Behavioral cloning on a self driving car

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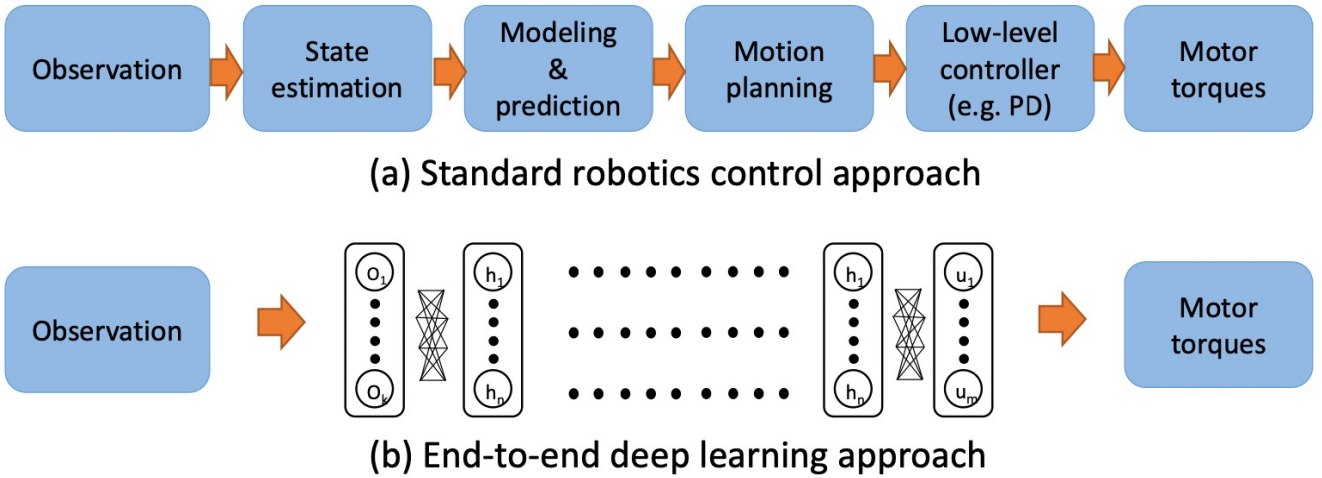
The Idea

