Steering Angle Prediction using Image Processing & NN

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GitHub Link:
https://github.com/svadakkeveetil/csi5130_steer_angle_pred

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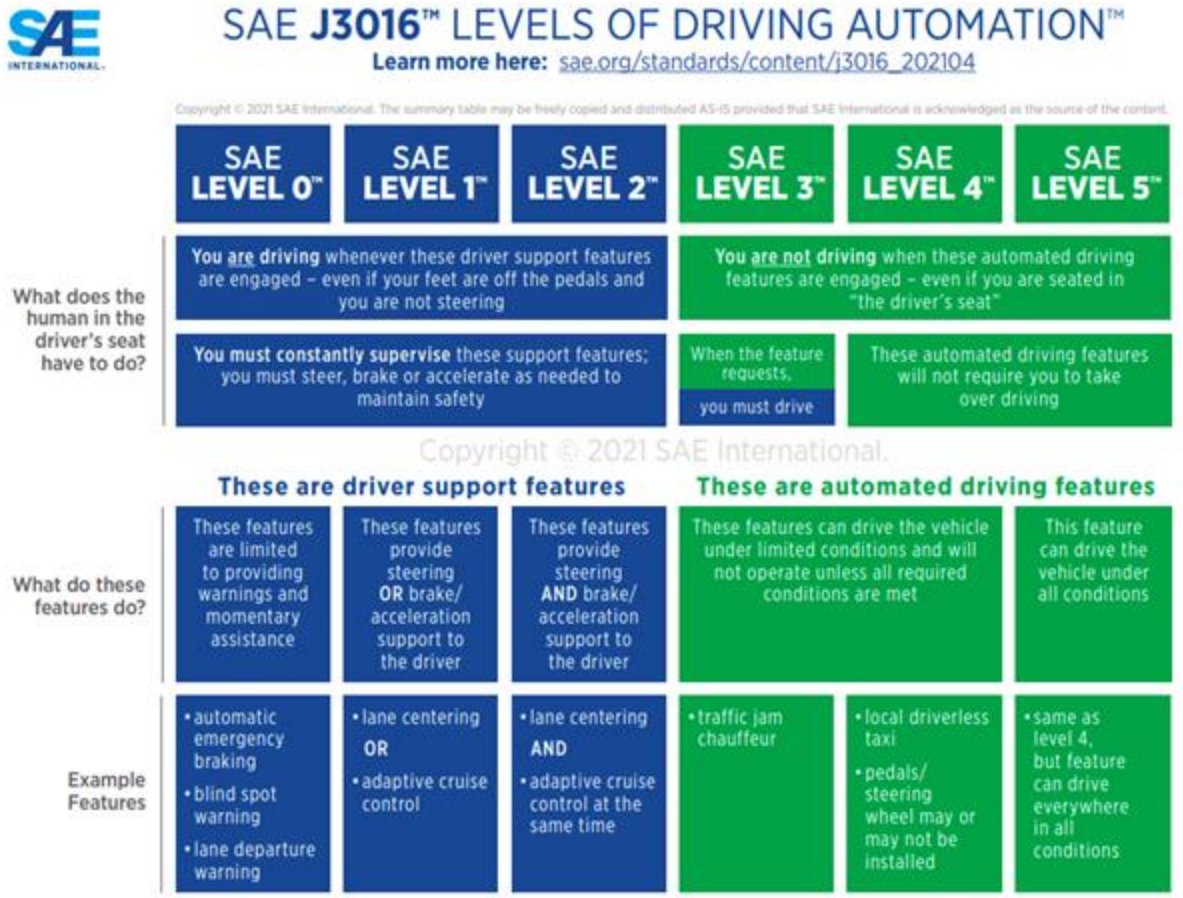
Agenda

- *Introduction*
- *Related Work*
- *Data*
- *Extraction*
- *Models*
- *Results*
- *Conclusion*

