END-TO-END IMITATION LEARNING

Home Assignment

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Problem Statement

Objective- To build an end-to-end deep learning model for autonomous driving that predicts 4 waypoints per forward pass using image and speed data.

Aim-
Model Architecture: Construct an architecture utilizing a combination of Neural Networks for waypoint prediction.
Data Pipeline: Develop a robust data pipeline to load and pre-process image, speed, and waypoint data for model training.
Model Optimization: Train the deep learning model and optimizes the model's weights to predict waypoints effectively.

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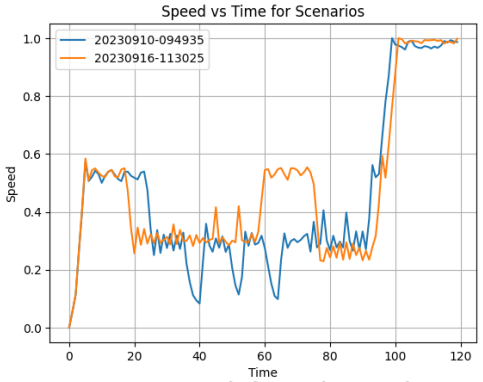
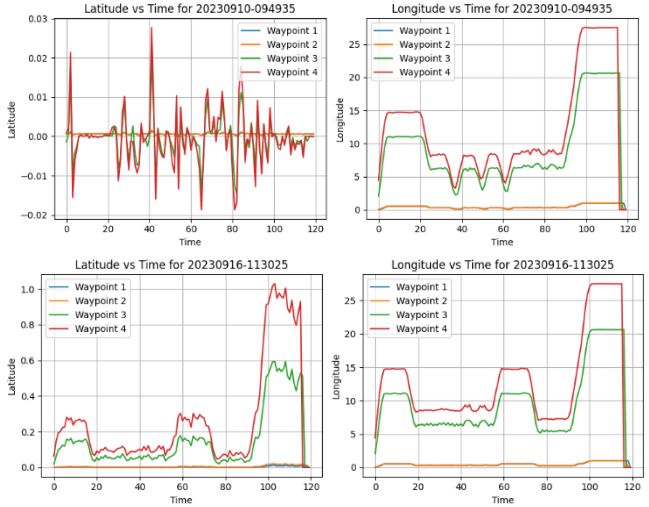
Understanding Data

Image data: (160, 320, 3)



Speed data: (120, 1)



Ground Truth Waypoints data: (120, 4, 2)

```
[[6.22154368e-03 9.97260136e-01]
[1.33123949e-02 9.98815746e-01]
[4.29142927e-01 2.06165118e+01]
[7.96319795e-01 2.74919742e+01]]
.
.
[[7.53922360e-03 9.96226302e-01]
[1.52256552e-02 9.98239507e-01]
[4.88350593e-01 2.06210757e+01]
[8.66492458e-01 2.74850198e+01]]
```

Predicted Waypoints data: (B, 4, 2)

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Data Pipeline

Number of Scenarios: 2
Waypoints shape: (120, 4, 2)
Speed shape: (120, 1)
Number of images: 120
Shape of an image array: (160, 320, 3)

