project Report: Waste Classification Using Transfer Learning

Project Title

CleanTech: Transforming Waste Management Using Transfer Learning

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Internship Platform

SmartInternz

Domain

Artificial Intelligence & machine learning

Objective

The main goal of this project is to build a smart waste classification system using deep learning and transfer learning techniques. The system classifies uploaded waste images into five categories — **Cardboard**, **Glass**, **Paper**, **Plastic**, and **Trash** — to support automated waste segregation and promote clean and sustainable waste management practices.

Tools & Technologies Used

- Python – Programming language
- TensorFlow / Keras – Deep learning framework
- MobileNetV2 – Transfer learning model
- Flask – Web framework for backend

- HTML / CSS – Frontend web interface
- VS Code – Code editor
- Kaggle – Waste image dataset source

Dataset Description

- **Source**: Kaggle
- **Classes**: Plastic, Trash, Glass, Paper, Cardboard
- **Type**: Image dataset
- **Structure**: Each class is stored in a separate folder
- **Preprocessing**:
    - Image resizing to 224x224
    - Normalization (rescale to [0, 1])
    - Data augmentation (horizontal flip, zoom)

Model Architecture

- **Base Model**: MobileNetV2 (pretrained on ImageNet)
- **Modifications**:
    - Frozen base layers
    - Added Global Average Pooling layer
    - Dense layer with 128 units (ReLU)
    - Output layer with 5 units (Softmax)

- **Loss Function**: Categorical Crossentropy
- **Optimizer**: Adam
- **Epochs**: 5
- **Metrics**: Accuracy

Web Application Workflow

1. User uploads an image using a simple HTML form.
2. Flask receives the image and preprocesses it.
3. The trained deep learning model predicts the waste category.
4. The result is returned to the browser and displayed on the page.

Project Structure

cpp
CopyEdit

```
waste_classifier_project/
├── app.py
├── waste_model.h5
├── templates/
│   └── index.html
├── static/
│   └── (uploaded images or styling)
├── requirements.txt
└── README.md
```

Output Example

Input Image	Predicted Class

plastic_bottle.jpg	Plastic
brown_box.jpg	Cardboard

Results & Accuracy

- **Training Accuracy**: ~90%
- **Validation Accuracy**: ~85%
- **Inference Time**: < 1 second per image

Future Scope

- Integration with IoT smart bins for real-time classification
- Cloud deployment using services like AWS or Heroku
- Real-time dashboards to monitor waste segregation
- Support for more waste categories (e-waste, metal, food waste, etc.)

Conclusion

This project demonstrates how transfer learning can be effectively used to solve real-world problems like waste management. The use of MobileNetV2 allows the model to perform well even with limited resources, and the Flask-based web interface makes the solution easy to use. Overall, the system can play a valuable role in promoting smart and sustainable waste handling.

Submitted By

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