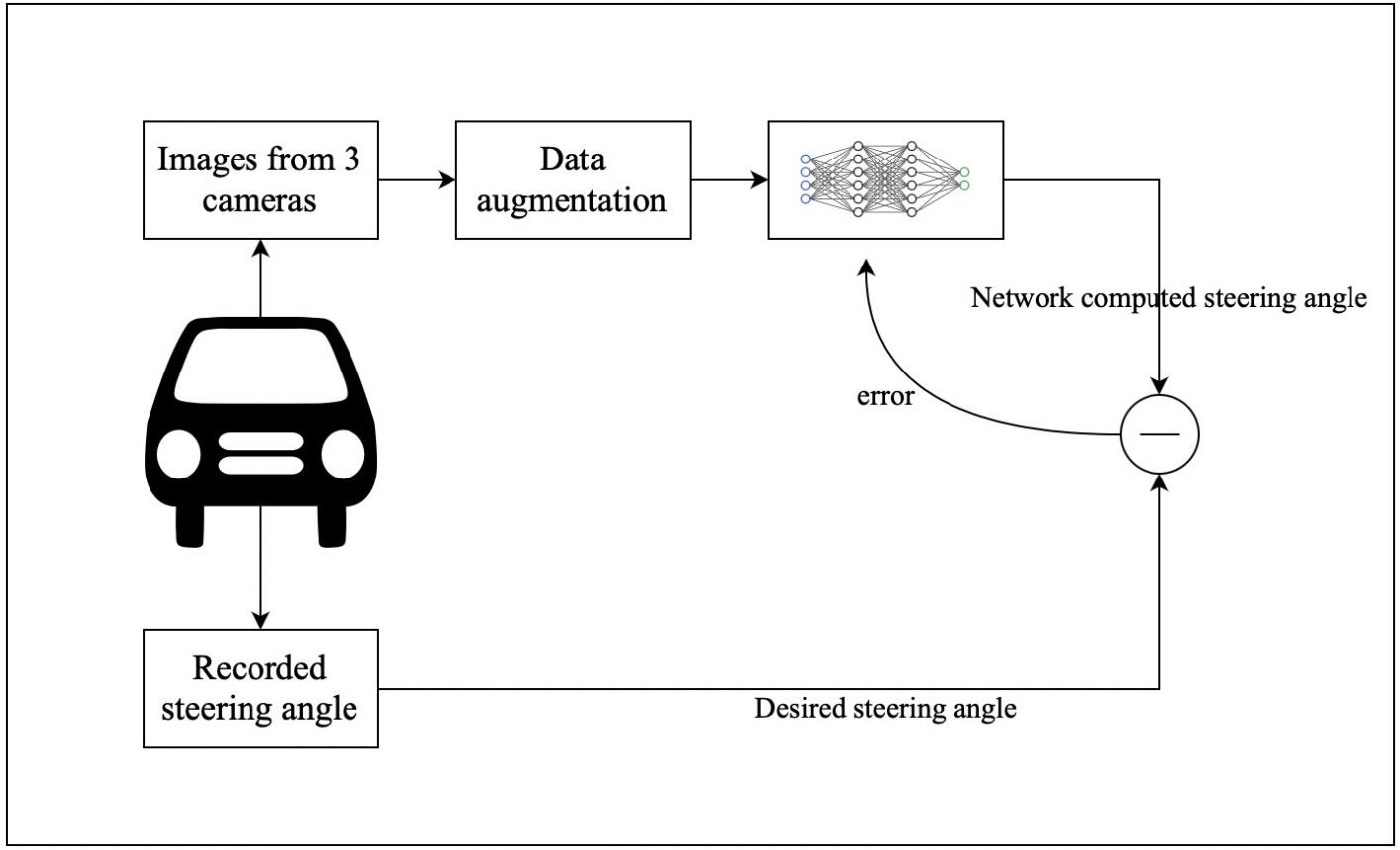
- Learning from pixels
- End to end trained neural network using CNN
- Autonomous driving by mapping camera images to steering angle



https://images.nvidia.com/content/tegra/automotive/images/2016/solutions/pdf/end-to-end-dl-using-px.pdf

Approach

- Step 1: Collecting data
  - Data augmentation
  - Corner cases
- Step 2: Training CNN
  - NVIDIA Model
- Step 3: Driving autonomously



