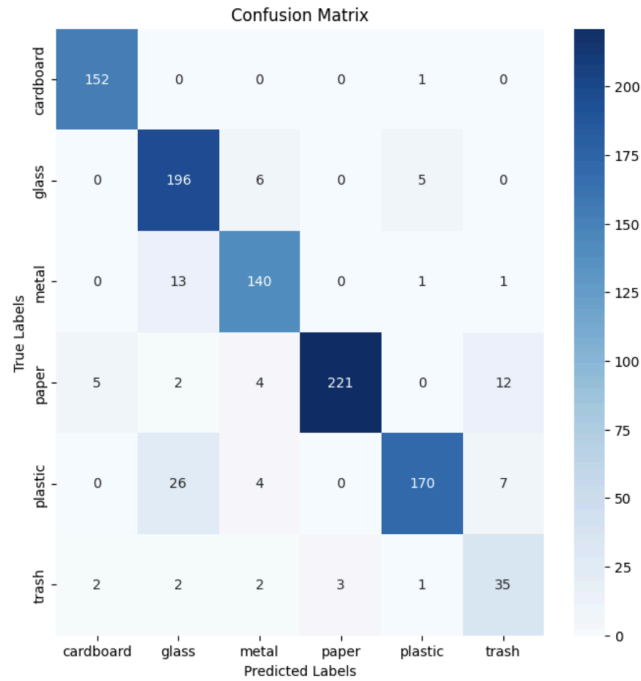


Results Appendix

I. CNN (EfficientNet) Figures

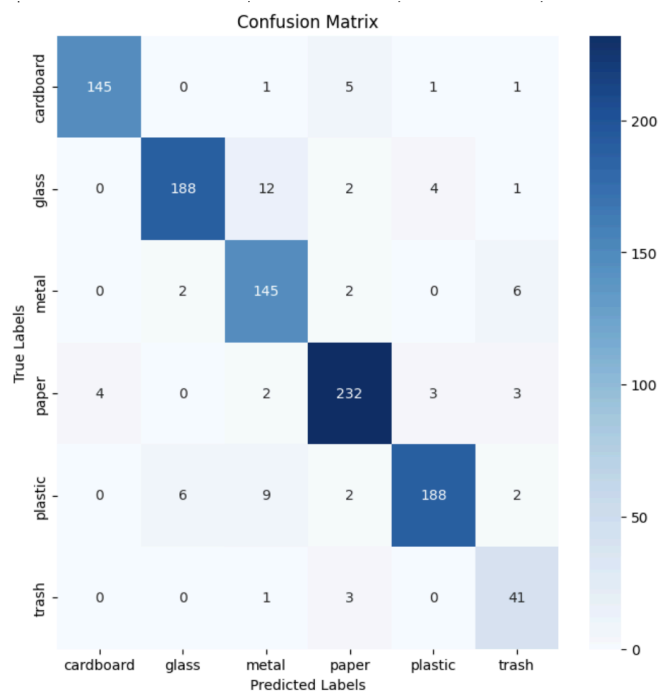


Classification Report:

	precision	recall	f1-score	support
cardboard	0.96	0.99	0.97	153
glass	0.82	0.95	0.88	207
metal	0.90	0.90	0.90	155
paper	0.99	0.91	0.94	244
plastic	0.96	0.82	0.88	207
trash	0.64	0.78	0.70	45
accuracy			0.90	1011
macro avg	0.88	0.89	0.88	1011
weighted avg	0.91	0.90	0.91	1011

Epoch 1/4 - Train Loss: 0.5556, Train Acc: 0.8048, Val Loss: 0.2959, Val Acc: 0.9041

