Traffic Signs Classification Using Convolutional Neural Networks

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CSEL-4104

Objective

- Develop a system to recognize and classify traffic signs using CNNs.
- Integrating DIP techniques and CNNs for accurate traffic sign classification.
- Essential for autonomous driving, smart driving assistance, and traffic safety analysis.

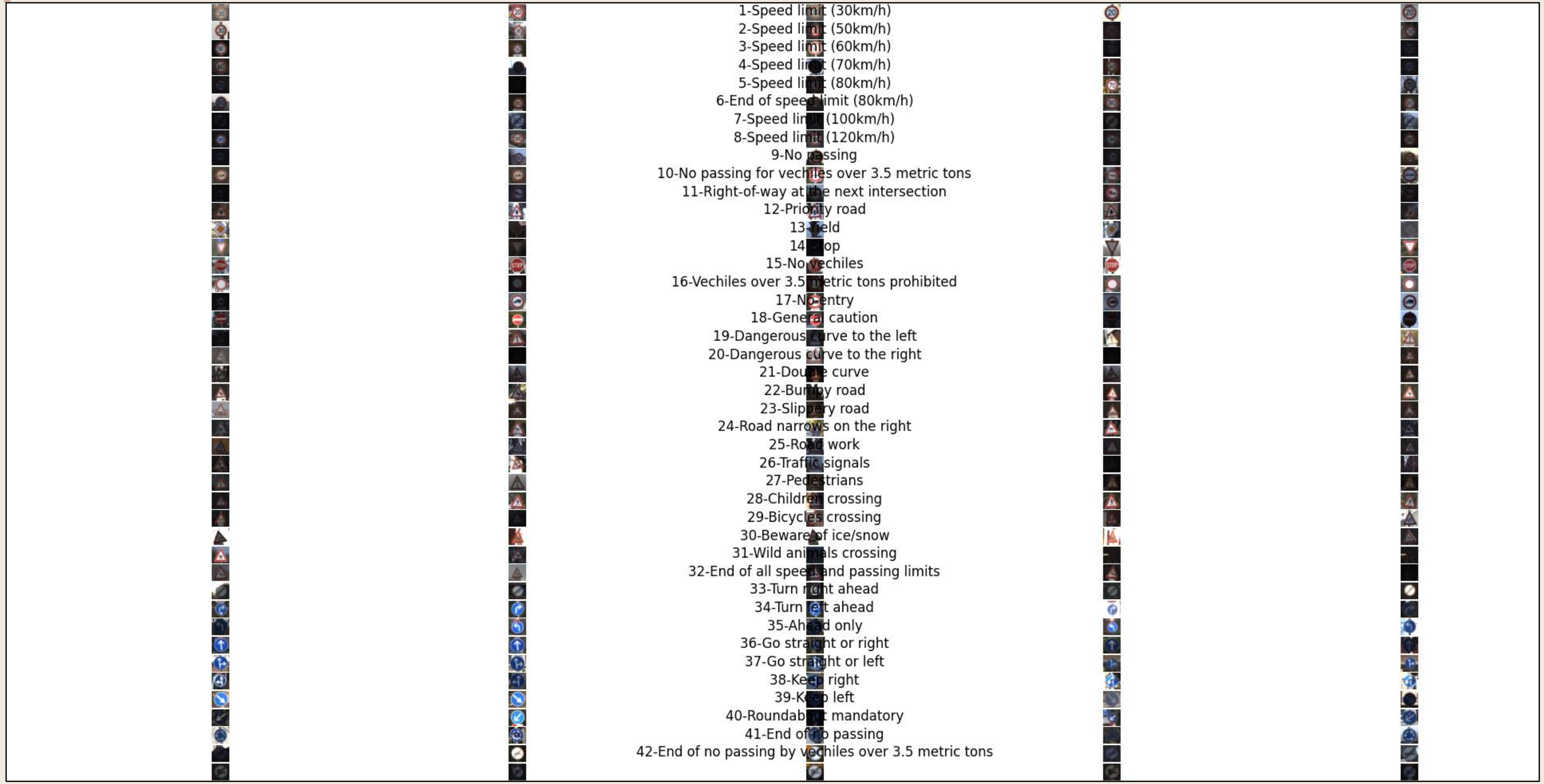
Motivation

- To make road navigation safer and more informed for both drivers and pedestrians.
- To enable seamless, on-the-go identification of traffic signs for all road users, not just vehicles.

