Advanced Lane Finding

Advanced Lane Finding Project

The goals / steps of this project are the following:

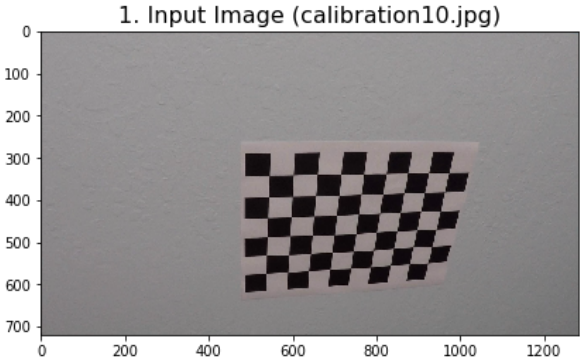
- Compute the camera calibration matrix and distortion coefficients given a set of chessboard images.
- Apply a distortion correction to raw images.
- Use color transforms, gradients, etc., to create a thresholded binary image.
- Apply a perspective transform to rectify binary image ("birds-eye view").
- Detect lane pixels and fit to find the lane boundary.
- Determine the curvature of the lane and vehicle position with respect to center.
- Warp the detected lane boundaries back onto the original image.
- Output visual display of the lane boundaries and numerical estimation of lane curvature and vehicle position.

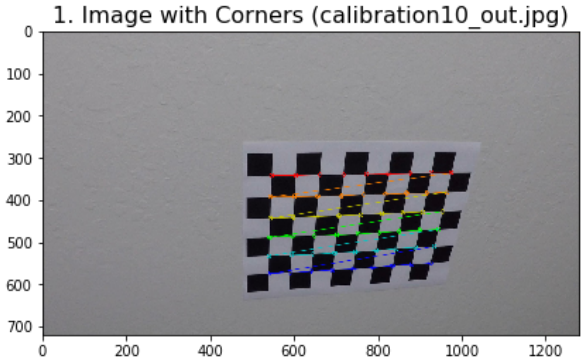
Camera Calibration

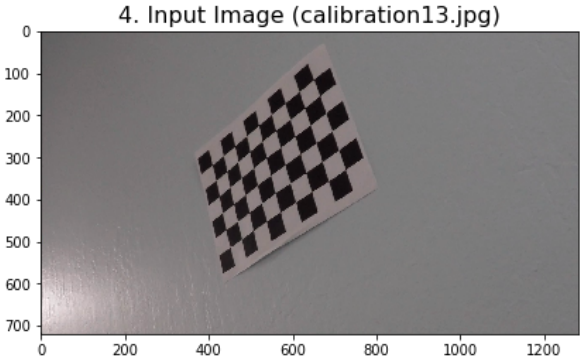
Compute the camera calibration matrix and distortion coefficients given a set of chessboard images.

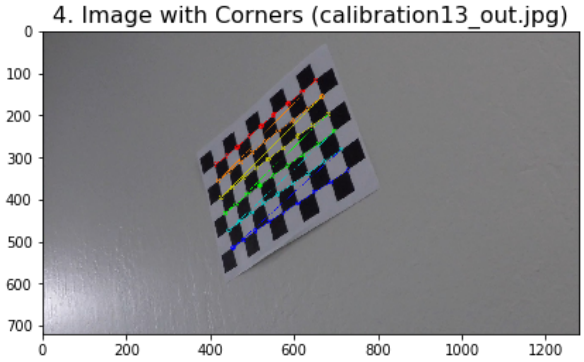
I used the OpenCV functions findChessboardCorners and drawChessboardCorners to identify the locations of corners on a chessboard photos in camera_cal folder taken from different angles.

I then used the output points_3d and points_2d to compute the camera calibration and distortion coefficients using the cv2.calibrateCamera() function. I applied this distortion correction to the test image using the cv2.undistort() function and obtained this result:



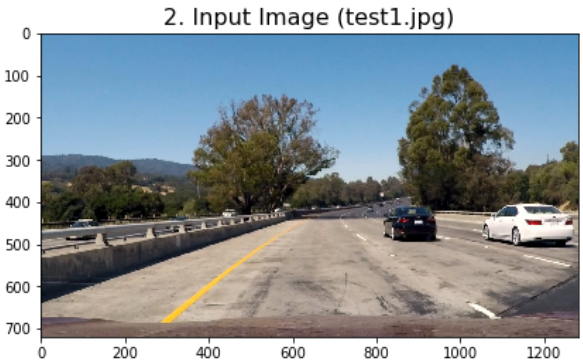


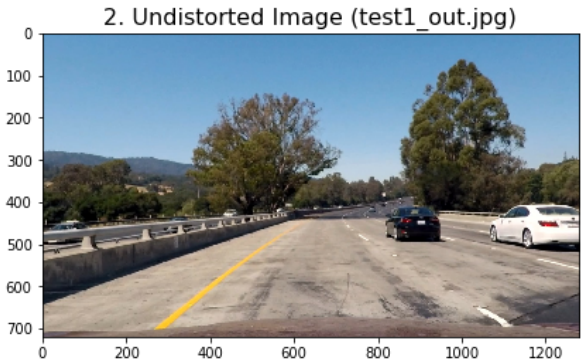


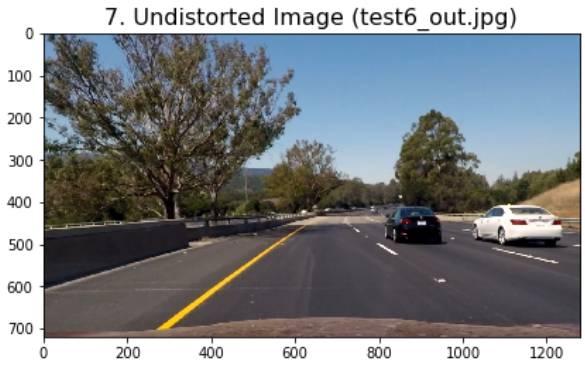


Pipeline

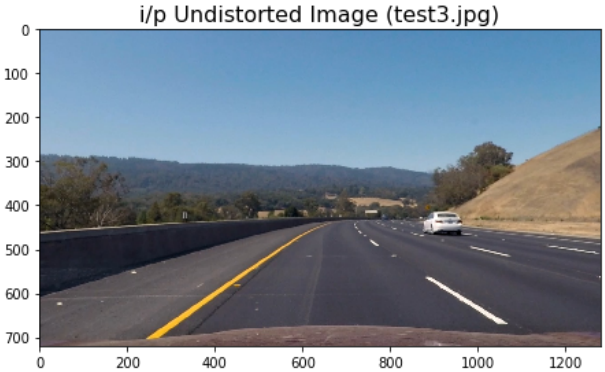
1. Applied distortion correction on the images provided using calculated camera calibration matrix and distortion coefficients. Code provided in cell [4].

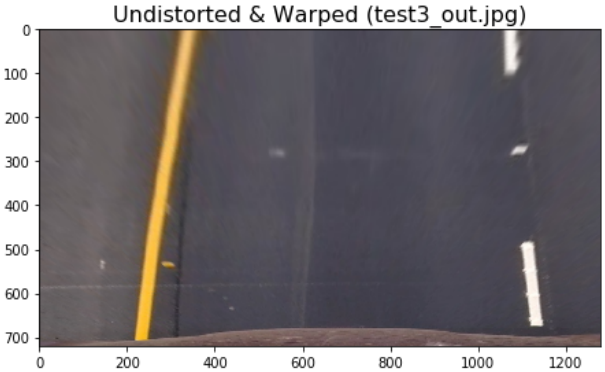


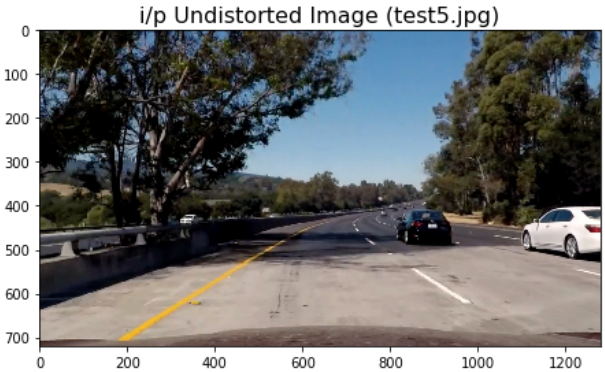


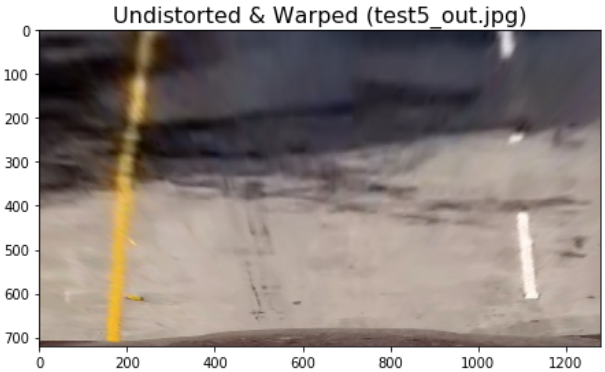


2. Apply a perspective transform to the image ("birds-eye view").
   Code is provided on cell [5] on function called prespective_transform.
   It uses the CV2's **getPerspective**Transform and **warpPerspective** fns and **remove_distortion** written as discussed.