Figure 1. Epoch 1 for EfficientNet

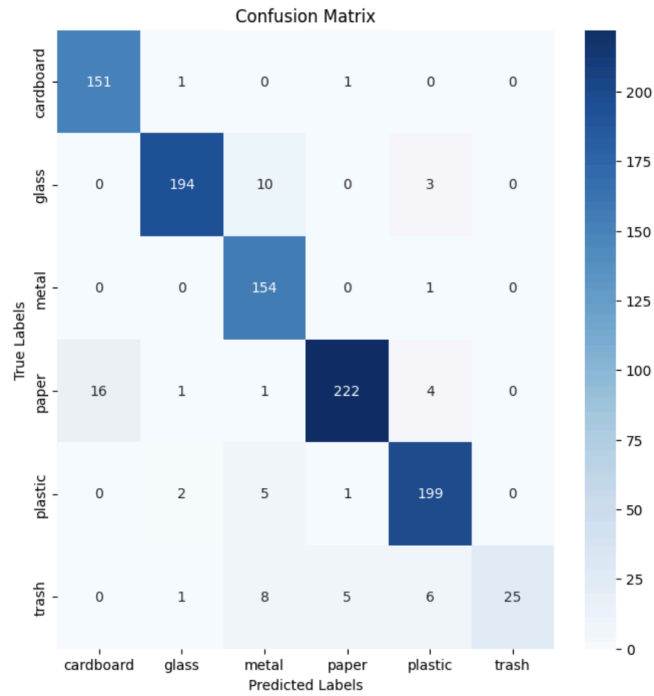


Classification Report:

	precision	recall	f1-score	support
cardboard	0.97	0.95	0.96	153
glass	0.96	0.91	0.93	207
metal	0.85	0.94	0.89	155
paper	0.94	0.95	0.95	244
plastic	0.96	0.91	0.93	207
trash	0.76	0.91	0.83	45
accuracy			0.93	1011
macro avg	0.91	0.93	0.92	1011
weighted avg	0.93	0.93	0.93	1011

Epoch 2/4 – Train Loss: 0.3078, Train Acc: 0.9011, Val Loss: 0.2249, Val Acc: 0.9288

Figure 2. Epoch 2 for EfficientNet

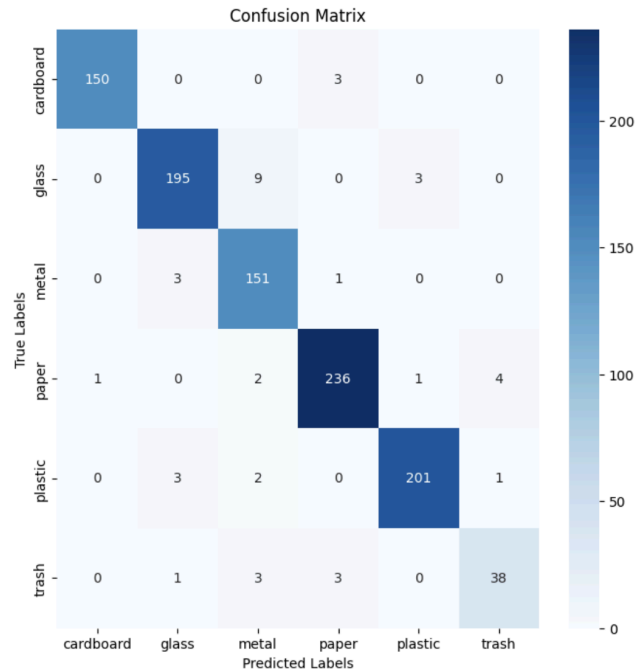


Classification Report:

	precision	recall	f1-score	support
cardboard	0.90	0.99	0.94	153
glass	0.97	0.94	0.96	207
metal	0.87	0.99	0.92	155
paper	0.97	0.91	0.94	244
plastic	0.93	0.96	0.95	207
trash	1.00	0.56	0.71	45
accuracy			0.93	1011
macro avg	0.94	0.89	0.90	1011
weighted avg	0.94	0.93	0.93	1011

