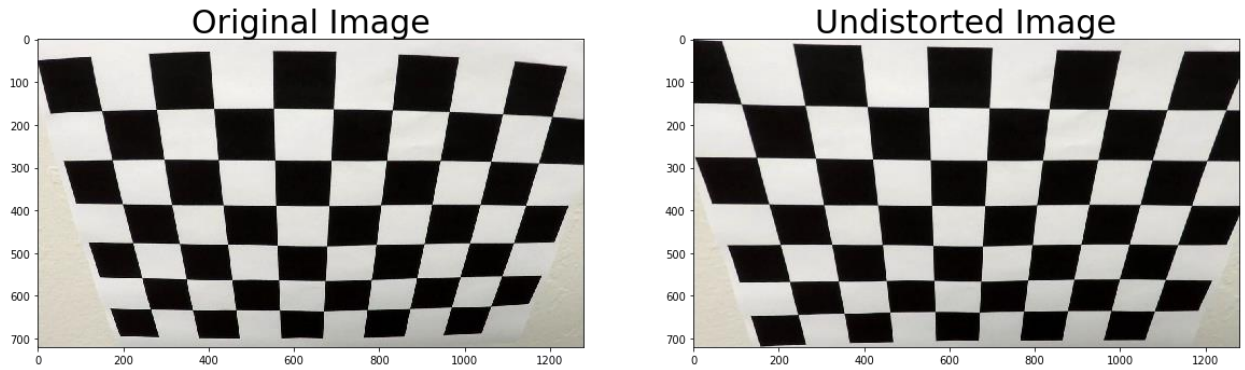
Camera Calibration

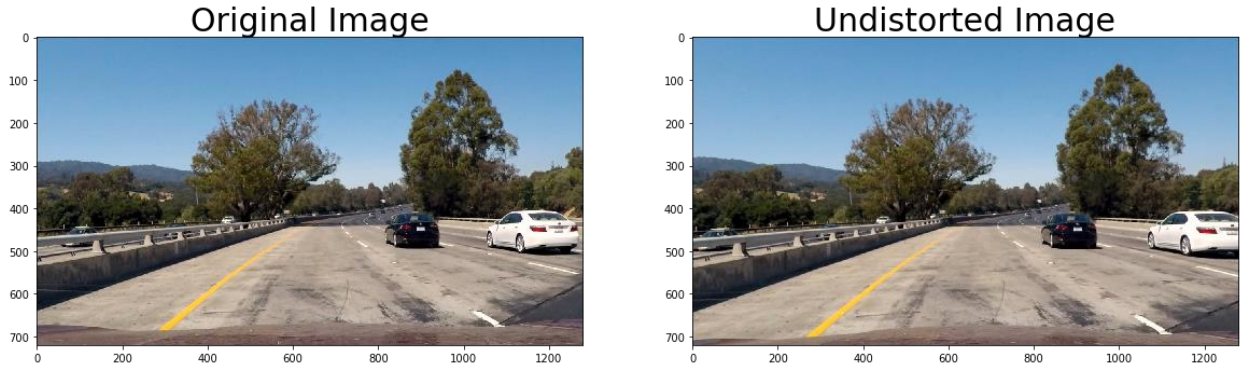
I addressed camera calibration in first four code blocks in ipython. I used cv2.findChessBoardCorners() to find all the corners in the 20 camera calibration images. All the corner points are saved in an array called imgpoints. Then cv2.calibrationCamera() is called to calculate the camera matrix and distorted coefficients. At the cv2.undistort() is used to get the final undistorted images. Below is an example.



Pipeline (Test Image)

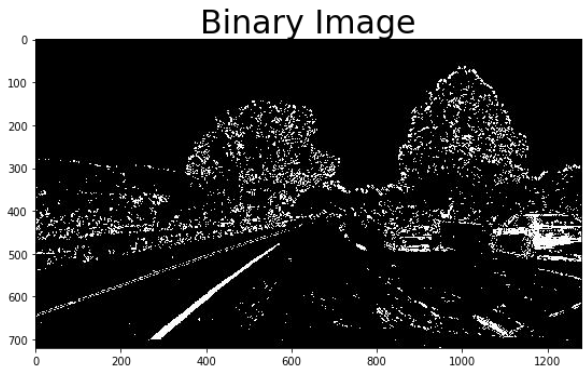
1) Distortion-corrected Image

I undistorted all input test images in the fifth code block. Below is an example.