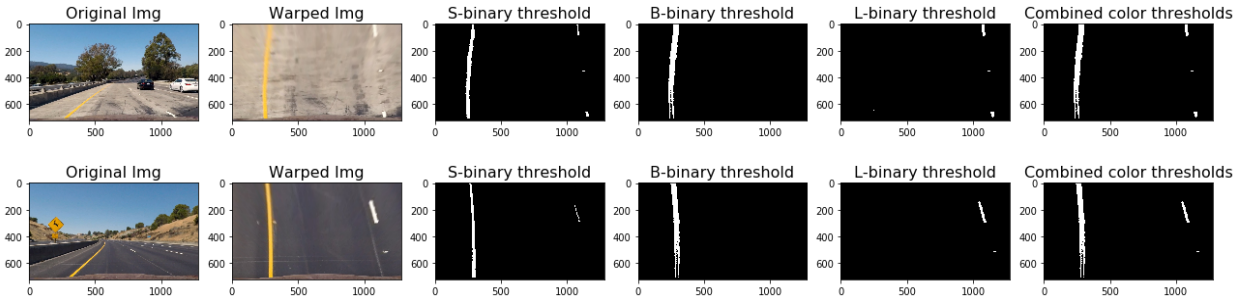




3. Use color transforms, gradients, etc., to create a thresholded binary image. To find the following channels and return them and combined image:
   a. S-Channel
   b. B-Channel
   c. L-Channel

   Code is provided on cell [6]. I used the color combination and gradient to get the binary image.

   Wrapped image is converted to another color space and generated the binary image to be able to highlight the lane lines only and ignore others

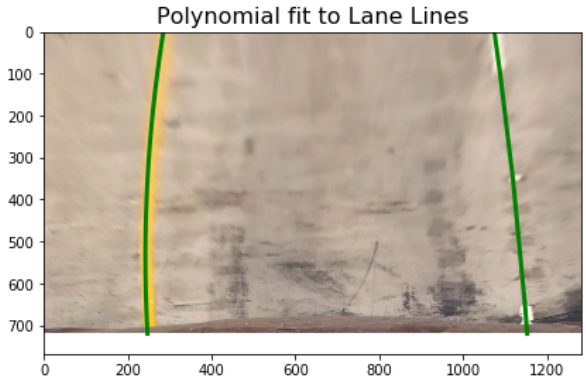


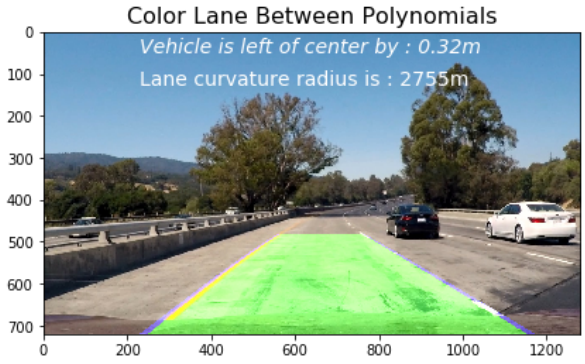
4. Fitting a polynomial to the lane lines and fill the space between them
   Code is provided in cell [17].
   I have used the combined binary image to fit the polynomial to each lane line, as follows:

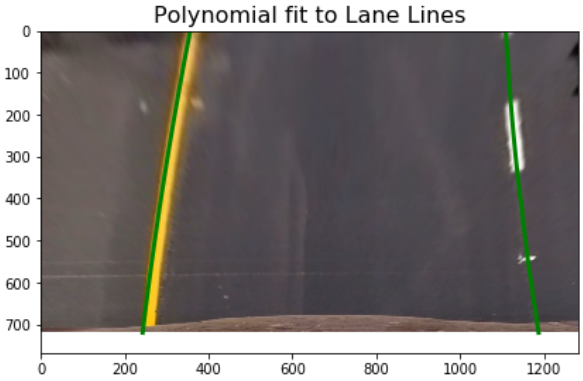
- Determine the location of lane lines using the peaks of image histogram.
- Identified all non-zero pixels around histogram peaks using numpy.nonzero().
- Fitted polynomial to each lane using numpy.polyfit().