Epoch 3/4 – Train Loss: 0.2141, Train Acc: 0.9305, Val Loss: 0.2033, Val Acc: 0.9347

Figure 3. Epoch 3 for EfficientNet



Classification Report:				
	precision	recall	f1-score	support
cardboard	0.99	0.98	0.99	153
glass	0.97	0.94	0.95	207
metal	0.90	0.97	0.94	155
paper	0.97	0.97	0.97	244
plastic	0.98	0.97	0.98	207
trash	0.88	0.84	0.86	45
accuracy			0.96	1011
macro avg	0.95	0.95	0.95	1011
weighted avg	0.96	0.96	0.96	1011

Epoch 4/4 – Train Loss: 0.1607, Train Acc: 0.9478, Val Loss: 0.1249, Val Acc: 0.9604

Figure 4. Epoch 4 for EfficientNet

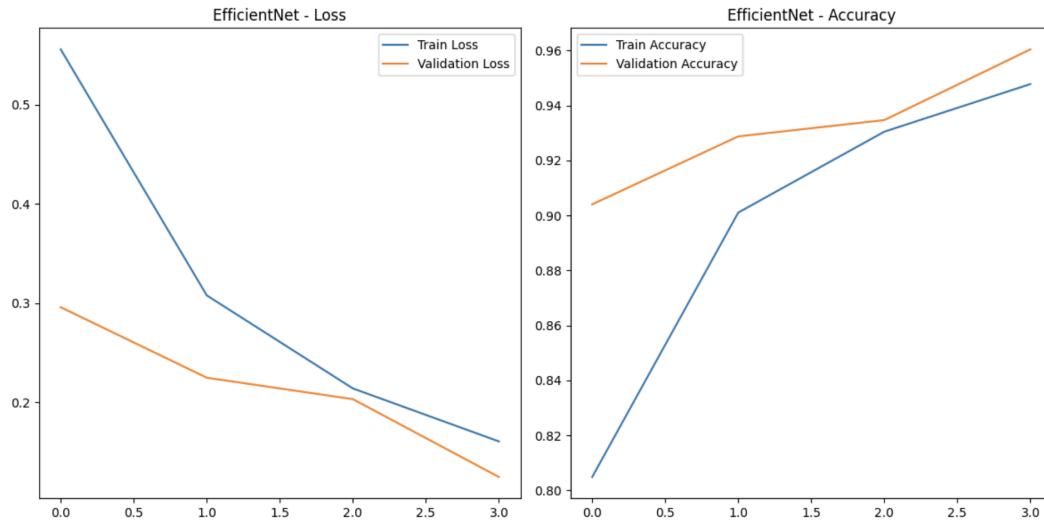
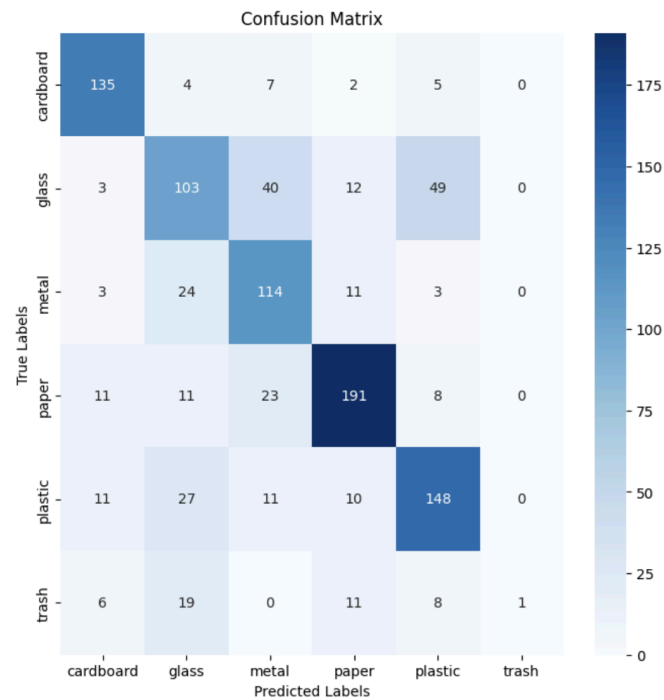