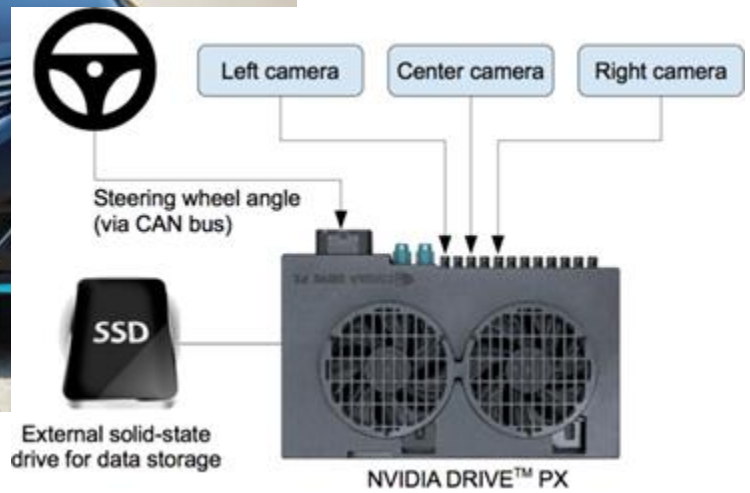
Introduction

- Levels of Autonomy
- Features required multiple sensors to perceive the environment
- 3 inputs - Brake, Throttle and Steering
- Research on Drive by wire systems to achieve L4+ autonomy
- Accurate estimation & control of steering wheel angle important for safety & stability of system

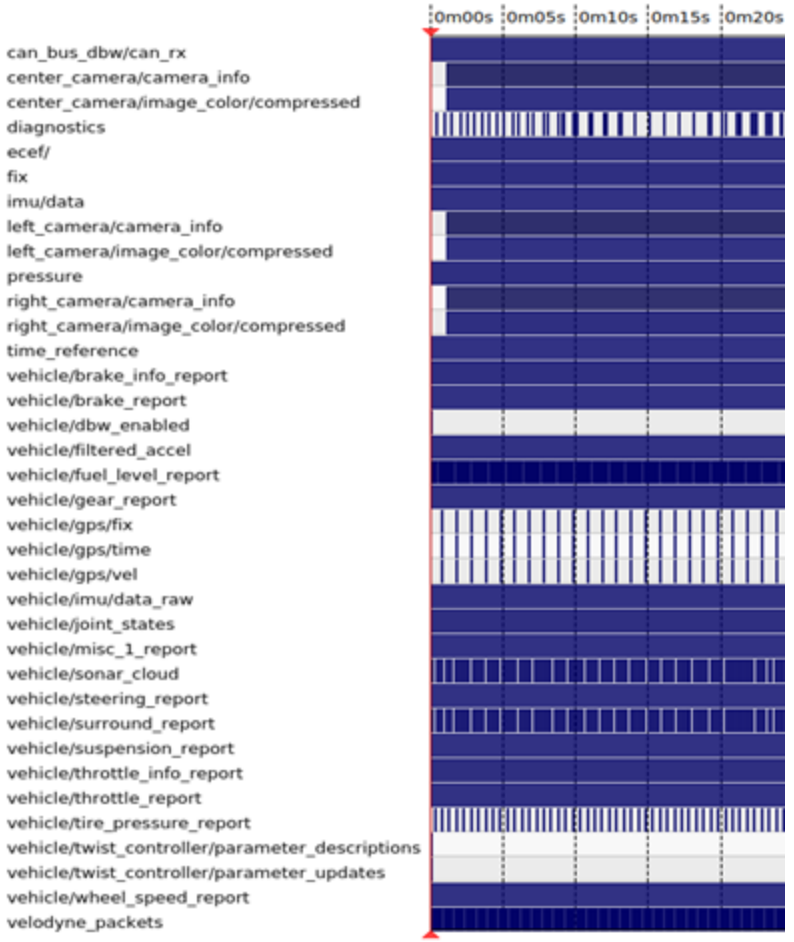


Where is the data coming from?

