



## PROJECT

## Advanced Lane Finding

A part of the Self-Driving Car Program

## PROJECT REVIEW

## CODE REVIEW

## NOTES

SHARE YOUR ACCOMPLISHMENT!  

## Requires Changes

## 1 SPECIFICATION REQUIRES CHANGES

Great work on this project, you have put a lot of effort into it and it looks great! There is just one thing I would like to see you improve. You seem to be slightly off on your radius of curvature calculation, I have given you an example of how you can fix this error.

I have also left some suggestions that can hopefully help you improve even more! Keep up the great work and stay Udacious!

## Writeup / README

The writeup / README should include a statement and supporting figures / images that explain how each rubric item was addressed, and specifically where in the code each step was handled.

Your write up is great! I encourage that in the future you try to create it in the md format. This way you are able to publish work and projects on github for maximum visibility. If you don't have much experience with this, Udacity offers a course that I will link below.

<https://www.udacity.com/course/writing-readmes--ud777>

## Camera Calibration

OpenCV functions or other methods were used to calculate the correct camera matrix and distortion coefficients using the calibration chessboard images provided in the repository (note these are 9x6 chessboard images, unlike the 8x6 images used in the lesson). The distortion matrix should be used to un-distort one of the calibration images provided as a demonstration that the calibration is correct. Example of undistorted calibration image is Included in the writeup (or saved to a folder).

Nice job correctly calculating the camera matrix and distortion coefficients!

## Pipeline (test images)

Distortion correction that was calculated via camera calibration has been correctly applied to each image. An example of a distortion corrected image should be included in the writeup (or saved to a folder) and submitted with the project.

Good job applying the camera calibration to the other images!

A method or combination of methods (i.e., color transforms, gradients) has been used to create a binary image containing likely lane pixels. There is no "ground truth" here, just visual verification that the pixels identified as part of the lane lines are, in fact, part of the lines. Example binary images should be included in the writeup (or saved to a folder) and submitted with the project.

Good job extracting the lane lines in particular your thresholding techniques! An idea for more robust extraction is to try color thresholding in all the RGB, HSV and HSL channels for your yellows and whites! By using color thresholding you are able to make the lane detection more robust by relying less on gradients for good results! Furthermore, thresholding is a lot faster in terms of processing than gradients!

Here is some sample code to play around with:

```
HSV = cv2.cvtColor(your_image, cv2.COLOR_RGB2HSV)

# For yellow
yellow = cv2.inRange(HSV, (20, 100, 100), (50, 255, 255))

# For white
sensitivity_1 = 68
white = cv2.inRange(HSV, (0,0,255-sensitivity_1), (255,20,255))

sensitivity_2 = 60
HSL = cv2.cvtColor(your_image, cv2.COLOR_RGB2HLS)
white_2 = cv2.inRange(HSL, (0,255-sensitivity_2,0), (255,255,sensitivity_2))
white_3 = cv2.inRange(your_image, (200,200,200), (255,255,255))

bit_layer = your_bit_layer | yellow | white | white_2 | white_3
```

OpenCV function or other method has been used to correctly rectify each image to a "birds-eye view". Transformed images should be included in the writeup (or saved to a folder) and submitted with the project.

Great job with the transform! An idea you could try, is to transform the image first and then extract your lanes to get your binary image. This method will provide cleaner results on the transformed image!

Methods have been used to identify lane line pixels in the rectified binary image. The left and right line have been identified and fit with a curved functional form (e.g., spine or polynomial). Example images with line pixels identified and a fit overplotted should be included in the writeup (or saved to a folder) and submitted with the project.

Nice job fitting polynomials to the extracted lane lines!

Here the idea is to take the measurements of where the lane lines are and estimate how much the road is curving and where the vehicle is located with respect to the center of the lane. The radius of curvature may be given in meters assuming the curve of the road follows a circle. For the position of the vehicle, you may assume the camera is mounted at the center of the car and the deviation of the midpoint of the lane from the center of the image is the offset you're looking for. As with the polynomial fitting, convert from pixels to meters.

Your radius of curvatures are higher than expected. Please revisit this lesson modules for more additional details.

Here are some things to try:

1. Try fitting the middle of the polynomial with this change: `y_eval = np.max(ploty)/2`.
2. Be sure to convert your lane points to meters before fitting the polynomials to them and make sure to "yval" is in units of meter before using that point.
3. Be on the look out for radius of curvatures between 400-1500 meters for you curves and values higher than 2500 m for when the road appears to be straight.
4. Also make sure your conversion values are that of what is provided by Udacity.

The fit from the rectified image has been warped back onto the original image and plotted to identify the lane boundaries. This should demonstrate that the lane boundaries were correctly identified. An example image with lanes, curvature, and position from center should be included in the writeup (or saved to a folder) and submitted with the project.

Warp looks great!

## Pipeline (video)

The image processing pipeline that was established to find the lane lines in images successfully processes the video. The output here should be a new video where the lanes are identified in every frame, and outputs are generated regarding the radius of curvature of the lane and vehicle position within the lane. The pipeline should correctly

map out curved lines and not fail when shadows or pavement color changes are present. The output video should be linked to in the writeup and/or saved and submitted with the project.

Your video looks great! In addition to other filtering mechanisms like averaging the polynomial coefficients and rejecting outliers. You can use `cv2.matchShapes` as a means to make sure the final warp polygon is of quality before using. OpenCV's `matchShapes`, compares two shapes and returns a similarity index, with 0 being identical shapes. You can use this to make sure the polygon for your next frame is close to what it is expected to look like and if not you can elect to use old polygon instead. This way you can let your algorithm be really good when it can and when it can just fake it until a few frames later when it produces good results.

Here is an example:

```
# Early in the code before pipeline
global polygon_points_old
polygon_points_old = None

# In the pipeline

if (polygon_points_old == None):
    polygon_points_old = polygon_points

a = polygon_points_old
b = polygon_points
ret = cv2.matchShapes(a,b,1,0.0)

if (ret < 0.045):
    # Use the new polygon points to write the next frame due to similarities of last successfully written polygon area

    polygon_points_old = polygon_points

else:
    # Use the old polygon points to write the next frame due to irregularities
    # Then write the out the old polygon points
    # This will help only use your good detections
```

## Discussion

Discussion includes some consideration of problems/issues faced, what could be improved about their algorithm/pipeline, and what hypothetical cases would cause their pipeline to fail.

Great job with the discussion and reflecting on the project!

 RESUBMIT

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### Best practices for your project resubmission

Ben shares 5 helpful tips to get you through revising and resubmitting your project.

[Watch Video](#) (3:01)

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