# CS 766 Project Proposal: Lane Detection and Tracking in Adverse Visibility Conditions

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## 1 Overview

Lane detection and tracking has become a prominent area as the push for autonomous vehicles surges. Reasons for doing so include automating and enhancing the driving experience. In addition, with most road accidents occurring due to driver carelessness, the Advanced Driver Assistance System (ADAS) can provide reduced driver workload and establish a sense of security. Although there currently exists a slew of lane detection and tracking algorithms, there seems to be no *robust* solution for detection and tracking in *adverse conditions*. We would like to investigate this issue in-depth by implementing the current state-of-the-art lane detection and tracking algorithms for *adverse visibility conditions*. Time-permitting, we would like to implement our own approach to solve this problem.

## 2 Project Outline

### 2.1 Current State-of-the-Art

There is great interest in algorithms to improve autonomous driving. However, most current approaches have only been shown to work in amicable weather conditions. Lee *et al.* [2] recently proposed a sensor fusion algorithm to handle extremities in weather (e.g. rain) where they combine camera, LiDAR, GPS, and vehicle sensor information. We will restrict this project to camera information. That is, RGB color image information.

One can divide the task of lane detection and tracking into separate stages: preprocessing, detection, and tracking. The first stage, preprocessing, is generally focused on edge detection. Popular approaches include: the Sobel operator and Canny edge detection. For detection, Hough transform and the Random Sample Consensus algorithm are commonly used approaches. Lastly, tracking is typically performed by using a filter (e.g.'s Kalman filter, particle filter). Due to the vast number of combinations for preprocessing, detection, and tracking techniques, the real ingenuity comes from deciding what approach to implement for each stage. Only a few algorithms presented in [1] appear to be robust in certain weather conditions. Through our investigations, there does not exist a general method for adverse weather conditions when one is limited to RGB images.

### 2.2 Our Plan

We would like to improve on current approaches that are limited to RGB images for lane tracking. Our first step will be to re-implement a couple different approaches. This will give us greater insight into the problem and help us understand the strengths and weaknesses of current approaches.

Once we have reimplemented current approaches, we want to explore improving their robustness to adverse visibility conditions in a couple ways. First, we'd like to try combining two approaches and see if this ensemble can help overcome the algorithms weaknesses. For example, Leng and Chen's [3] approach is successful with worn-out lines, and Yoo's [4] approach is successful in illumination changes. By combining the two in some novel way, perhaps we could combine the strengths of either approach. Secondly, our new approach might try preprocessing the images with a generative adversarial network (GAN). Recent state-of-the-art GANs can de-rain or de-snow images while minimizing introduced artifacts [5]. By combining these recent advances with existing lane tracking approaches, we believe our solution can offer a better alternative to state-of-the-art lane tracking given solely RGB images.

### 2.3 Evaluation

We will follow the most common metrics used to evaluate the performance of lane detection algorithms. They are the following: precision, recall, F-score, accuracy, and area under the ROC curve (AUC). In the case of lane detection, the aforementioned metrics can be interpreted as the following:

- Precision: The fraction of detected lane markers that are actually lane markers.
- Recall: The fraction of actual lane markers detected.
- F-score: Combination of precision and recall.
- Accuracy: How well actual lane markers are identified correctly.
- AUC: Plot of True Positive Rate vs. False Positive Rate.

### 2.4 Timeline

Table 1: Timeline for Lane Detection and Tracking in Adverse Visibility Conditions Project

| Task | Completed By |
|---|---|
| Research current approaches | February 21 |
| Gather necessary datasets | February 28 |
| Re-implement existing approaches | March 23 |
| Mid-term report | April 2 |
| Combine two approaches or use GAN | April 18 |
| Give presentation | April 23 |
| Website completed | May 7 |

## References


[1] A. Manoj Kumar and Philomina Simon. Review of lane detection and tracking algorithms in advanced driver assistance system. 2015.

[2] U. Lee, J. Jung, S. Shin, Y. Jeong, K. Park, D. H. Shim, and I. s. Kweon. Eurecar turbo: A self-driving car that can handle adverse weather conditions. In *2016 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pages 2301–2306, Oct 2016.

[3] Y. C. Leng and C. L. Chen. Vision-based lane departure detection system in urban traffic scenes. In *2010 11th International Conference on Control Automation Robotics Vision*, pages 1875–1880, Dec 2010.

[4] H. Yoo, U. Yang, and K. Sohn. Gradient-enhancing conversion for illumination-robust lane detection. *IEEE Transactions on Intelligent Transportation Systems*, 14(3):1083–1094, Sept 2013.

[5] He Zhang, Vishwanath Sindagi, and Vishal M. Patel. Image de-raining using a conditional generative adversarial network. *CoRR*, abs/1701.05957, 2017.