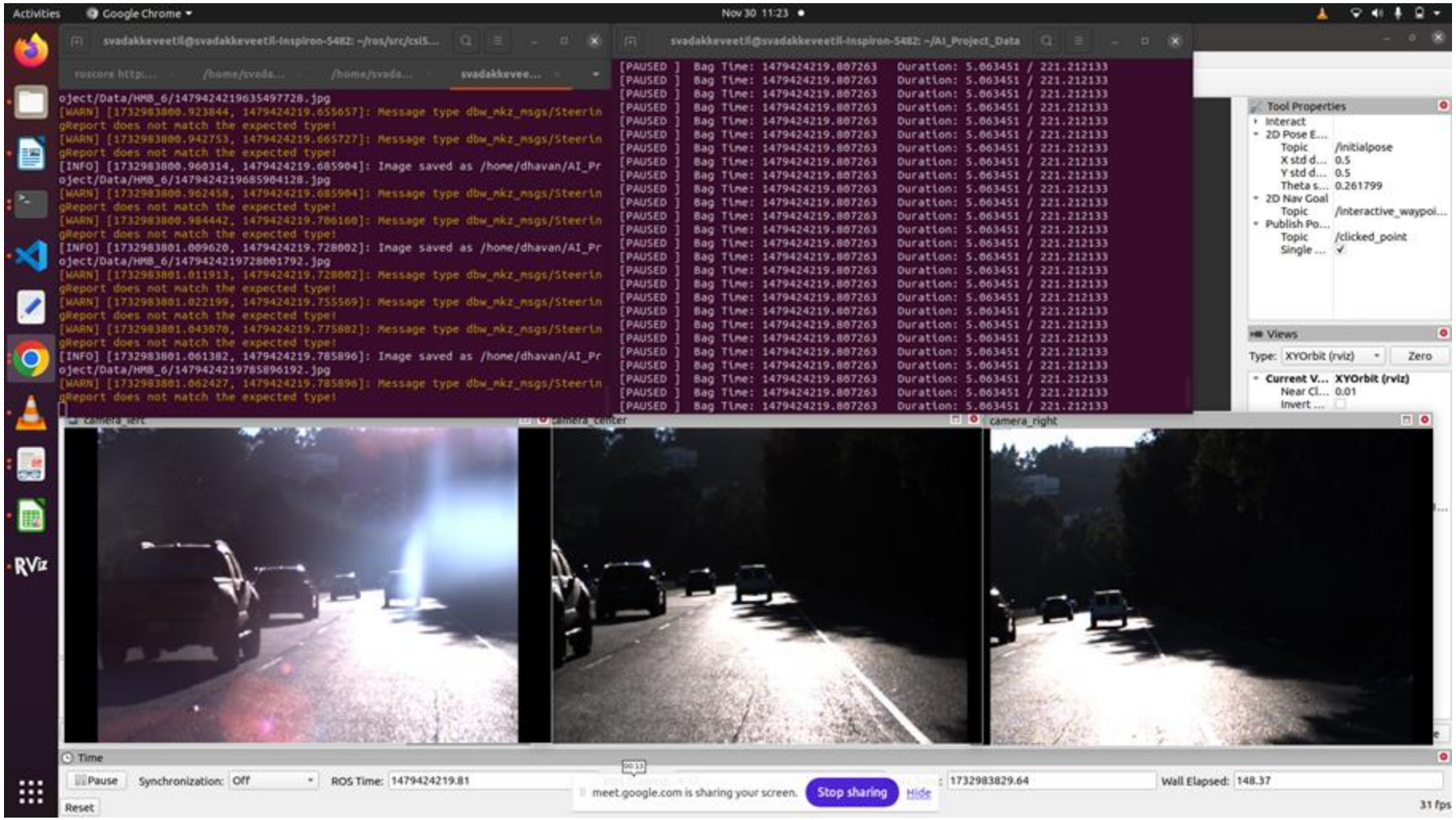
- Udacity self driving Challenge - Used NVIDIA drive to extracted CAN data and camera images from cameras mounted
- Data in ROSBAG format
- Data collected from Lincoln MKZ



Information of ROSBAG



Preparing the Data - Extracting Images



ROSBAG Files

↓

Center Camera

↓

Steering Angle

↓

Creates .jpg - Images

↓

Creates .csv Data File

PreProcessing Data

Load Data

Image Preprocessing

X_train .npy Files Save

Image Data

Y_train .npy Files Save

Steering Angle

Models

- Multi CNN layer with single FC
- ReLu vs Batch Normalization
- NVIDIA model
- Large FC layers