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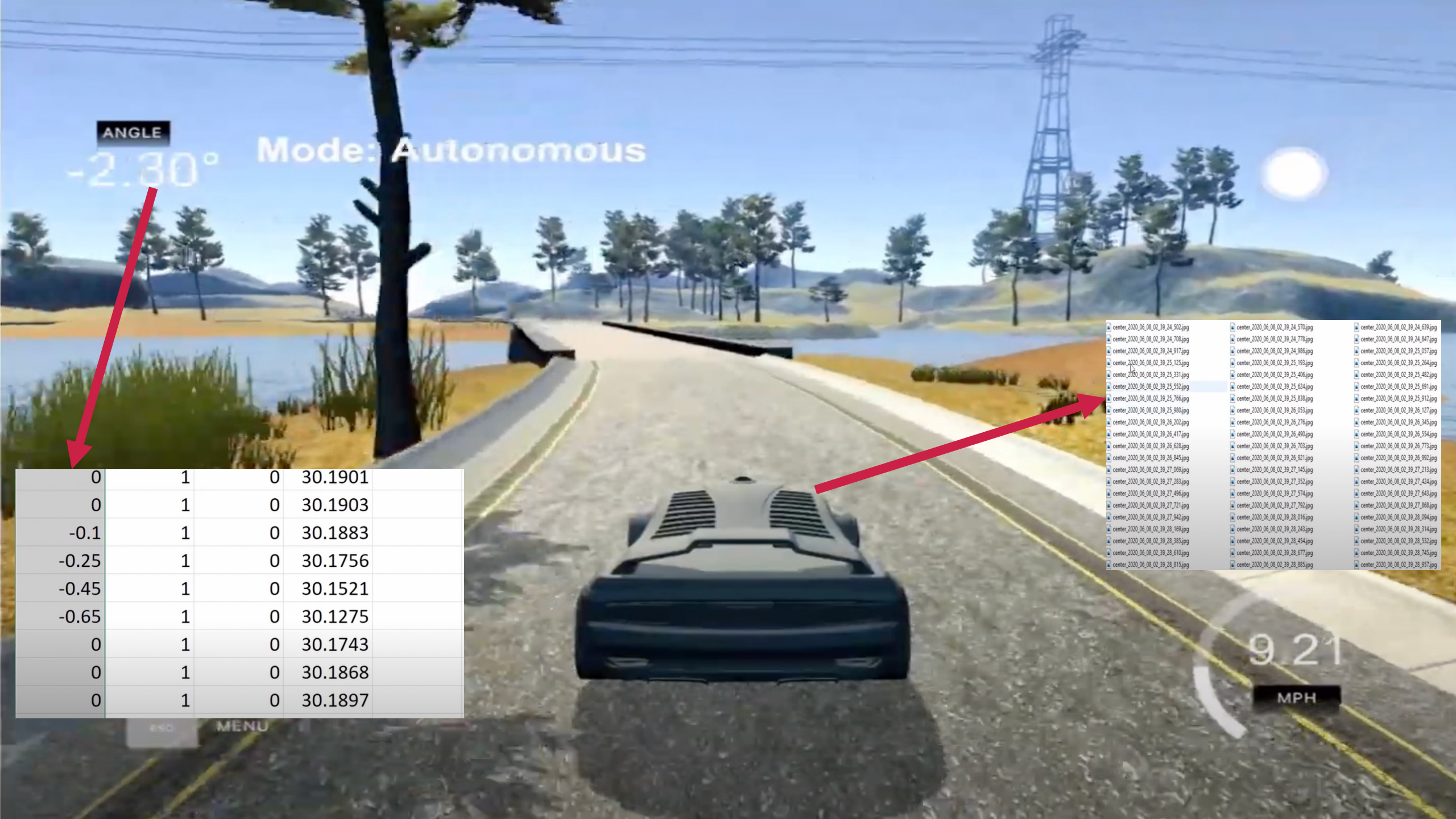
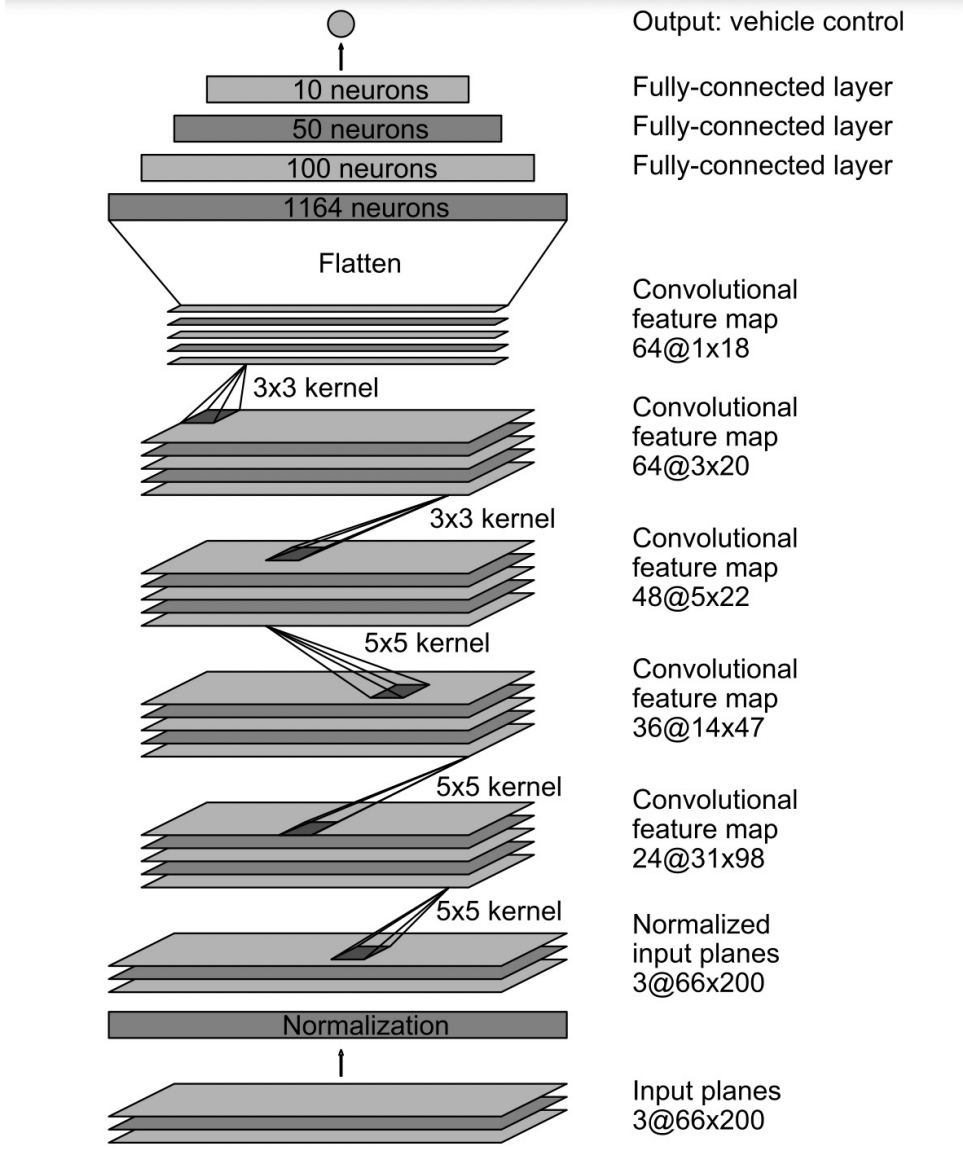


