**Municipal Solid Waste Classification Using Transfer Learning**

**TEAM MATES:**

A.DIVYA MEGHANA (Team Lead)

B.KUSULA KUMARI (Team memb)

B.GEETH PRANEETH(Team memb)

K.HARSHITHA(Team memb)

**INTRODUCTION:**

Waste management is a critical issue in urban development. Efficient waste classification plays a vital role in reducing environmental pollution and promoting recycling. Manual classification is time-consuming and error-prone. This project leverages transfer learning with deep learning techniques to automate the classification of municipal solid waste into three categories: Biodegradable, Recyclable, and Trash.

**OBJECTIVE**

The primary objective of this project is to build an intelligent waste classification system using a pre-trained convolutional neural network (CNN), specifically the VGG16 model. This system can classify images of waste into predefined categories with high accuracy, making waste disposal and recycling more efficient.

**TECHNOLOGIES USED**

**- Python**

- TensorFlow / Keras  
- VGG16 (Pre-trained CNN Model)  
- Flask (for web application)  
- HTML, CSS (for frontend design)  
- Jupyter Notebook (for model training and testing)

**DATASET DESCRIPTION**

The dataset used in this project is the "Municipal Solid Waste Dataset" sourced from Kaggle. It contains images of waste labeled into three categories:

- Biodegradable  
- Recyclable  
- Trash

The dataset was split into training, validation, and test sets. Data augmentation techniques such as rotation, flipping, and zooming were applied to increase the diversity of training samples.

**METHODOLOGY**

**1. Data Preprocessing:**

- Images were resized to match the input shape required by VGG16.  
 - Applied normalization and augmentation.

**2. Transfer Learning with VGG16:**

- The top layer of VGG16 was removed.  
 - Custom layers were added for our specific classification task.  
 - The model was trained using the augmented dataset.

**3. Model Evaluation:**

- Evaluated using accuracy, precision, recall, and F1-score.  
 - Early stopping and validation monitoring were used to prevent overfitting.

**4. Model Deployment:**

- The trained model was saved as internship1.h5.  
 - A Flask-based web app was developed for real-time predictions.

**WEB APPLICATION WORKFLOW**

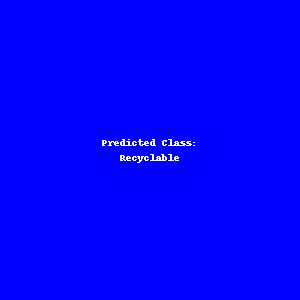
**- The user uploads a waste image.**

- The app processes the image and passes it to the trained model.  
- The model predicts the class (Biodegradable/Recyclable/Trash).  
- The result is displayed on the web page.

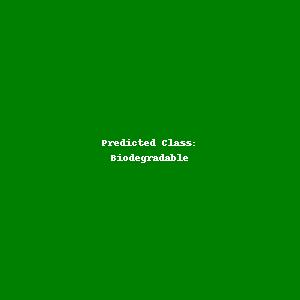
**RESULTS AND DISCUSSION**

The model achieved high accuracy on the test set, proving that transfer learning with VGG16 is effective for image-based waste classification. The web app enables users to classify waste images in real-time, promoting sustainable waste management practices**.**

**OUTPUT 1:**



**OUTPUT 2:**

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**ADVANTAGES**

**- Reduces the need for manual waste segregation.**

- Fast and accurate classification.  
- Scalable for smart city waste management systems.

**LIMITATIONS**

**- Model performance is limited by the dataset quality.**

- May not generalize well to waste images from different environments without retraining.

**FUTURE SCOPE**

**- Include more waste categories.**

- Integrate with IoT devices for smart bins.  
- Improve model performance with more advanced architectures like ResNet or EfficientNet.

**CONCLUSION**

This project demonstrates the practical application of transfer learning for solving real-world problems like waste management. The system effectively classifies municipal waste using a pre-trained deep learning model and provides a user-friendly web interface for end-users.

**-----THANK YOU-----**