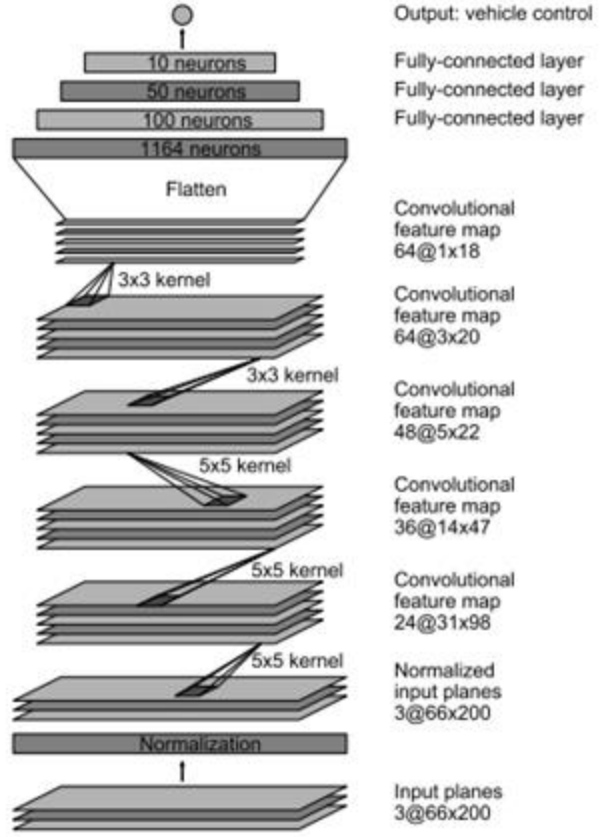
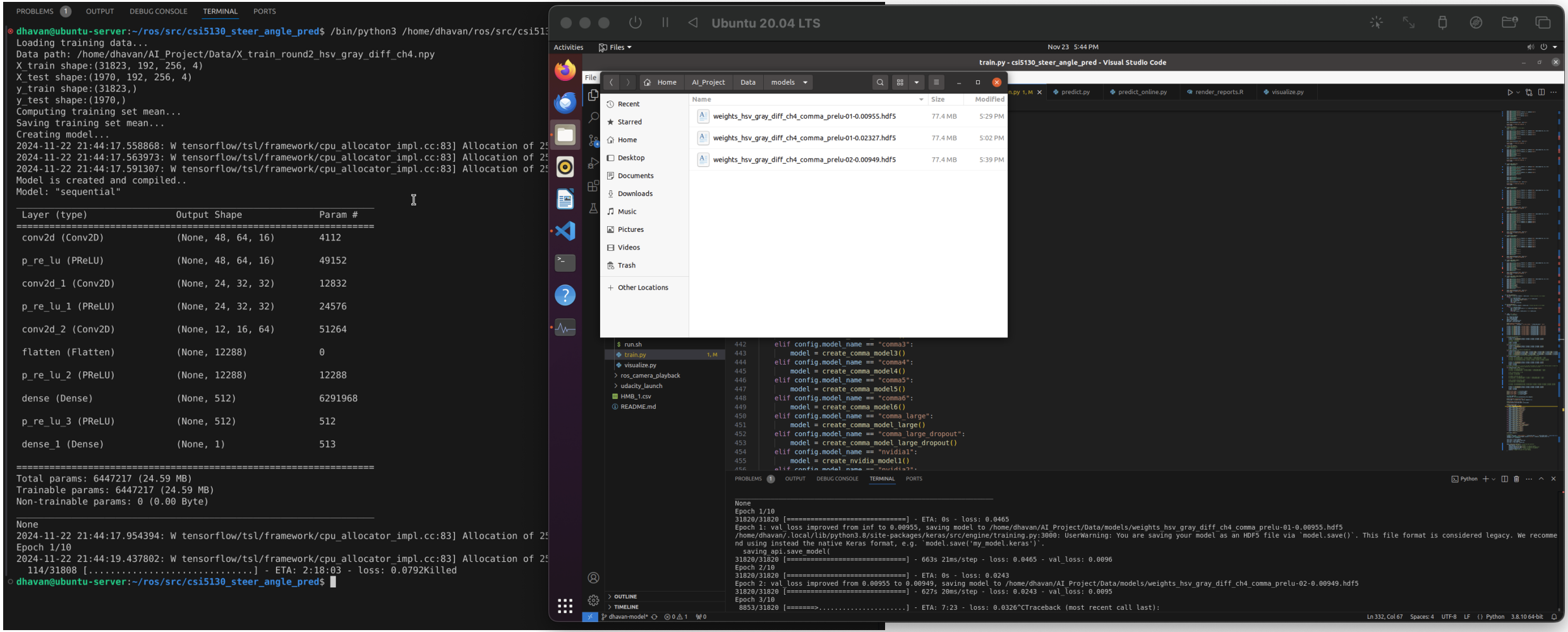


Figure 4: CNN architecture. The network has about 27 million connections and 250 thousand parameters.