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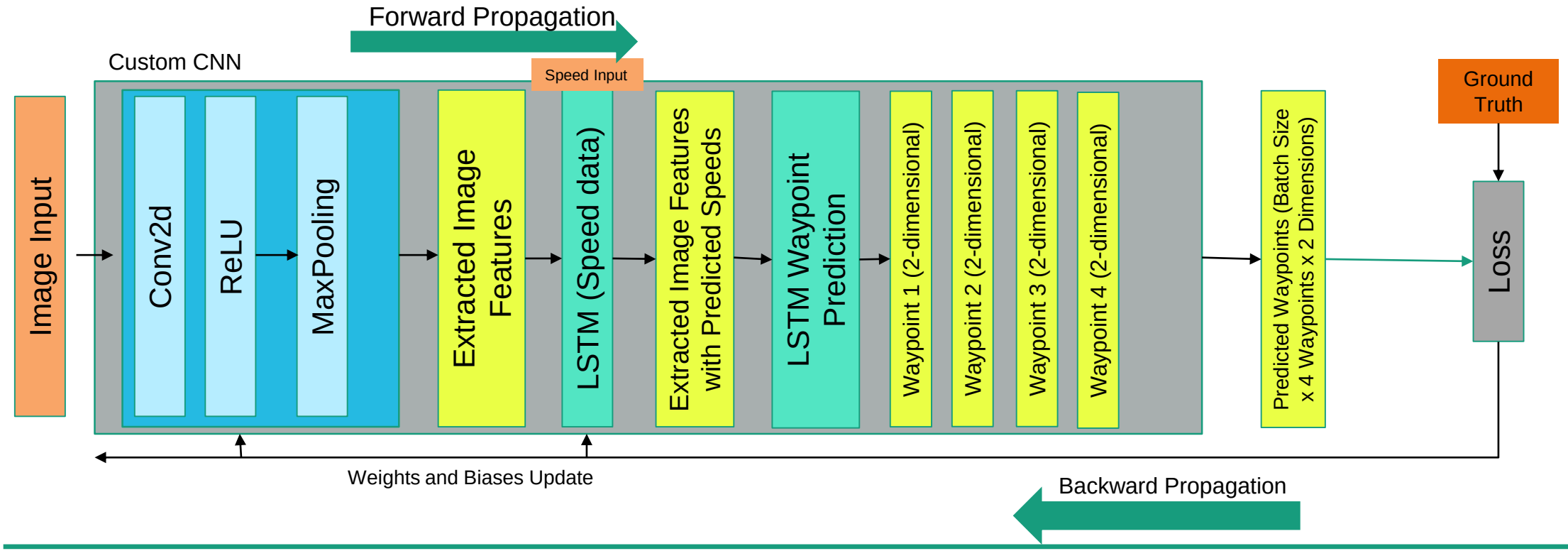
Model Architecture



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Training, Evaluation & Hyperparameters

- **Device Configuration:**
  - Setting the model and data to the appropriate device (GPU or CPU).
- **Training Loop:**
  - Iterating through a specified number of epochs (e.g., 20 epochs).
  - Inside the loop:
    - Training: Executing the training process for each epoch using **Train function**.
    - Recording and storing the train loss and R2 score in **Train losses** and **Train R2 Score** lists.
    - Testing: Evaluating the model's performance on the test set using **Evaluate** function.
    - Recording and storing the test loss and R2 score in **Test losses** and **Test R2 Score** lists.
- Displaying the trend of loss reduction over training epochs for each scenario.

Number of epochs = 20

Model = Hybrid CNN+LSTM Model

Optimizer = Adam Optimizer

Learning Rate = 0.01

Loss Function = Mean Squared Error Loss Function

Metrics = MSE, R2 Score as a metric for assessing model performance.