Figure 5. Loss and Accuracy Graphs for EfficientNet

Over the 4 epochs, the EfficientNet model demonstrated steady improvement, with training accuracy rising from 80.48% to 94.78% and validation accuracy reaching 96.04%. Both training and validation loss consistently decreased, indicating effective learning. The slightly higher training loss compared to validation loss likely reflects the impact of regularization or data augmentation rather than a need for additional epochs. The model performed strongly on classes like cardboard, metal, paper, and plastic, achieving high precision, recall, and F1-scores. However, the trash class struggled with relatively lower metrics, particularly recall (84% in Epoch 4), potentially due to class imbalance or overlapping features with other categories. Addressing the underperformance of 'trash' through increased representation, data augmentation, or refined features could further enhance results. By Epoch 4, the model appears to have converged, achieving high overall accuracy (96%) and robust performance, with room for targeted improvements.

II. CNN (ResNet50) Figures

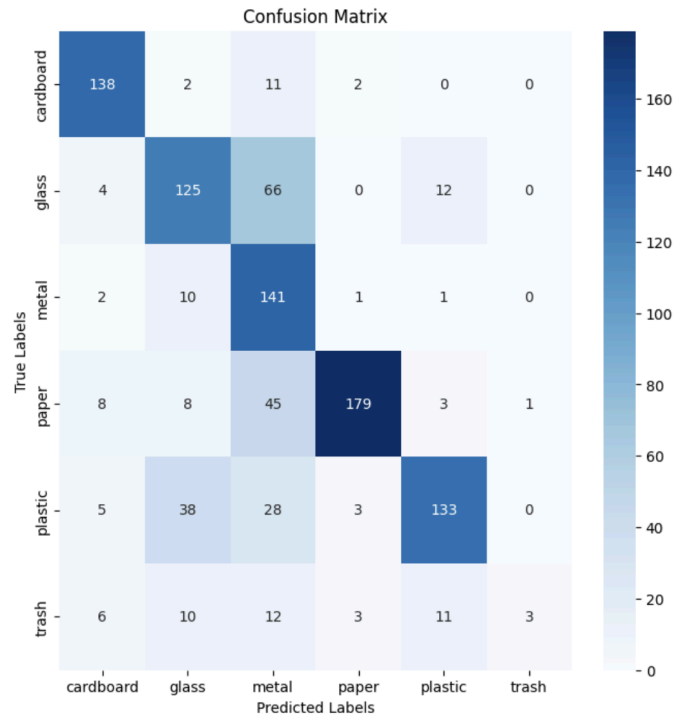


Classification Report:

	precision	recall	f1-score	support
cardboard	0.80	0.88	0.84	153
glass	0.55	0.50	0.52	207
metal	0.58	0.74	0.65	155
paper	0.81	0.78	0.79	244
plastic	0.67	0.71	0.69	207
trash	1.00	0.02	0.04	45
accuracy			0.68	1011
macro avg	0.73	0.61	0.59	1011
weighted avg	0.70	0.68	0.67	1011

Epoch 1/4 – Train Loss: 1.1651, Train Acc: 0.5657, Val Loss: 0.8632, Val Acc: 0.6845