Model Training

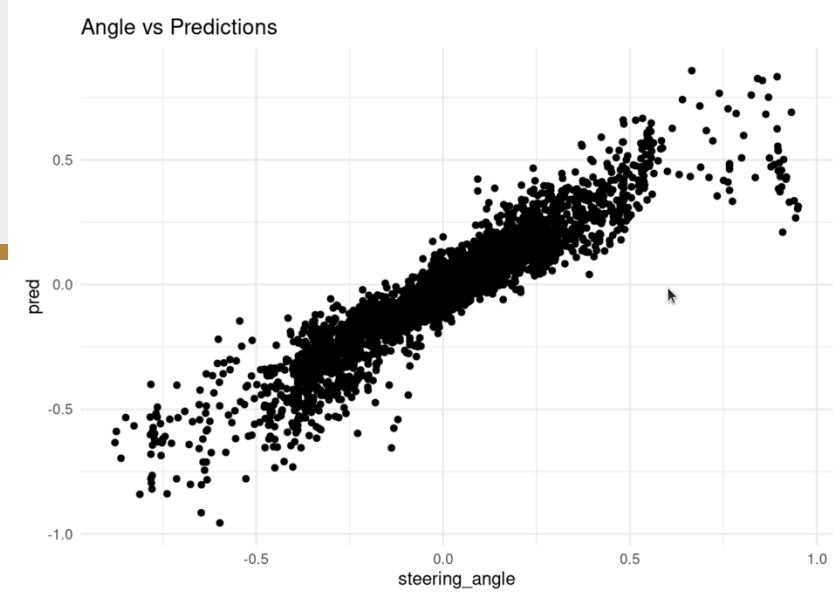


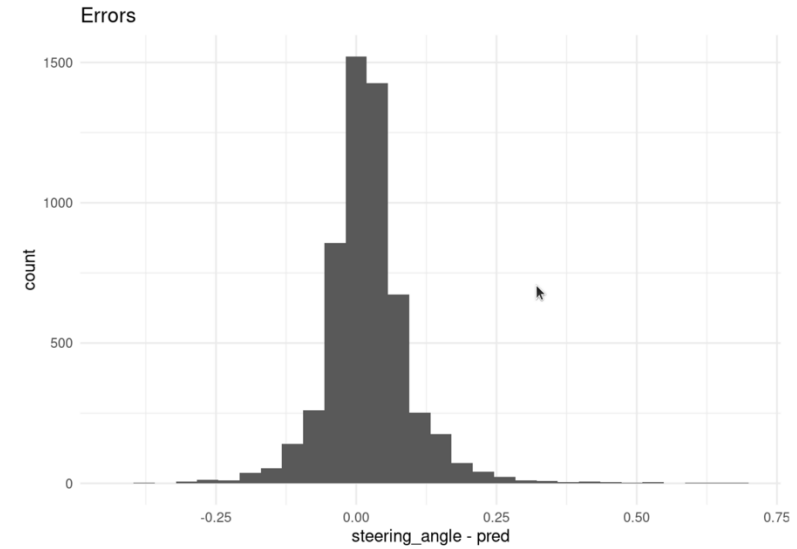
Different Models

Model	CNN Layers	Activation Layer	Fully Connected Layer/ Dense Layer	Issues
Comma Model Prelu	3	PReLu	1 (512 units)	No
Comma model lrelu	3	LReLu	1 (512 units)	No
Comma Model Batch Normalization	3	BN & ReLu	1 (512 units)	No
Comma Model ReLu	2	ReLu	1 (256 units)	No
Comma Model Prelu LSTM	3	PReLu & 1 LSTM	1 (512 units)	No
Comma Model Large	2	ReLu	1 (1024 units)	Yes (Same predictions for test set)
Comma Model Large Dropouts	2	ReLu	1 (1024 units) with dropouts 0.5	No
NVIDIA	5	ReLu	3 (100, 50, 10 units)	Yes (Same predictions for test set)

Results

Model	MSE	RMSE
Comma Model PRelu	0.00864	0.09295160031
Comma model LReLu	0.03348	0.1829754082
Comma Model Batch Normalization	0.05733	0.2394368393
Comma Model 6	0.00662	0.08136338243
Comma Model Prelu LSTM	0.01642	0.1281405478
Comma Model Prelu Large with Drop out	0.01307	0.1143241007
Rambo	0.00324	0.05692099788





Comma Model with Prelu as activation layer performed the best comparing the RMSE values

Visualization

- Model 6 with multiple CNN and a single dense layer and ReLu activation performed the best
- Output visualization of estimated vs actual was created using PyGame

Conclusion

- Steering wheel angle recognition using image processing and neural networks.
- NN models based on CNN & dense layers
- ReLu & Batch normalization used as activation layers
- 6 model evaluated using MSE and RMSE

Next Steps

- Analyze the NVIDIA and using large dense layers
- Hyperparameter tuning for different filters and batch size
- Data augmentation to include the effect of shadow and daylight savings
- Evaluate the performance of using transfer learning and LSTM

Thank You
Any Questions?