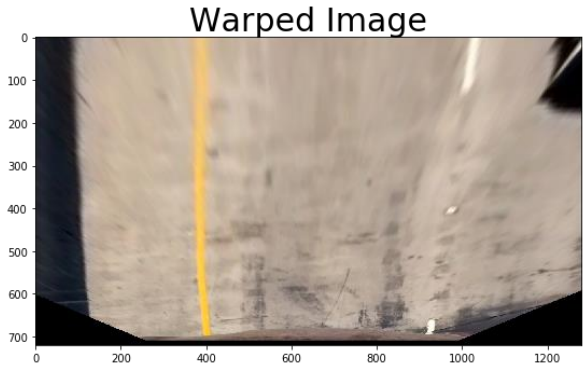
2) Get Binary Image

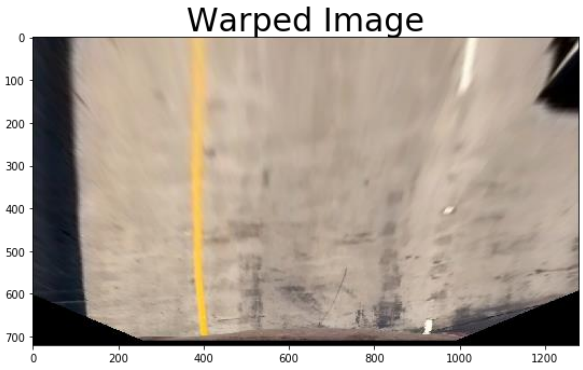
I used a combination of gradients and color transform to create a binary image containing likely lane pixels. For gradient part, I used Sobel operator to calculate x-gradient, y-gradient, magnitude-gradient and directional gradient and the combined these results to generate the final gradient binary image output. For color transformation, I used HLS color and created a binary image from S channel with a threshold. I combined the two binary images output to get the final binary image. The related code is in the sixth code block. Below is an example of the output.

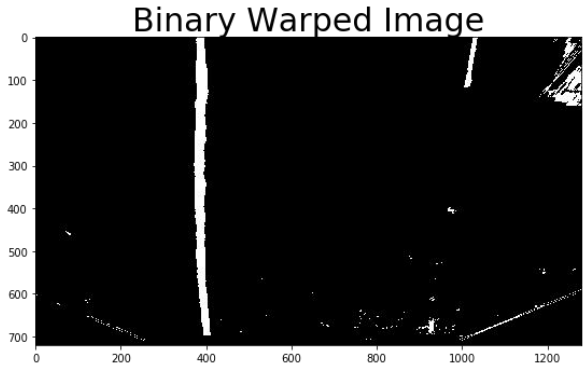


3) Perspective Transform

I performed perspective transform in the seventh to ninth code block. I chose four point in one of the original undistorted input image, and matched these points with another four points which form a rectangular. With these two pairs of four points, I called cv2.getPerspectiveTransform to get the transform matrix and inverse transform matrix. With I transform matrix, perspective transform was taken up by calling cv2.warpPerspective. I used the approach to get the binary image of the warped image. Below is an example of the result.