0	1	0	30.1901
0	1	0	30.1903
-0.1	1	0	30.1883
-0.25	1	0	30.1756
-0.45	1	0	30.1521
-0.65	1	0	30.1275
0	1	0	30.1743
0	1	0	30.1868
0	1	0	30.1897

Architecture and Tools

- NVIDIA model
- CNN using Keras



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Approach

- Reading the data
- Splitting the data into training, testing and validation samples
- Data Augmentation:
    a) Image flipping
        b) Steering angle negation
- Histogram
- Cropping the images to remove unwanted variables
- Resampling of the data to the mean
- Normalize image data

Specifications

- Library: Keras API of tensorflow
- Optimizer: Adam, SGD, RMSprop
- Activation function: ReLu
- Loss function: MSE

Optimizer	Epoch	Learning rate	MSE Train	MSE Val	Car performance	Comments
Adam	20	10^{-4}	8.21e-04	0.0248	Lap not completed	Overfitting
	10	10^{-4}	0.0042	0.0233	Lap not completed	Overfitting
	5	10^{-4}	0.0095	0.0236	Lap completed with good performance	-
	5	10^{-3}	0.0102	0.0208	Lap not completed	Aggressive Turns
	10	10^{-3}	0.0057	0.0219	Lap not completed	Aggressive Turns
	50	10^{-3}	6.1e-04	0.0228	Lap not completed	Aggressive Turns
SGD	5	10^{-4}	0.0523	0.0677	Lap not completed	Could not converge
	10	10^{-4}	0.0517	0.0677	Lap not completed	Could not converge
	50	10^{-4}	0.0480	0.0630	Lap not completed	Could not converge
RMSprop	5	10^{-4}	0.0089	0.0234	Lap completed with average performance	-
	10	10^{-3}	0.0054	0.0203	Lap not completed	Overfitting

Advantages & Limitations

- Smaller networks
- Maximum system performance
- Better performance with unclear visual guidance
- No lane detection
- Non-deterministic
- Camera dependent (no depth information)
- Combination with other algorithms (eg: LiDAR)

References

End to End learning for self driving cars:
https://images.nvidia.com/content/tegra/automotive/images/2016/solutions/pdf/end-to-end-dl-using-px.pdf