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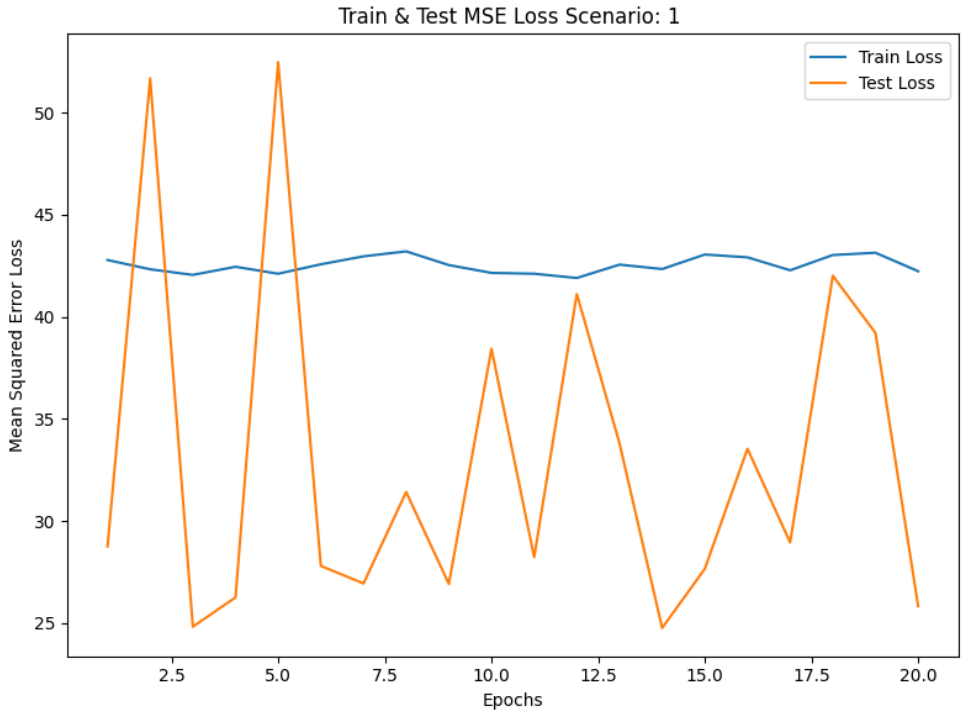
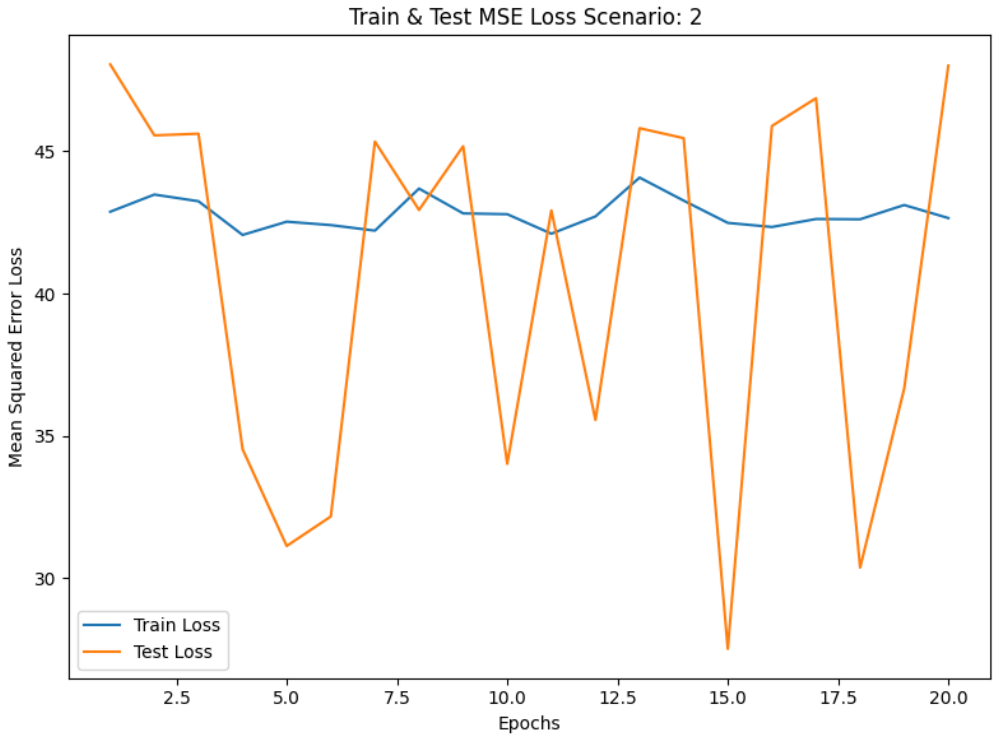
Results

Model Generalization across two scenarios





Overall Test Loss (MSE): 38.4031 - Test R2 Score: -0.2263

Overall Test Loss (MSE): 32.5026 - Test R2 Score: -0.3099

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Summary & Key Observations

- Built an End-End deep learning model for autonomous driving.
- Defined appropriate metrics and loss functions to predict The 4 waypoints from the perspective of the current ego position and orientation, in meters.
- The model demonstrates proficiency in predicting waypoints for autonomous driving scenarios.
- The R2 scores indicate that a significant proportion of the variance in the waypoint data is captured by the model, reflecting its ability to comprehend and predict waypoints accurately.

Considerations:

- suggesting the model's capability to generalize well to new scenarios can be further be improved by providing more amount of data.

Thank You