Figure 6. Epoch 1 for ResNet50

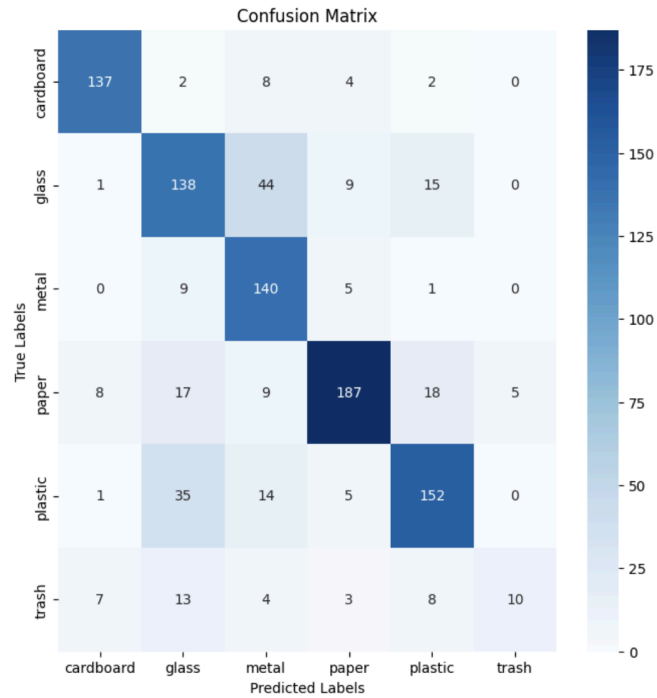


Classification Report:

	precision	recall	f1-score	support
cardboard	0.85	0.90	0.87	153
glass	0.65	0.60	0.62	207
metal	0.47	0.91	0.62	155
paper	0.95	0.73	0.83	244
plastic	0.83	0.64	0.72	207
trash	0.75	0.07	0.12	45
accuracy			0.71	1011
macro avg	0.75	0.64	0.63	1011
weighted avg	0.77	0.71	0.71	1011

Epoch 2/4 - Train Loss: 0.8120, Train Acc: 0.6982, Val Loss: 0.8106, Val Acc: 0.7112

Figure 7. Epoch 2 for ResNet50

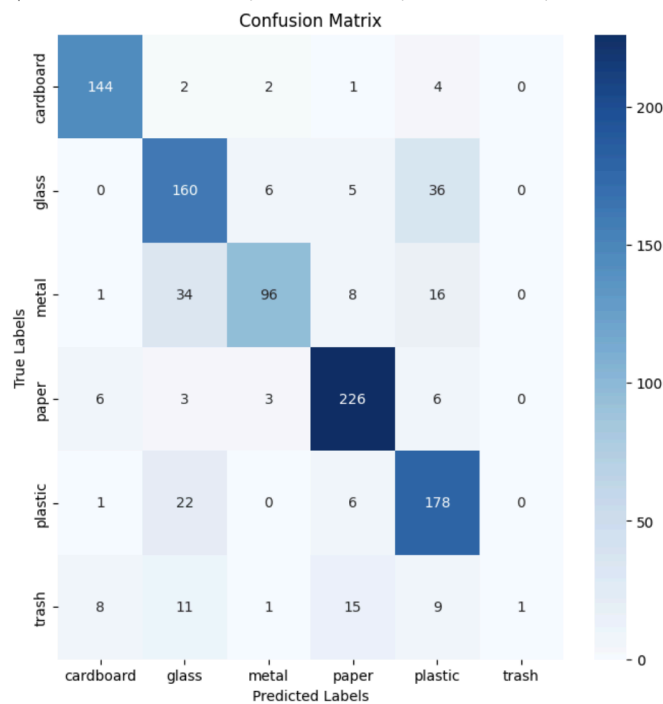


Classification Report:

	precision	recall	f1-score	support
cardboard	0.89	0.90	0.89	153
glass	0.64	0.67	0.66	207
metal	0.64	0.90	0.75	155
paper	0.88	0.77	0.82	244
plastic	0.78	0.73	0.75	207
trash	0.67	0.22	0.33	45
accuracy			0.76	1011
macro avg	0.75	0.70	0.70	1011
weighted avg	0.77	0.76	0.75	1011

Epoch 3/4 - Train Loss: 0.7119, Train Acc: 0.7430, Val Loss: 0.6761, Val Acc: 0.7557

