

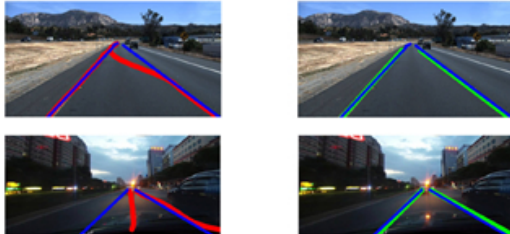
# RONELD: ROBUST NEURAL NETWORK OUTPUT ENHANCEMENT FOR ACTIVE LANE DETECTION

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## Abstract



Before

After

Accurate lane detection is critical for navigation in autonomous vehicles, particularly the active lane which demarcates the single road space that the vehicle is currently traveling on. Recent state-of-the-art lane detection algorithms utilize convolutional neural networks to train deep learning models. While each of these models works particularly well on train and test inputs obtained from the same dataset, the performance drops significantly on unseen datasets of different environments. To address this, we present a real-time robust neural network output enhancement for active lane detection (RONELD) method to identify, track, and optimize active lanes from deep learning probability map outputs.

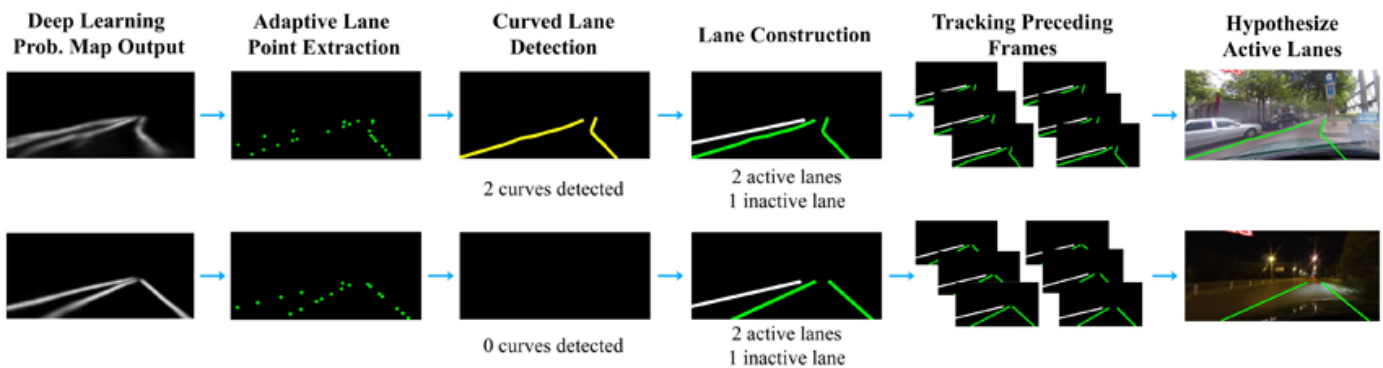
## Background

Despite the pressing need for accurate and reliable lane detection to enable successful autonomous vehicles, detecting lanes has remained challenging throughout the years. One reason is the rather simple and homogeneous appearance of lane markings which lacks distinctive features. Other obstacles, such as weather and illumination conditions, also plague lane detection research. Furthermore, lane detection scenarios occur in diverse driving environments, various road surface conditions, and in real-time, which necessitates a robust and low computational cost algorithm for successful lane detection on autonomous vehicles.

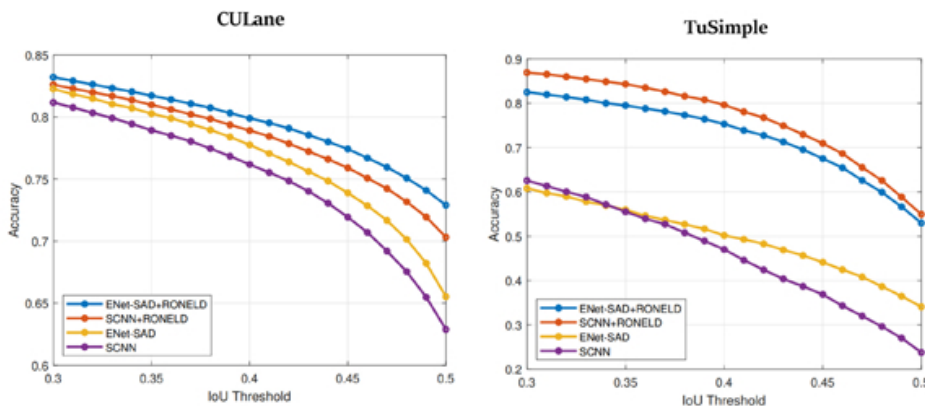
**Traditional lane detection:** Traditional lane detection methods rely on hand-crafted features such as color-based features, bar filter, ridge features, hough transform, random sample consensus (RANSAC), etc., to identify lane segments. Tracking techniques such as particle or Kalman filters are used as a final stage for lane tracking to map the lanes onto the current frame. In general, most of these traditional methods based on hand-crafted features lack robustness and can only solve the lane detection problem in limited scenarios or require strict lane assumptions.

**Deep learning based lane detection:** Recently, deep learning models have gained popularity after displaying compelling results in other computer vision problems. Current state-of-the-art methods include the Spatial Convolutional Neural Network (SCNN), which generalized deep layer-by-layer convolutions to slice-by-slice convolutions within feature maps, and ENet-SAD, a self-attention distillation (SAD) method that was incorporated with the lightweight ENet model.

## Methodology



## Results



## Conclusion

We have presented a robust neural network output enhancement for active lane detection (RONELD) method which achieves compelling results in cross-dataset validation tests and shows high potential for use in real-time autonomous driving applications. Using RONELD, we identify, track, and optimize active lane detection on probability maps from deep learning based lane detection algorithms. We have demonstrated on two state-of-the-art algorithms, tagged as SCNN + RONELD and ENet-SAD + RONELD, in our experiments on the CULane and TuSimple datasets. Results over the two datasets indicated that by applying RONELD, accuracy increases by up to 69.4% on the looser 0.3 and 0.4 IoU thresholds, and increases up to two-fold on the strictest 0.5 IoU threshold against both SCNN and ENet-SAD algorithms.

## References

1. X. Pan, J. Shi, P. Luo, X. Wang, and X. Tang, "Spatial as deep: Spatial CNN for traffic scene understanding," in AAAI Conf. Artificial Intelligence, 2018, pp. 7276-7283.
2. Y. Hou, Z. Ma, C. Liu, and C. C. Loy, "Learning lightweight lane detection cnns by self attention distillation," in 2019 IEEE/CVF International Conference on Computer Vision (ICCV), 2019, pp. 1013-1021.
3. TuSimple, "TuSimple competitions for cvpr2017," <https://github.com/TuSimple/tusimple-benchmark/>, accessed: 2019-10-02.

Code on Github:

[github.com/czmng/RONELD-Lane-Detection](https://github.com/czmng/RONELD-Lane-Detection)