Image Acquisition & Dataset

- **Dataset:** German Traffic Sign Recognition Benchmark (GTSRB)
- **Image Details:**
  - More than 35,000 images
  - Each sized 32x32 pixels
- **Classes:** Speed limits, warning signs, prohibitory signs, and other types, with a total of 43 different classes.

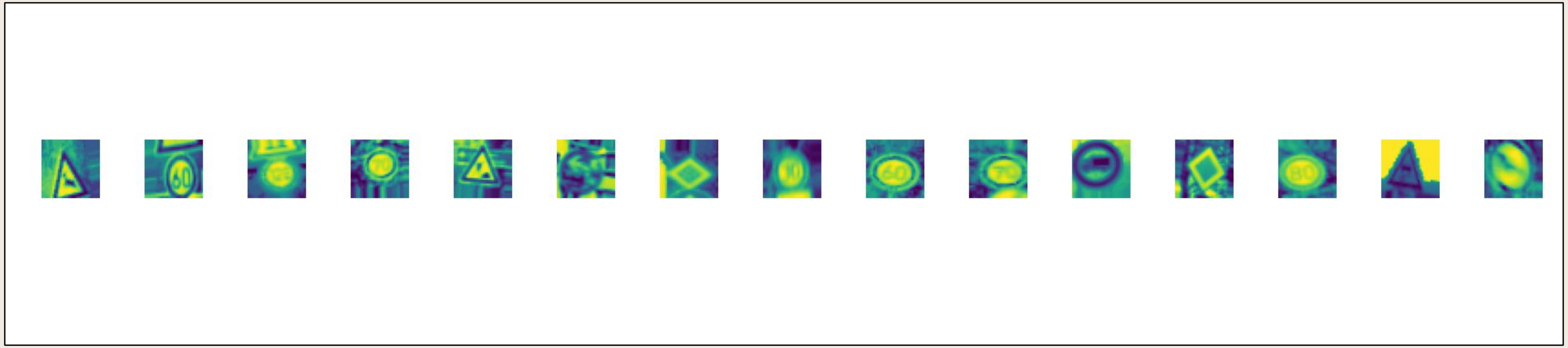
Dataset Overview



Data Preprocessing

- Grayscale conversion for simplified processing.
- Histogram equalization for better contrast.
- Data normalization to standardize data.
- Scaling pixel values to a range [0, 1] to enhance model performance.

Converted Gray Scale Images



Data Augmentation

- **Techniques Used:**
  - Width and height shifting
  - Zoom and shear transformations
  - Rotation for angle diversity
- **Purpose:** To improve model generalization by generating variations of the original images.

How CNN Utilizes DIP in This Project

- **Convolution layers** for feature extraction.
- **Pooling layers** for dimensionality reduction.
- **Dropout layers** to prevent overfitting.
- **Dense layers** for feature integration.
- **ReLU** and **Softmax** functions for activation and classification outputs.

