Long Short-Term Vehicle Dynamics

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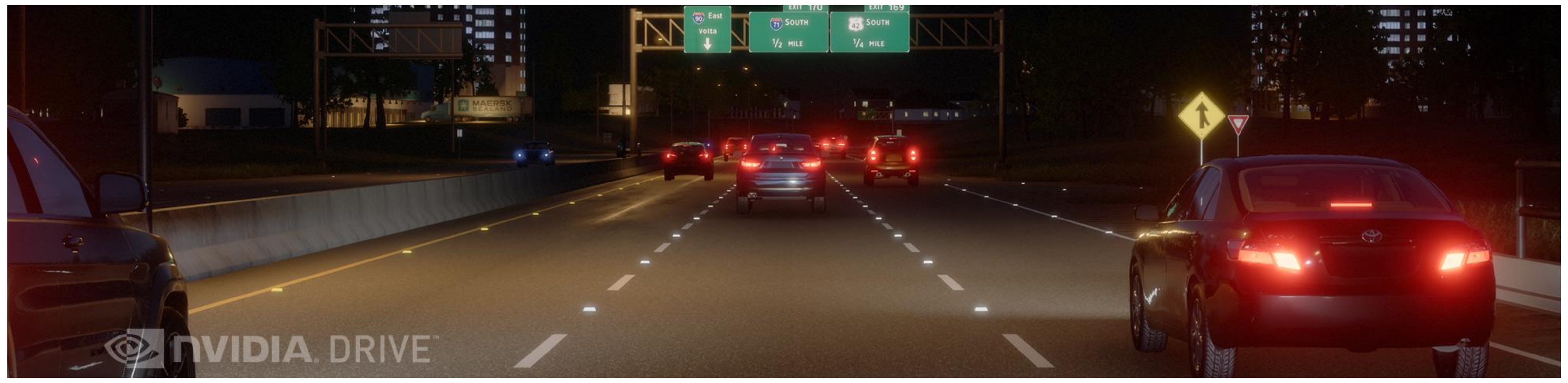
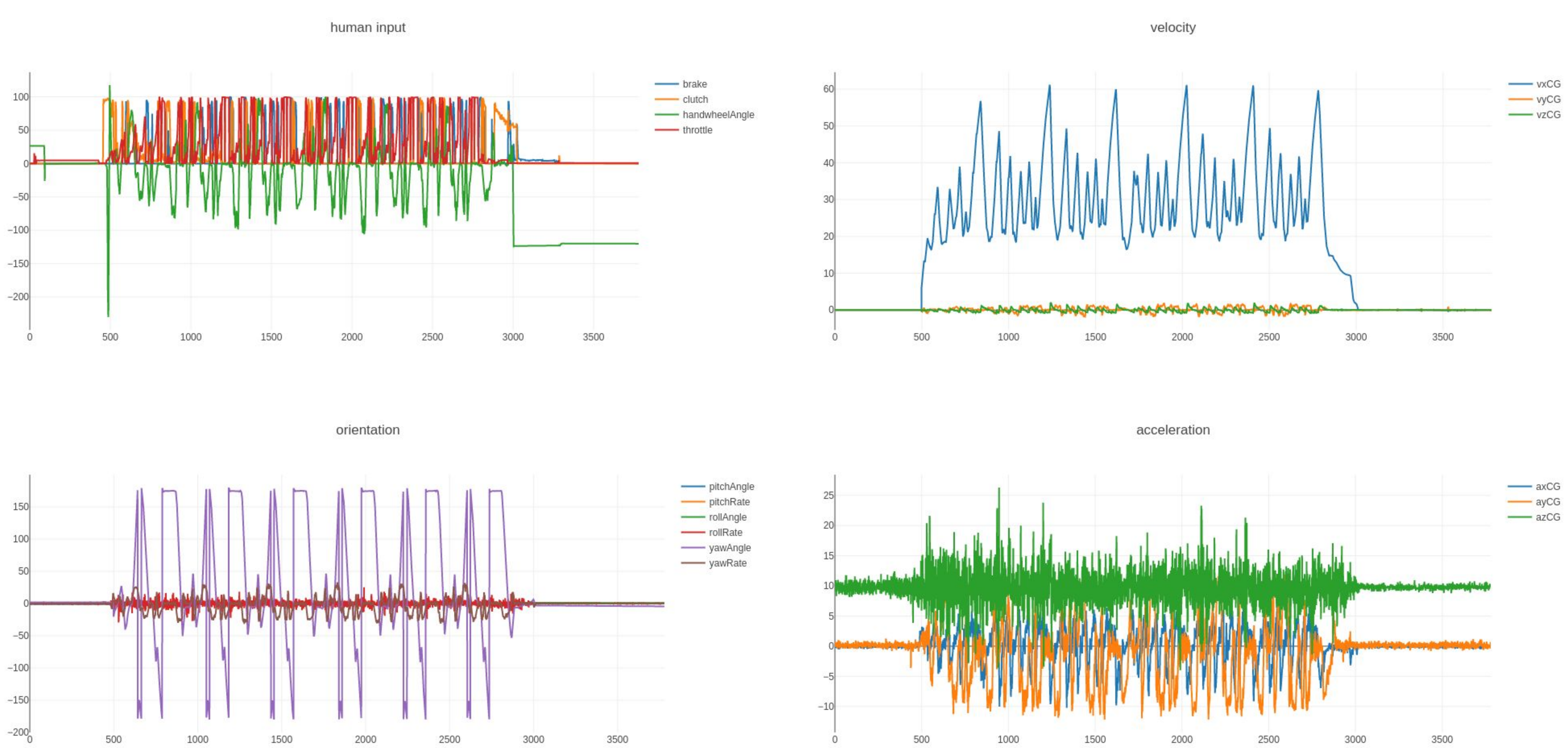


Motivation

This project focused on potential roles of Deep Neural Network's (DNNs) to improve vehicle dynamics simulation by utilizing data to learn the model. The motivation for this was to attempt to find ways to further tune vehicle-specific physics for autonomous vehicle simulation applications.

Data

Data was acquired from the open Stanford REVS Vehicle Dynamics Database. This dataset contains 22 files vehicle dynamics recorded from an expert driving a 1965 Ferrari in 2013 and 2014 at Monterey Motorsports Reunion and Targa Sixty-Six events.



Models

1 - hand engineering features

Initial attempts involved hand-engineering discrete derivatives of motion into the data set, then attempting to learn how to predict the next motion update. This approach was abandoned for network architectures that could better model the time delay between input (steering, brake, throttle) and vehicle actuation.

2 - Long Short-Term Memory (LSTM) Recurrent Neural Network (RNN)

LSTM's were employed to handle the problem of unknown temporal delays between vehicle input and output actuations.

Results

The network architectures that resulted in optimal results involved an input sequence of length ~150 (1.5 sec worth of history) and 5.5 hours of training on a NVIDIA GTX 1080 Ti. Results indicate that a LSTM can accurately predict features of vehicle movement strongly correlated to inputs (steering, brake, throttle), however features with weaker correlations were predicted with much higher