Figure 8. Epoch 3 for ResNet50



Classification Report:

	precision	recall	f1-score	support
cardboard	0.90	0.94	0.92	153
glass	0.69	0.77	0.73	207
metal	0.89	0.62	0.73	155
paper	0.87	0.93	0.90	244
plastic	0.71	0.86	0.78	207
trash	1.00	0.02	0.04	45
accuracy			0.80	1011
macro avg	0.84	0.69	0.68	1011
weighted avg	0.81	0.80	0.78	1011

Epoch 4/4 – Train Loss: 0.6166, Train Acc: 0.7757, Val Loss: 0.6274, Val Acc: 0.7962

Figure 9. Epoch 4 for ResNet50

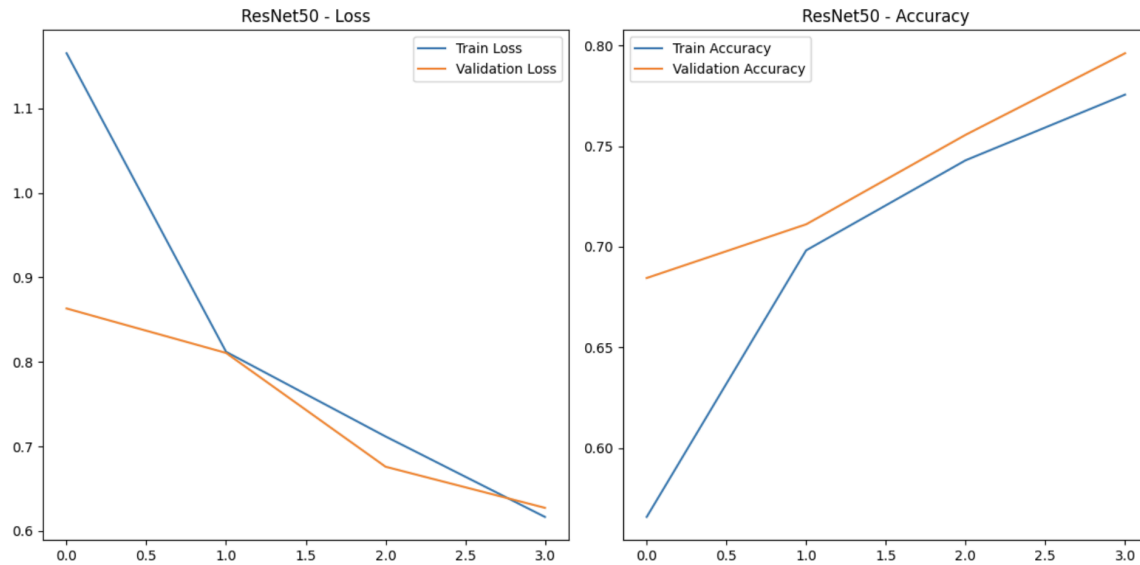


Figure 10. Loss and Accuracy Graphs for ResNet10

Over the 4 epochs, the ResNet50 model showed steady improvement in both training and validation metrics. Training accuracy rose from 56.57% in Epoch 1 to 77.57% in Epoch 4, while validation accuracy improved from 68.45% to 79.62%. Training and validation loss consistently decreased, indicating effective learning and convergence. The slightly lower validation loss compared to training loss likely reflects regularization or data augmentation effects rather than overfitting, making 4 epochs a reasonable stopping point. The model performed strongly on classes such as cardboard and paper, achieving high F1-scores by the final epoch. However, categories like 'trash' struggled significantly, with a recall of only 2% and an F1-score of 0.04. This suggests the need for targeted improvements, potentially through addressing class imbalance, feature refinement, or additional data augmentation. While the model shows promise for waste classification, significant variability across classes highlights the importance of further refinement to achieve balanced performance. Overall, ResNet50 demonstrates potential but requires additional optimization to address underperforming categories like 'trash.'