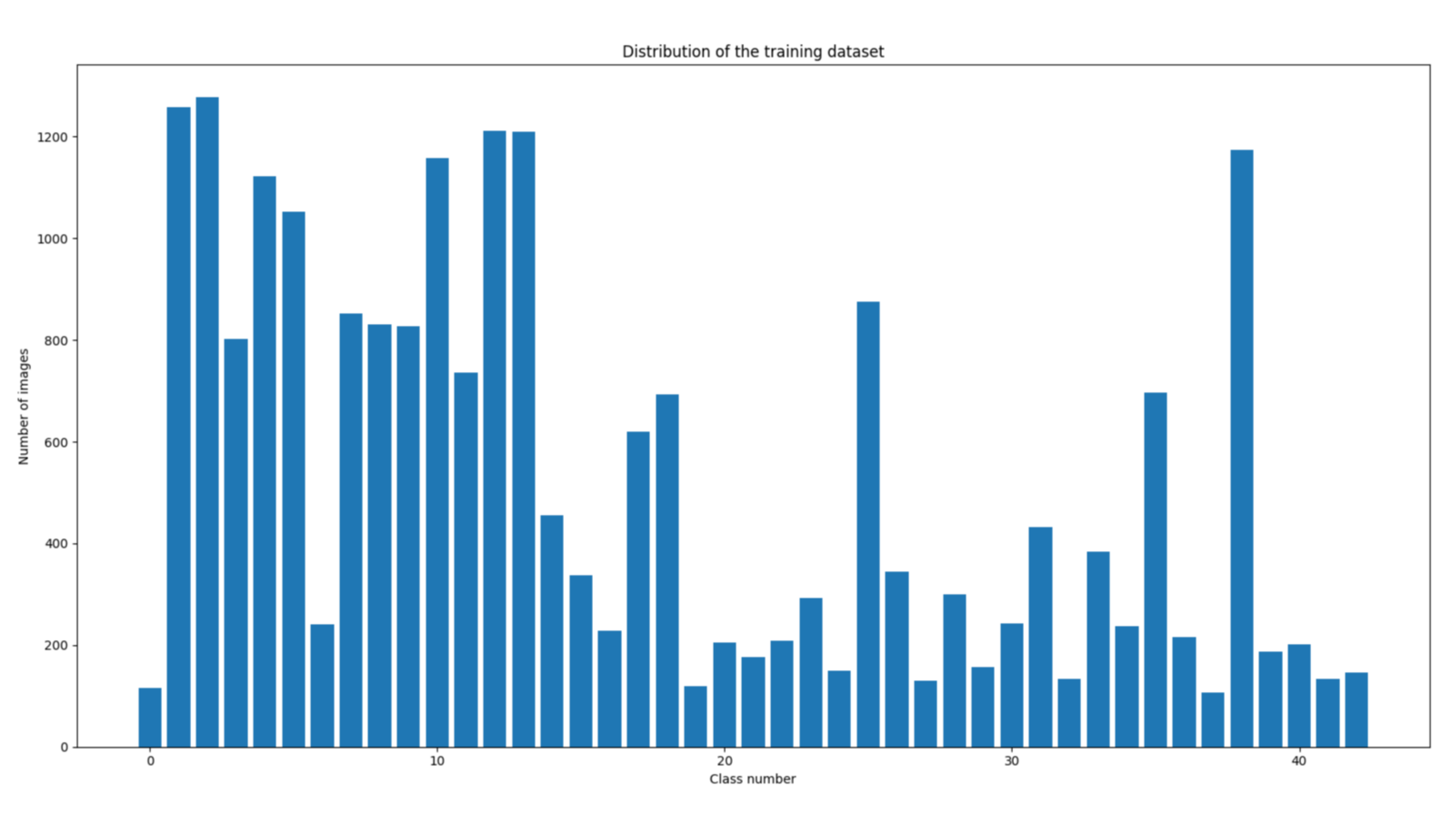
Process of Model Training

- **Data Splitting:**
    - **Training Set:** 80% of the dataset
    - **Validation Set:** 20% of the training set
- **Parameters:**
    - **Batch Size:** 2000
    - **Epochs:** 10

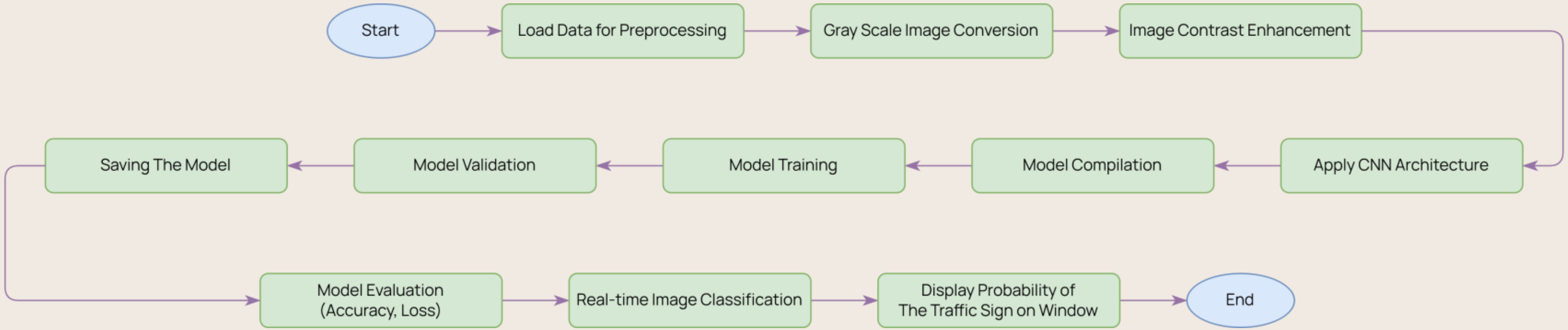
Process of Model Training (Cont.)

