Trust your Tesla

Collision Course Prediction for Simulated Autonomous Vehicles

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BROWN

Motivation

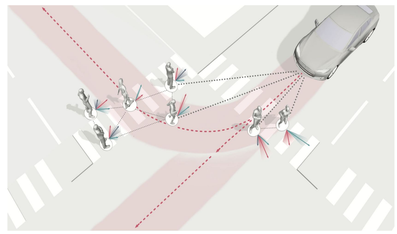
Societal trust in autonomous vehicles.

Improving autonomous vehicles' ability to predict collisions could save countless lives.

The Problem

Collision Prediction
Predict riskiness of a vehicle's trajectory at a moment's notice.

Time Series Data
Train on sequences of images to predict collision in real-time.



Goal

1. Given a sequence of 8 images of a simulated car's environment, accurately predict a collision course.
2. Achieve a testing accuracy of at least 75% if not higher.

Key Insights

The ConvLSTM Unit

The ConvLSTM is similar to the Fully Connected LSTM, but replaces matrix multiplication of weights and inputs with convolution. Combining convolution with the memory gated structure of the LSTM allows for better hidden spatio-temporal representations which leads to better predictions.

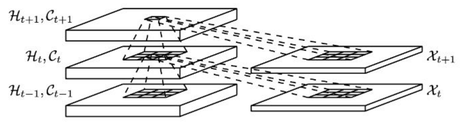
$$i_t = \sigma(W_{xi} * X_t + W_{hi} * H_{t-1} + W_{ci} \circ C_{t-1} + b_i$$

$$f_t = \sigma(W_{xf} * X_t + W_{hf} * H_{t-1} + W_{cf} \circ C_{t-1} + b_f)$$

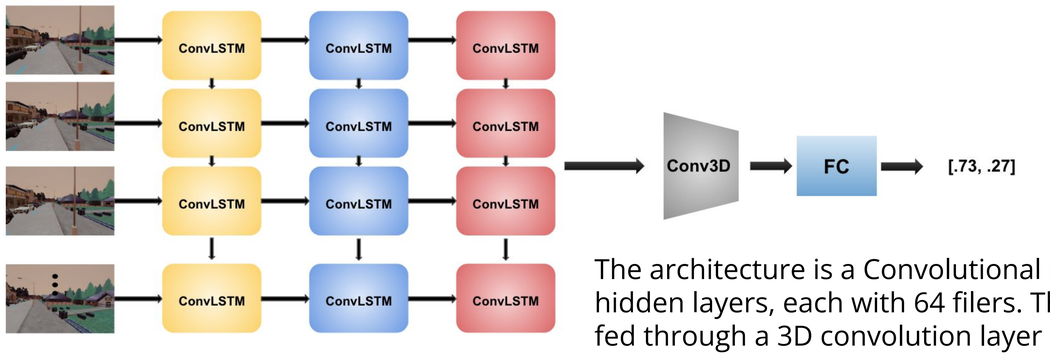
$$C_t = f_t \circ C_{t-1} + i_t \circ tanh(W_{xc} * X_t + W_{hc} * H_{t-1} + b_c)$$

$$o_t = \sigma(W_{xo} * X_t + W_{ho} * H_{t-1} + W_{co} \circ C_t + b_o)$$

$$H_t = o_t \circ tanh(C_t)$$



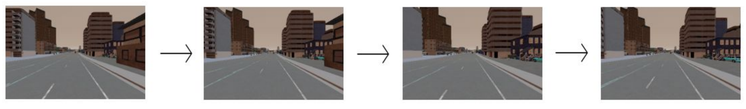
Model Architecture



The architecture is a Convolutional LSTM with 3 hidden layers, each with 64 filers. The output is fed through a 3D convolution layer and then fully connected layers for classification

- Best results when Conv3D had 1 filter

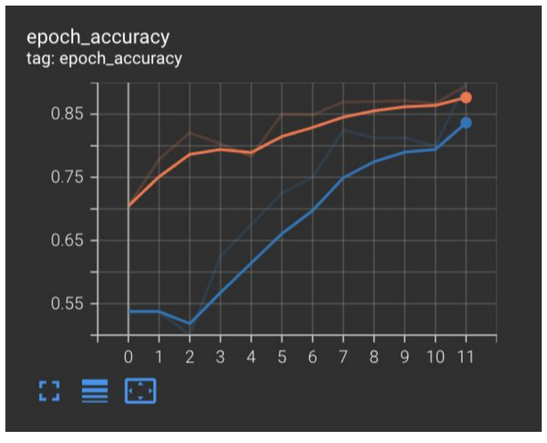
Results

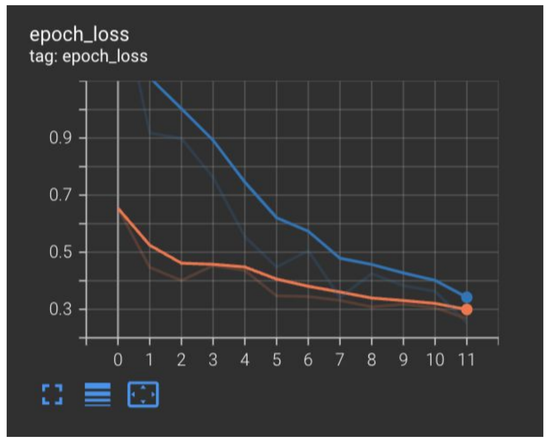


Prediction:
Passenger is safe!

Prediction:
Vehicle Collision!

More Results





Architecture	Train Accuracy	Validation Accuracy	Testing Accuracy
ConvLSTM(3 x 64)-Conv3D(32)-FC	0.8312	0.7375	0.7872
ConvLSTM(3 x 64)-Conv3D(1)-FC	0.8951	0.9000	0.9170

References and Acknowledgments

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[2] N. Srivastava, E. Mansimov, R. Salakhutdinov, "Unsupervised Learning of Video Representations using LSTMs."arXiv:1502.04681
[3] Opera, S. et. al,. "A Review on Deep Learning Techniques for Video Prediction." arXiv: 2004.05214
[4] Paarvendhan,. "https://github.com/perseus784/Vehicle_Collision_Prediction_Using_CNN-LSTMs"..

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