Vijay D., Feb 2017 Class
Udacity Car ND

Report P1: Basic Highway Lane Detection

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1. Sequence of Steps to Lane Detection

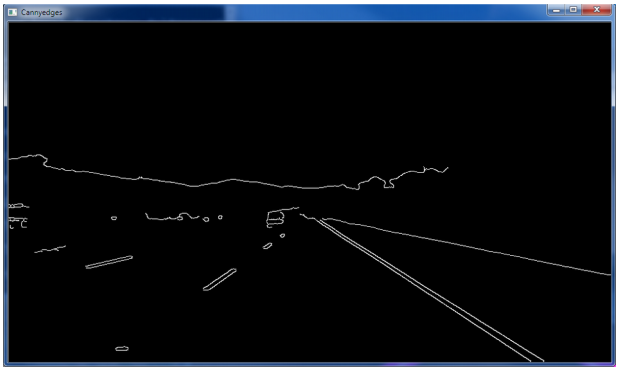
The sequence used to arrive at an acceptable lane detection, given images (and videos) of highway lanes, is the following:

1. GRAYSCALE: Convert the imported image to grayscale to reduce complexity
2. BLUR: Blur the image to reduce complexity a little more
3. MAKE MASK: Pick the range of white values of the lane markers in the gray-blurred image, and convert to a mask
4. CANNY EDGE DETECTION: Send this ANDed image through the Canny edge detection algorithm
5. MARK ROI: Establish the region of interest in which we want to identify the edges
6. BITWISE AND: Perform a bitwise AND to separate the lane markers (and unfortunately, anything else that might be in the same range of white values).

7. HOUGH LINE EXTRACTION: Send the edge image through the Hough line extraction routine
8. DISCARD OUTLYING LINES: Discard lines that do not belong to the lanes based on slope
9. EXTEND LINE: Using slope and one of the lane lines, extend this line to the top of the ROI and the max. height of it (in +Y). Do for both sides of the lane.
10. SUPERIMPOSE EXTENDED LINE ON ORIGINAL IMAGE: Draw the two lane lines on top of the original image using addWeighted() function.

2. Example of lane detection on an image (solidWhiteRight.jpg)

After Step 2



After Step 4

After Step 10

3A. Potential Shortcomings With This Method

- A blurry grayscale may not be the best approach to detecting lane markers (an alternative that works to an extent is to convert to a negative image first).
- There are a few parameters in the Canny edge detection and Hough line extraction routines that offer too wide a spectrum to tweak manually. Even after manual tweaking, it may not be general enough to apply to every image.
- Finding and filtering lines (based on slope) through Hough extraction may not be adequate in the presence of hard turns, T-intersections, etc.

3B. Potential Improvements

- There must be better and more reliable methods for detecting lanes of any color.
- While the OpenCV inRange() function seems to hold promise, it also brings its own shortcomings when filtering out colors.
- While this script is partially successful in processing the challenge video, converting the images to the HSV color space might offer better filtering and performance.
- Marking the ROI and extending lane lines on either side can be made fully parametric based on image dimensions (it is partially parametric now).

Short Notes

a. To save time during testing, this process is menu-driven which has been retained in the final script version — helps with loading different images and videos without changing code. Scrip, when executed, displays a menu similar to that shown below (type 1-10, or press Enter to exit):

```
Project: P1, Vijay D.
Basic Lane Detection

PICK A VIDEO: -OR-
_____________________________________________
1:  Video w/solid white right lane marker
2:  Video w/solid yellow left lane marker
3:  Video - Challenge (with 2 shadow zones)

AN IMAGE:
_____________________________________________
4:  White right lane marker
5:  Yellow left lane marker
6:  White curve marker
7:  Yellow left curve lane marker
8:  Yellow left curve lane marker 2
9:  Challenge image with shadow
10: White car lane switch

Your Choice (Enter:exit): ___
```

b. Run the program with '-d 1' to turn 'debug' flag ON to output interim text & graphics results.
c. To quit after processing begins, click inside the graphics window and press ESC to quit