Traffic Sign Recognition using CNN

1. Introduction

Traffic sign recognition is a crucial task in autonomous driving and driver assistance systems. The aim of this project was to build a deep learning-based model capable of identifying and classifying traffic signs from images using a Convolutional Neural Network (CNN).

2. Dataset Description

The dataset used in this project is the German Traffic Sign Recognition Benchmark (GTSRB). It consists of traffic sign images belonging to 43 different classes. The dataset is structured as follows:

- Training data: 39,209 images stored in subfolders named 0, 1, 2, ..., 42 corresponding to class IDs.
- Testing data: 12,630 images structured in the same way.

Each image is labeled with its corresponding class ID, and the dataset covers a wide variety of traffic signs including speed limits, prohibitions, warnings, and other regulatory signs.

3. Data Preprocessing

The images were preprocessed to prepare them for training:
- Resized to 32x32 pixels.
- Normalized to a range of [0,1].
- Converted into NumPy arrays.
- Training and testing datasets were created with the following shapes:
  - Training data: (39209, 32, 32, 3)
  - Training labels: (39209,)
  - Testing data: (12630, 32, 32, 3)
  - Testing labels: (12630,)

4. Model Architecture

A Convolutional Neural Network (CNN) was used to train the classifier. The network consists of the following layers:
- Convolutional layers with ReLU activation
- MaxPooling layers for dimensionality reduction
- Dropout layers to prevent overfitting

- Fully connected dense layers
- Softmax output layer with 43 neurons corresponding to the traffic sign classes

5. Model Training

The model was trained for 15 epochs. The training process showed steady improvement:
- Initial accuracy: ~35% with a high loss value.
- After 5 epochs: Training accuracy reached 95%, validation accuracy 98%.
- Final accuracy: ~99% on training and ~99.4% on validation.

This demonstrates the strong learning capability of CNN for image classification.

6. Results

The trained model achieved the following results:
- Final validation accuracy: 99.45%
- Test accuracy: 95.91%

These results indicate that the model generalizes well to unseen data.

7. Model Saving

The model was saved in HDF5 format as 'traffic_sign_model.h5'. Although HDF5 is now considered a legacy format, it is still widely supported. Future recommendations suggest using the newer '.keras' format for saving models.

8. Conclusion

This project successfully built and trained a CNN model for traffic sign recognition using the GTSRB dataset. The model achieved high accuracy on both validation and test sets, making it suitable for integration in real-world traffic systems such as autonomous vehicles and driver assistance technologies.