- **Training Process:**
  - Data augmentation applied before fitting data to the model.
  - Preprocessed images passed through CNN layers
- **Framework:** Keras and TensorFlow
- **Optimization:** Adam optimizer

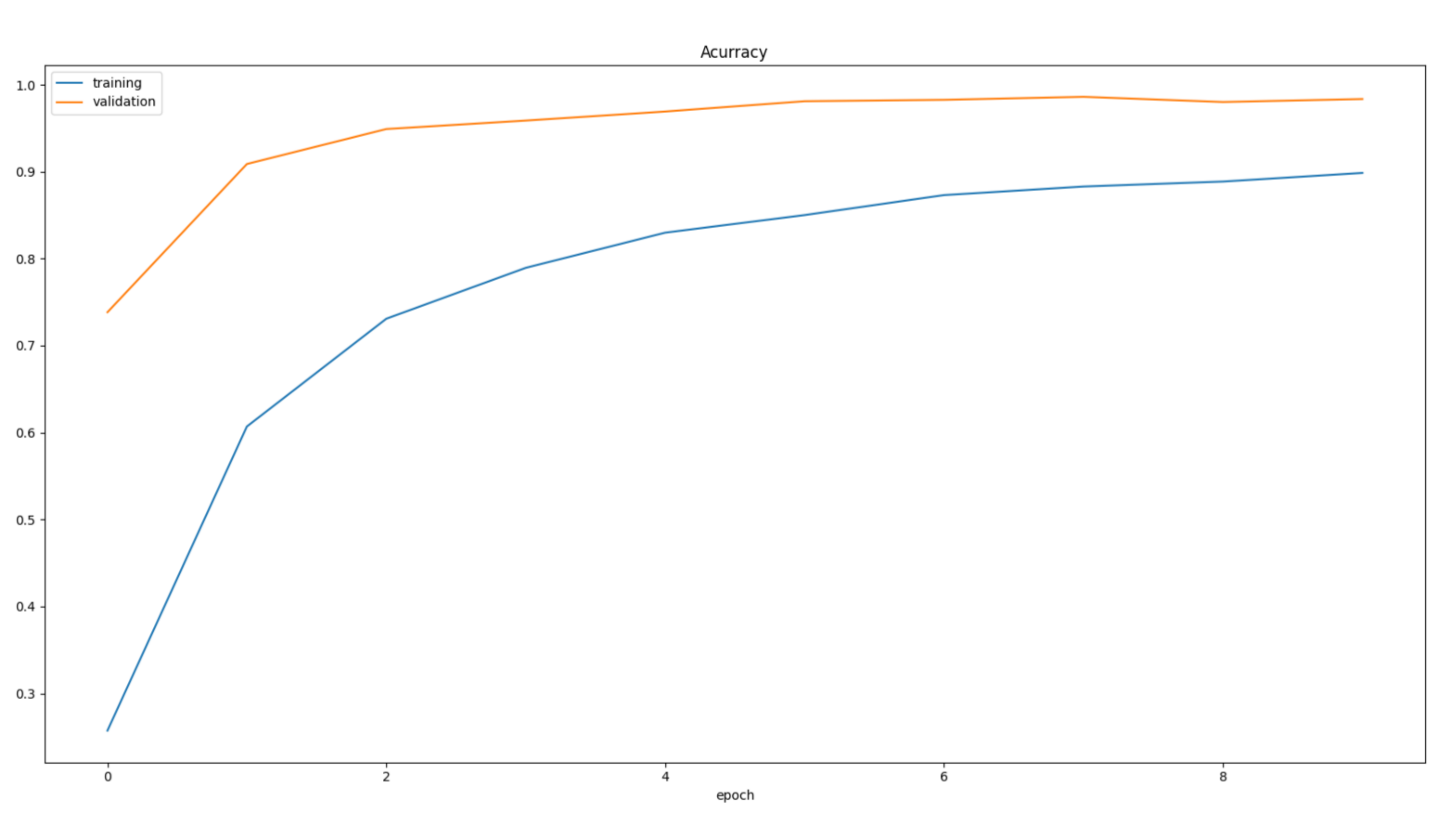
Distribution of the Training Dataset



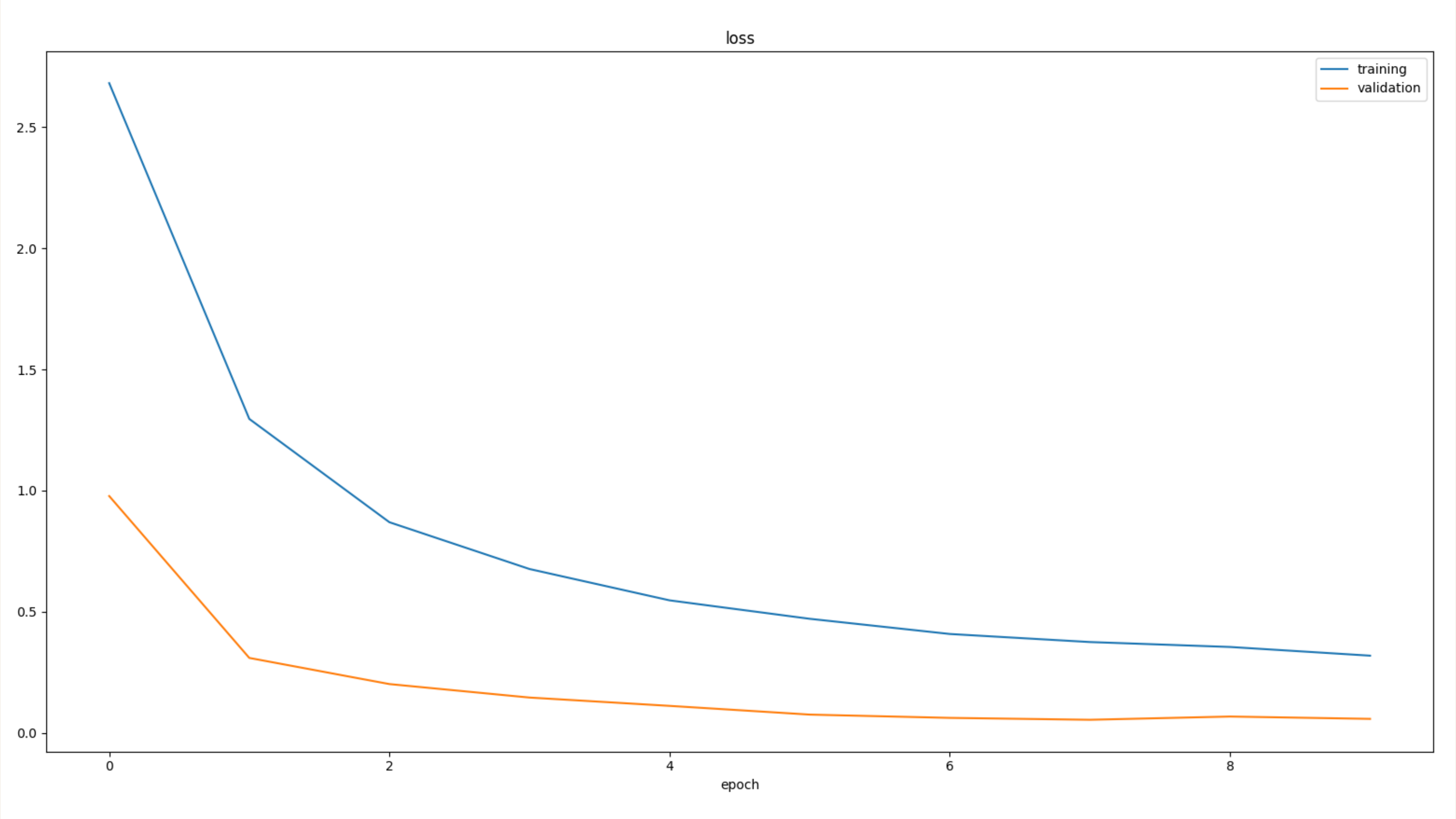
Project Workflow



Training vs Validation Accuracy Curve



Training vs Validation Loss Curve



Results & Evaluation

Test Accuracy	Test Score
98.29%	**6.19%**

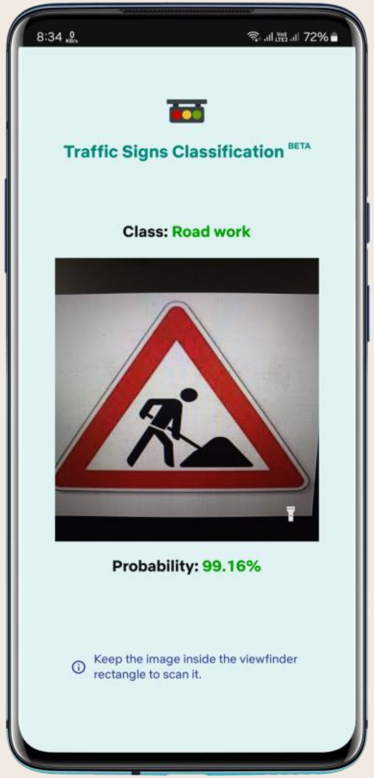
```
2000/2000 ━━━━━━━━━━━━━━━━━━━━ 95s 47ms/step - accuracy: 0.5962 - loss: 1.3331 - val_accuracy: 0.9088 - val_loss: 0.3094
Epoch 3/10