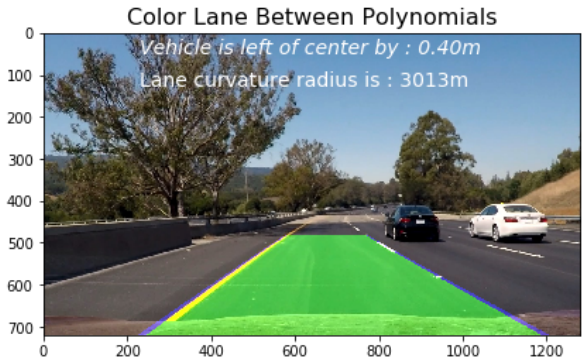
With this, I was able to calculate the position of the vehicle w.r.t center with the following calculations:

- Calculated x intercepts avg. from each of the two polynomials position
- Calculated distance from center by taking the abs value of the vehicle's position and subtracting the halfway point along the horizontal axis distance from center.
- If horizontal position of the car was > image_width/2, then car was considered to be on left of center, else right of center.
- Finally, the center distance was converted from pixels to meters by multiplying the number of pixels by 3.7/730.









5. Calculating raduis of curvature
   Code is provided in cell [19] funtion calculate_radius_of_curvature.

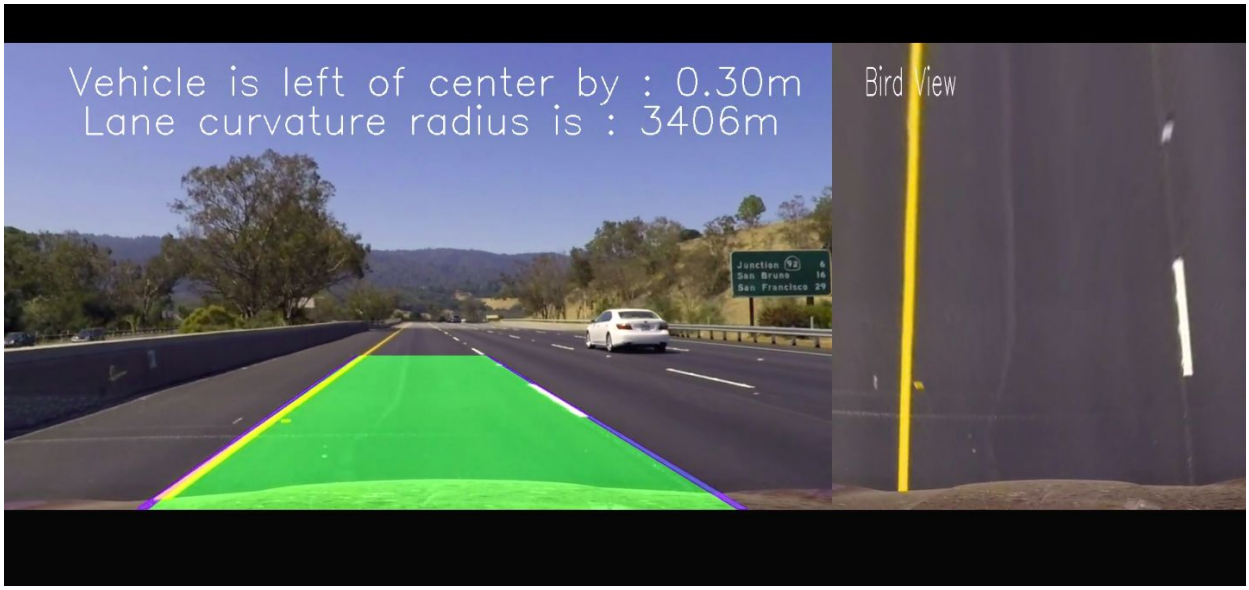
The curvature is calculated using the following code:

```
# Find radius of curvature for both lane line
    xm_per_pix = 3.7/730 # meteres/pixel in x dimension
    ym_per_pix = 23.0/720 # meters/pixel in y dimension

    left_lane_fit_curvature = np.polyfit(left_y*ym_per_pix, left_x*xm_per_pix, 2)
    right_lane_fit_curvature = np.polyfit(right_y*ym_per_pix, right_x*xm_per_pix, 2)
    radius_left_curve = ((1 + (2*left_lane_fit_curvature[0]*np.max(left_y)*ym_per_pix +
left_lane_fit_curvature[1])**2)**1.5)/np.absolute(2*left_lane_fit_curvature[0])
    radius_right_curve = ((1 + (2*right_lane_fit_curvature[0]*np.max(left_y)*ym_per_pix +
right_lane_fit_curvature[1])**2)**1.5)/np.absolute(2*right_lane_fit_curvature[0])
```

Final output

Final output videos are in the output_video folder, and below sample of the output video.



Discussion

- The pipeline i have used was so good with the project video and could do the work required without problems.
- The pipeline for the challenge video was little bit good. It could do some detection but failed at some.
- The pipeline failed with the harder challenge and it wa not good.

I think to solve the problem and get good solution working with all the videos, i need to revisit the binary image section and redesign it and read more about this topic so i can get the best combination that detect the lines in any condition of road and light.