Lane Marking Extraction Algorithm Report

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1 Introduction

This report details the implementation of traditional image processing techniques for extracting and highlighting lane markings from a highway image. The goal is to isolate white and yellow lane markings while filtering out other elements of the scene using colour thresholding, edge detection, morphological operations, and the Hough Transform.

Figure 1: Original Image

2 Approach

The implemented approach follows a sequence of image processing steps to extract and segment lane markings effectively:

1. **Colour Masking** - Convert the image to HSV colour space to define thresholds for white and yellow lanes.
2. **Morphological Operations** - Apply noise reduction techniques to refine the extracted lane masks.
3. **Edge Detection** - Use Canny edge detection to detect lane edges.
4. **Hough Line Transform** - Identify lane markings by detecting straight lines.
5. **Blending and Visualization** - Overlay the detected lane markings onto the original image.

3 Challenges and Solutions

3.1 Sky Interference with White Lane Detection

One of the key challenges in extracting white lane markings was interference from the sky, which shares similar colour characteristics in the HSV space. The sky, being bright, often led to false positives in white lane detection.

To mitigate this issue:

- Edge detection was performed to isolate lane structures from smooth gradient areas such as the sky.
- The Hough Transform was applied to detect straight lines, ensuring that only structured lane-like features were retained while removing random bright areas like the sky.

3.2 Optimizing Hough Transform Parameters

The Hough Line Transform was used to extract straight lane markings from the processed edge-detected image. The selection of optimal parameters was crucial for accurate lane extraction:

Resolution Parameters:

- 1 pixel for distance resolution.
- $\pi/180$ radians for angular resolution.

Threshold (Votes Required in the Accumulator):

- 50 for white lines: Ensured that only significant lane markings were considered.
- 40 for yellow lines: Accounted for the fact that yellow lines were generally more prominent.

Minimum Line Length:

- 200 pixels for white lanes: Avoid detection of small noise artifacts.
- 1 pixel for yellow lanes: Allowed the detection of short yellow lane segments.

Maximum Line Gap:

- 10 pixels for both white and yellow lanes: Balanced between detecting continuous lanes while ignoring broken artifacts.

A lot of min-maxing of these parameters was required to fine-tune the results, ensuring that actual lane lines were detected while avoiding excessive noise.

4 Results

4.1 Processed Image

- The final output highlights extracted white and yellow lane markings on the original highway image.
- A weighted overlay using `cv2.addWeighted()` ensures clear lane marking visibility while retaining contextual details of the original image.

Figure 2: Processed Image

4.2 Binary Masks

- **White Lane Mask**: A binary mask isolating white lanes on a black background.

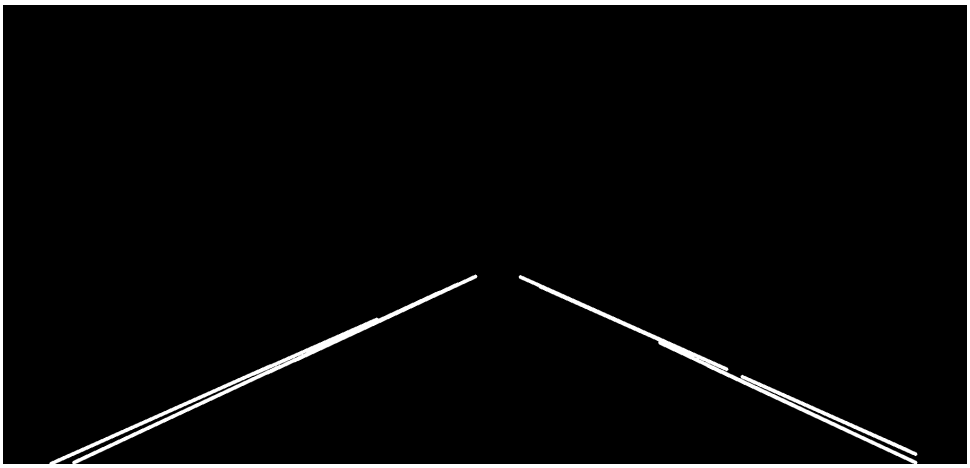

Figure 3: White Lanes

- **Yellow Lane Mask**: A binary mask isolating yellow lanes on a black background.

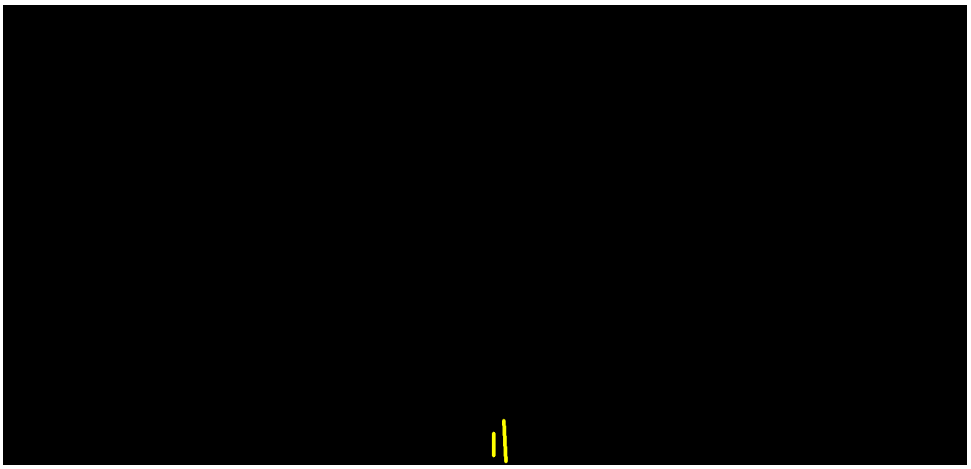

Figure 4: Yellow Lanes

5 Conclusion

- The implemented method successfully extracts and highlights lane markings using traditional image processing techniques.
- The primary challenge of sky interference was addressed by leveraging edge detection and the Hough Transform to extract structured lane features.
- Optimal Hough Transform parameters were determined through experimentation to balance sensitivity and accuracy.
- The final result meets the project requirements by providing segmented lane masks and a processed highway image with highlighted lane markings.
- Some improvements could be made to the detection algorithm for yellow edges as it was unable to detect all the yellow markings on the road.
- This was majorly due to the limits of resolution and morphological operations used in the code.