2000/2000 ━━━━━━━━━━━━━━━━━━━━ 49s 25ms/step - accuracy: 0.7250 - loss: 0.8862 - val_accuracy: 0.9490 - val_loss: 0.2015
Epoch 4/10
 446/2000 ━━━━━━━━━━━━━━━━━━━━ 2:48 109ms/step - accuracy: 0.7809 - loss: 0.7097983728: I tensorflow/core/framework/local
         [[{{node IteratorGetNext}}]]
2000/2000 ━━━━━━━━━━━━━━━━━━━━ 52s 26ms/step - accuracy: 0.7875 - loss: 0.6838 - val_accuracy: 0.9587 - val_loss: 0.1459
Epoch 5/10
2000/2000 ━━━━━━━━━━━━━━━━━━━━ 52s 26ms/step - accuracy: 0.8288 - loss: 0.5525 - val_accuracy: 0.9691 - val_loss: 0.1116
Epoch 6/10
2000/2000 ━━━━━━━━━━━━━━━━━━━━ 54s 27ms/step - accuracy: 0.8498 - loss: 0.4713 - val_accuracy: 0.9810 - val_loss: 0.0756
Epoch 7/10
2000/2000 ━━━━━━━━━━━━━━━━━━━━ 55s 27ms/step - accuracy: 0.8727 - loss: 0.4088 - val_accuracy: 0.9826 - val_loss: 0.0621
Epoch 8/10
 446/2000 ━━━━━━━━━━━━━━━━━━━━ 2:49 109ms/step - accuracy: 0.8796 - loss: 0.3782 status: OUT_OF_RANGE: End of sequenceow/
         [[{{node IteratorGetNext}}]]
2000/2000 ━━━━━━━━━━━━━━━━━━━━ 52s 26ms/step - accuracy: 0.8821 - loss: 0.3757 - val_accuracy: 0.9860 - val_loss: 0.0542
Epoch 9/10
2000/2000 ━━━━━━━━━━━━━━━━━━━━ 52s 26ms/step - accuracy: 0.8887 - loss: 0.3532 - val_accuracy: 0.9801 - val_loss: 0.0676
Epoch 10/10
2000/2000 ━━━━━━━━━━━━━━━━━━━━ 52s 26ms/step - accuracy: 0.8991 - loss: 0.3156 - val_accuracy: 0.9835 - val_loss: 0.0580
Test Score: 0.06193874403834343
Test Accuracy: 0.9829022884368896
```