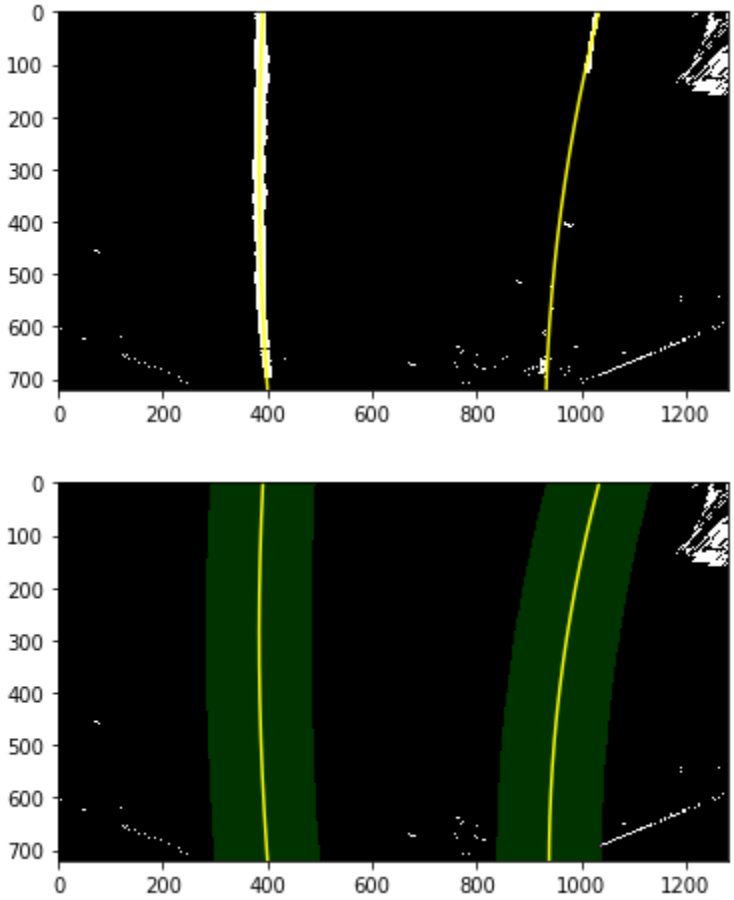






4) Fit the Lane line with Polynomial

I used the function fit_lane_line to get polynomial fit for the lane line detected. I used the slide window based method the locate all the points along the lane line. With these points, two order polynomial function is used to fit these points. Below are the results.

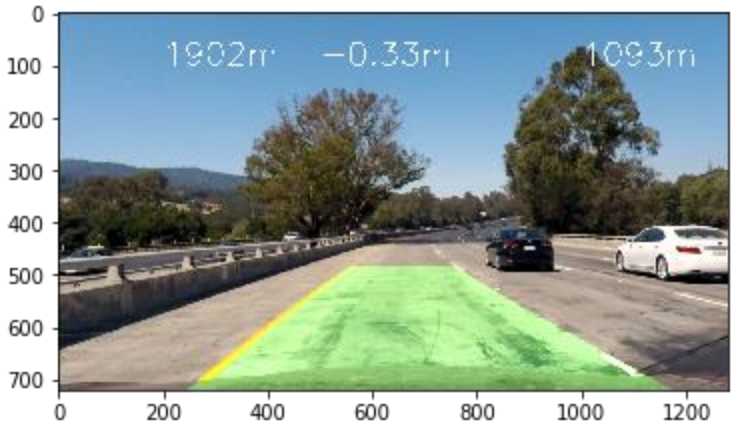


5) Curvature Calculation

I calculated curvature by using function get_curvature. I used the points gotten in lane line fit process and used the formula provided in the lecture to calculate real world curvature. For the above image, the curvatures for left and right lane are 1902.06375246 meter and 1093.87042014 meter, respectively.

6) Plot back down unto the road

Below is an example image.



Pipeline (Video)

Link:

https://drive.google.com/file/d/0B0mOwdme-PN5RE1BRXNiWm9yY3M/view?usp=sharing

Discussion

This project is great. It turns out the technique works very well. For example, perspective transform is very useful for detection lane line while ruling out of other edges which are not lane line. In this project, I have trouble to fully understand Sobel operator. But after reading the material several times, I can understand the code provided in the lecture. For the pipeline I designed, it involves too much computation. The gradient-base edge detection can be made simpler to save computation time. Also, it may be better if we can automatically select the points for transform matrix calculation. The pipeline may not work when the weather condition is not good, like raining or snowing.