Project Documentation: Road Sign Classification Using Deep Learning

# 1. Introduction

In the era of autonomous vehicles and intelligent transportation systems, the ability to recognize road signs is critical for safety and navigation. This project focuses on building a Convolutional Neural Network (CNN)-based image classifier that can accurately identify various road signs from images using deep learning techniques. A pre-trained EfficientNetB3 architecture was used to enhance performance and reduce training time.

# 2. Aim

The goal of this project is to develop a highly accurate and efficient image classification model that can identify traffic signs from images. This model can be integrated into real-time applications such as self-driving cars, driver assistance systems, and traffic monitoring solutions.

# 3. Business Problem / Problem Statement

In traffic systems, timely and accurate detection of road signs is vital for safe vehicle operation. Manual sign recognition is error-prone and impractical in real-time scenarios. Hence, automating the process with AI improves decision-making, reduces accidents, and enables smart transport systems.

# 4. Project Workflow

1. Data Collection and Loading

2. Image Preprocessing

3. CNN Model Building (with EfficientNetB3)

4. Model Training

5. Evaluation and Metrics

6. Streamlit Web App Development

7. Insights and Documentation

# 5. Data Understanding

The dataset consists of road sign images grouped in folders representing each sign class. Each class contains multiple images under different lighting and angles. Additionally, a labels file (CSV or Excel) maps each folder/class to the corresponding road sign name.

# 6. Data Preprocessing

- Loaded images using TensorFlow's image\_dataset\_from\_directory.

- Resized all images to a uniform shape (e.g., 224x224).

- Normalized pixel values to improve convergence.

- Encoded labels numerically.

- Split the data into training, validation, and test sets.

# 7. Model Architecture

- Utilized EfficientNetB3 with 'imagenet' weights for transfer learning.

- Added a custom classification head:

- GlobalAveragePooling

- Dropout

- Dense layers with softmax activation.

- Compiled with categorical\_crossentropy loss and Adam optimizer.

# 8. Training and Evaluation

- Trained the model over multiple epochs with early stopping and learning rate scheduling.

- Evaluation metrics used:

- Accuracy

- Classification Report (Precision, Recall, F1-score)

- Confusion Matrix

- Achieved training and test accuracy above 95%.

# 9. Streamlit App (Deployment)

- Developed an interactive Streamlit interface.

- Users can upload images of road signs.

- The model displays the predicted sign label and confidence score.

- Ensures user-friendly deployment for non-technical stakeholders.

# 10. Insights from Analysis

- EfficientNetB3 provided excellent accuracy with minimal training time.

- Model generalizes well across various sign types and lighting conditions.

- Some misclassifications occurred with low-quality or ambiguous images.

- Real-time prediction using Streamlit is smooth and accurate on GPU.

# 11. Conclusion

This Road Sign Classification project demonstrates how deep learning, particularly CNNs with transfer learning, can effectively solve computer vision problems. With strong performance metrics and a user-facing app, the solution is ready for integration into real-world intelligent transport systems.