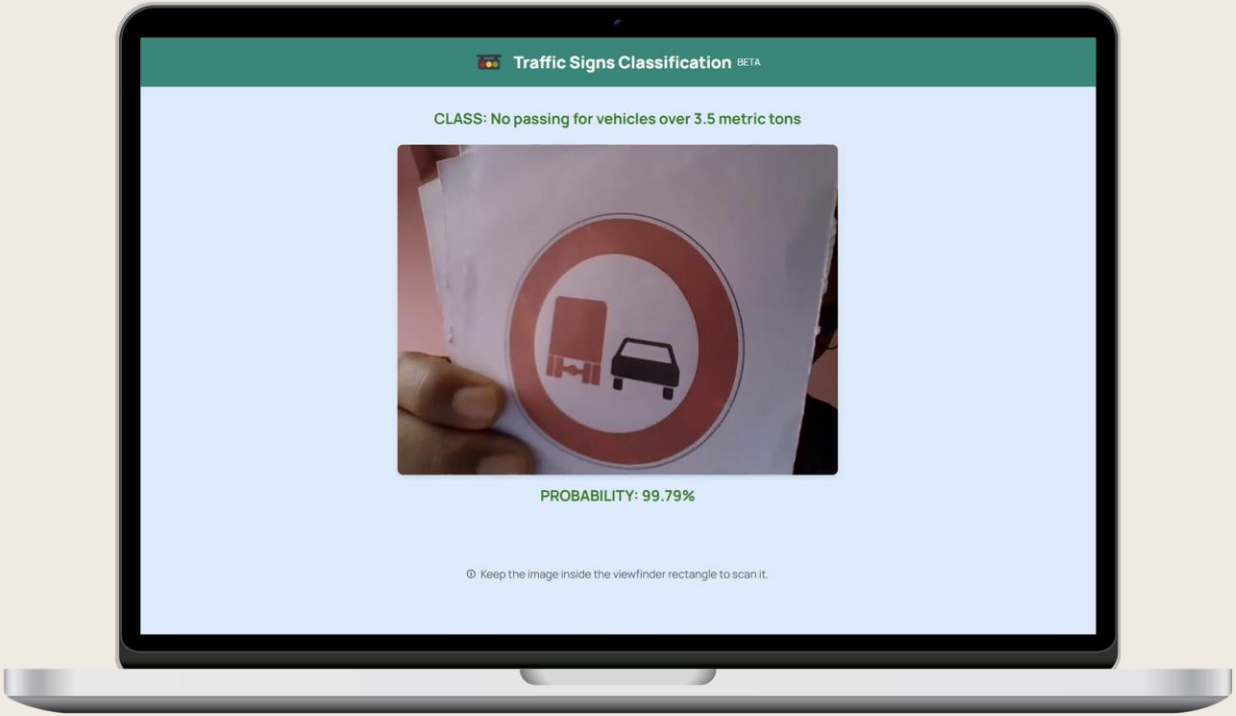
Live Testing Overview

Deployment

- **Android App:**
  - **Features:** On-the-go traffic sign recognition via the camera.
  - **Technologies:** TensorFlow Lite, OpenCV, Java, CameraX
- **Web Integration:**
  - **Features:** Allows users to classify traffic signs via the web app.
  - **Technologies:** Flask, HTML, CSS, JavaScript

Screenshots (App & Web)

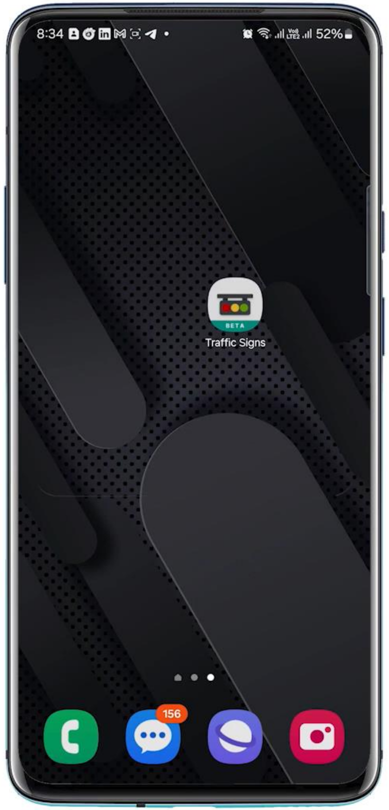




Future Work

- To collect a dataset of Bangladeshi traffic signs to enhance the model and make it more effective.
- To add audio alerts to tell users about detected traffic signs.
- Show detected signs on the screen in real-time using AR technology.

Video Demonstration



Android App

THANK YOU

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