PolyLaneNet: Lane Estimation via Deep Polynomial Regression

Lucas Tabelini, Rodrigo Berriel, Thiago M. Paixão, Claudine Badue,
Alberto F. De Souza, Thiago Oliveira-Santos

UNIVERSIDADE FEDERAL DO ESPÍRITO SANTO

LABORATÓRIO DE COMPUTAÇÃO DE ALTO DESEMPENHO

Introduction & Motivation

Lane detection: Given an image of a road scene, estimate each traffic line present in it.

Lane detection systems have many applications, including:

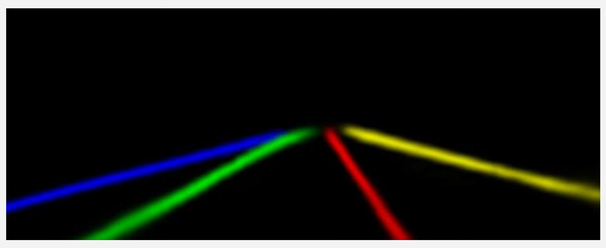
- **Advanced driver-assistance systems:**
- **Autonomous vehicles:**

In both applications, the lane detection system should be efficient (i.e., it should be able to run in real-time**)**. Moreover, in many cases, other systems will be sharing computation resources with it. Therefore, a **faster-than-real-time system is desirable.**

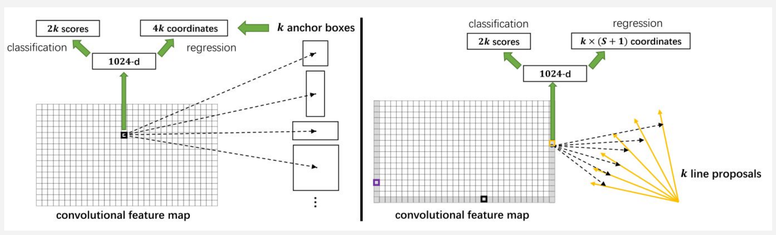
We propose **PolyLaneNet**: a lane detection method based on deep polynomial regression capable of running at a speed of **115+ FPS.**

Related Work

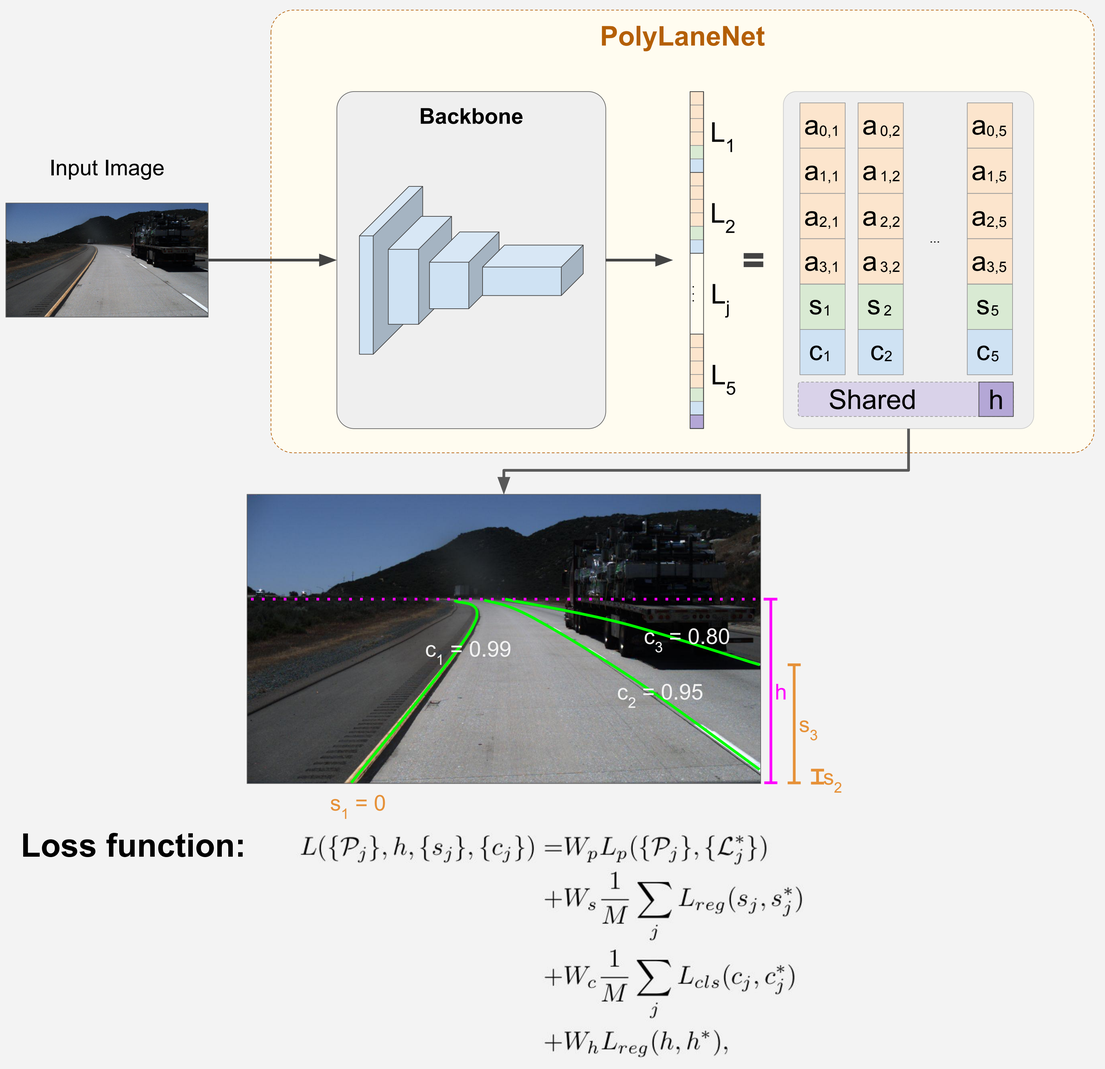
Segmentation-based



Anchor-based



PolyLaneNet



Loss function:

$$
\begin{aligned}
L(\{\mathcal{P}_j\}, h, \{s_j\}, \{c_j\}) = & W_p L_p(\{\mathcal{P}_j\}, \{\mathcal{L}_j^*\}) \\
& + W_s \frac{1}{M} \sum_j L_{reg}(s_j, s_j^*) \\
& + W_c \frac{1}{M} \sum_j L_{cls}(c_j, c_j^*) \\
& + W_h L_{reg}(h, h^*),
\end{aligned}
$$

Acknowledgments

CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico

FAPES FUNDAÇÃO DE AMPARO À PESQUISA E INOVAÇÃO DO ESPÍRITO SANTO

CAPES

Experiments & Results

Quantitative results on TuSimple

Method	Acc (%)	FP	FN	FPS	MACs	PP
Line-CNN	96.87	0.0442	0.0197	30		
ENet-SAD	96.64	0.0602	0.0205	75		□
SCNN	96.53	0.0617	0.0180	7		□
FastDraw	95.20	0.0760	0.0450	90		□
PolyLaneNet	93.36	0.0942	0.0933	115	1.748 G	

Ablation study on TuSimple's validation set

❖ Polynomial degree

Degree	Acc	FP	FN	LPD
1st	88.63	0.2231	0.1865	2.532
2nd	88.89	0.2223	0.1890	2.316
3rd	88.62	0.2237	0.1844	2.314

❖ Upperbound results for polynomial fitting

Degree	Acc	FP	FN	LPD
1st	96.22	0.0393	0.0367	1.512
2nd	97.25	0.0191	0.0175	1.116
3rd	97.84	0.0016	0.0014	0.732
4th	98.00	0.0000	0.0000	0.497
5th	98.03	0.0000	0.0000	0.382

❖ Backbone and input size

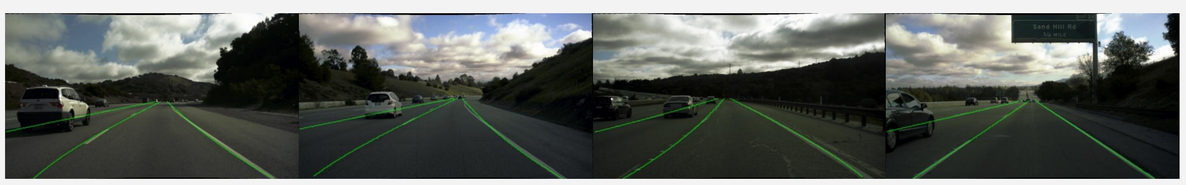
Modification		Acc	FP	FN	MACs (G)
Backbone	ResNet-34	88.07	0.2267	0.1953	17.154
	ResNet-50	83.37	0.3472	0.3122	19.135
	EfficientNet-b1	**89.20**	**0.2170**	**0.1785**	2.583
	EfficientNet-b0	88.62	0.2237	0.1844	1.748
Input size	320x180	85.45	0.2424	0.2446	0.396
	480x270	88.39	0.2398	0.1960	0.961
	640x360	**88.62**	**0.2237**	**0.1844**	1.748

❖ Model training settings

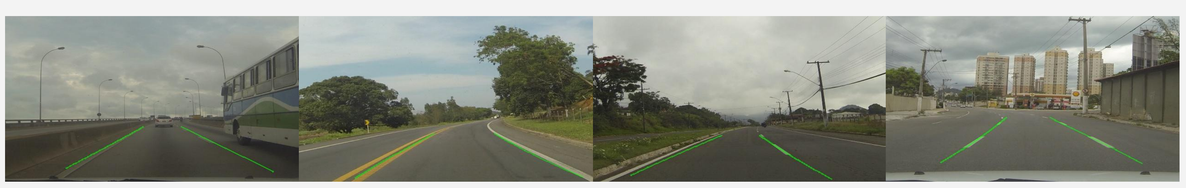
Modification		Acc	FP	FN
Top-Y sharing	No	88.43	0.2126	0.1783
	Yes	88.62	0.2237	0.1844
Pretraining	None	84.37	0.3317	0.2826
	ImageNet	88.62	0.2237	0.1844
Data Augmentation	None	78.63	0.4788	0.4048
	10x	88.62	0.2237	0.1844

Qualitative results on TuSimple

Qualitative results on LLAMAS



Qualitative results on ELAS



Conclusion

- Permissive metrics and reproducibility are two important issues in lane detection works
- PolyLaneNet is a simple, efficient and reproducible lane detection method

Code & Models

github.com/lucastabelini/PolyLaneNet