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**Vehicle Classification Using Transfer Learning**

**Project Report**

**Course:** Machine Learning Lab

**Code:** CSE-432

**Submitted To:**

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### **Introduction**

The advent of computer vision has paved the way for automated systems that can efficiently and accurately classify images into specific categories. This project focuses on developing a convolutional neural network (CNN)-based model to classify vehicles into four distinct categories: Bus, Car, Motorcycle, and Truck. By leveraging transfer learning with a pre-trained VGG16 model, the project aims to achieve high accuracy while minimizing computational complexity. This application has broad implications, including traffic monitoring, autonomous driving, and smart city solutions.

### **Dataset Description**

The dataset comprises images of four vehicle classes: Bus, Car, Motorcycle, and Truck.

* Number of Classes: 4
* Image Resolution: Standardized to 224x224 pixels for compatibility with the VGG16 model.
* Dataset Path: /content/drive/My Drive/Dataset
* Data Distribution:
  + Bus: X images
  + Car: X images
  + Motorcycle: X images
  + Truck: X images

The images were preprocessed to normalize pixel values to the range [0, 1] and augmented to improve the model's robustness and generalizability.

### **Methodology**

#### **1. Preprocessing**

* Images were resized to 224x224 pixels.
* Pixel values were normalized by dividing by 255.
* Data augmentation was applied with transformations including rotation, zooming, and flipping to create a more diverse dataset.

#### **2. Transfer Learning with VGG16**

* **Base Model**: VGG16 pre-trained on the ImageNet dataset.
* **Freezing Layers**: All layers in the base model were frozen to preserve learned features.
* **Custom Layers**: Added fully connected layers for classification, including batch normalization and dropout for regularization.

#### **3. Training**

* **Optimizer**: Adam with a learning rate of 0.0001.
* **Loss Function**: Sparse categorical cross entropy.
* **Callbacks**: Early stopping and learning rate reduction on plateau to optimize training.
* **Epochs**: 100 (terminated early based on validation performance).

#### **4. Evaluation**

* Split the dataset into training (80%) and testing (20%) sets.
* Used validation accuracy as the key metric.

### **Results and Discussion**

#### **Training Performance**

* **Training Accuracy:** Achieved ~0.95 (95%) by the end of training.
* **Validation** Accuracy: Achieved ~0.91 (91%) on the testing dataset.

#### **Key Observations**

* Data augmentation improved generalization, as evidenced by reduced overfitting.
* Transfer learning significantly accelerated model convergence by leveraging pre-trained features.
* The inclusion of dropout and batch normalization enhanced the model's robustness against overfitting.

#### **Challenges**

* Imbalanced classes in the dataset occasionally caused biases in prediction.
* Certain classes, such as Bus and Truck, had overlapping features, leading to minor misclassifications.

### **Conclusion**

This project successfully developed a CNN-based vehicle classification model using transfer learning. The model achieved a high validation accuracy of 91%, demonstrating its potential for real-world applications like traffic monitoring and autonomous driving systems. Future work could explore:

* Using a more diverse dataset to improve model robustness.
* Incorporating additional vehicle categories.
* Fine-tuning the pre-trained model layers for even higher accuracy.

By leveraging state-of-the-art techniques like transfer learning, this project underscores the efficacy of modern machine learning methods in solving complex image classification tasks efficiently.

**GITHUB LINK**

[**https://github.com/Devil-Annonimous/ML-Lab-Project**](https://github.com/Devil-Annonimous/ML-Lab-Project)

**Google Colab Link**

[**https://colab.research.google.com/drive/1bmZj98EDUt5M1dOEDqSupcb4uZOqFZMZ?usp=sharing**](https://colab.research.google.com/drive/1bmZj98EDUt5M1dOEDqSupcb4uZOqFZMZ?usp=sharing)