Project #5: Vehicle Detection

Self-Driving Car Nano Degree | Vikas Sharma

The goals / steps of this project are the following:

- Perform a Histogram of Oriented Gradients (HOG) feature extraction on a labeled training set of images and train a classifier Linear SVM classifier
- Optionally, you can also apply a color transform and append binned color features, as well as histograms of color, to your HOG feature vector.
- Note: for those first two steps don't forget to normalize your features and randomize a selection for training and testing.
- Implement a sliding-window technique and use your trained classifier to search for vehicles in images.
- Run your pipeline on a video stream (start with the test_video.mp4 and later implement on full project_video.mp4) and create a heat map of recurring detections frame by frame to reject outliers and follow detected vehicles.
- Estimate a bounding box for vehicles detected.

Data Processing

Firstly data for vehicle and non vehicle images was stored in separate folders,

```
vehicle images :   8792
non-vehicle images :   8968
```
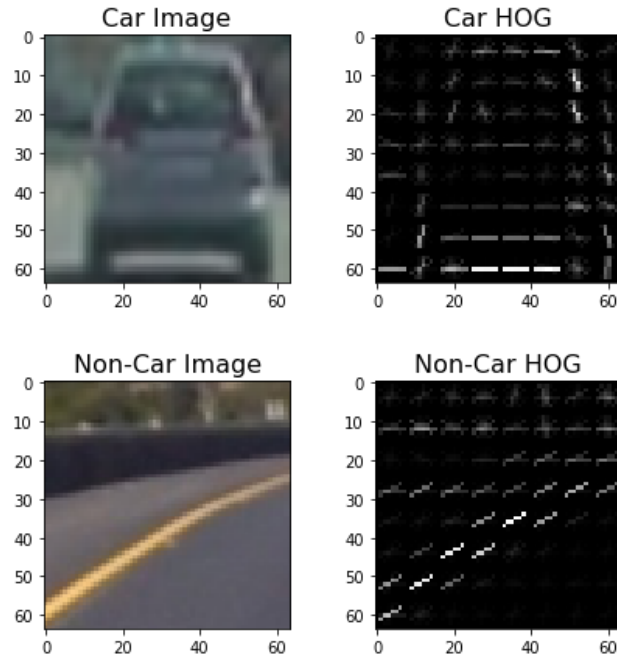
```
e.g.
```

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Histogram of Oriented Gradients (HOG) feature extraction

Used get_hog_features() function from the class to get HOG.

Results:

Feature extraction using Color Histogram, spatial bin and HOG

I used color_hist, spatial_bin and HOG functions to extract features.

I used following parameters to extract features([ref](#)).

colorspace = 'YUV' # Can be RGB, HSV, LUV, HLS, YUV, YCrCb

orient = 8

pix_per_cell = 8

cell_per_block = 2

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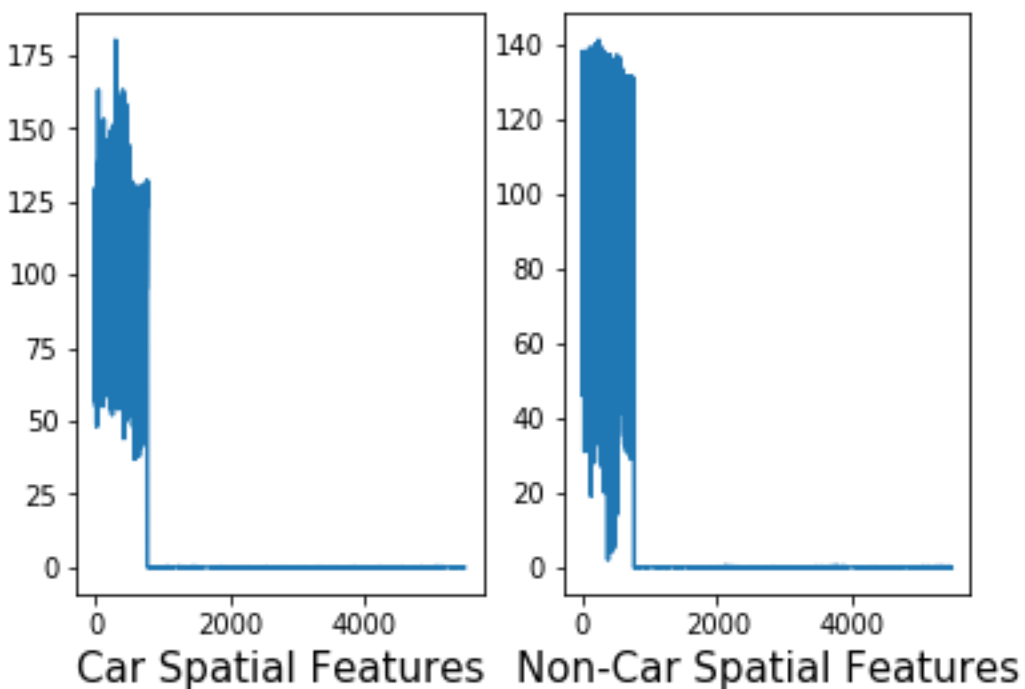
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hog_channel = 'ALL' # Can be 0, 1, 2, or "ALL"

spatial_size = (16, 16)

hist_bins = 32,

scale = 1.5

hist_range = (0, 256)

Car Spatial Features   Non-Car Spatial Features

Data Scaling using StandardScaler

I combined car and non car features in to an array.

I used StandardScaler to center the data around 0. The StandardScaler assumes data is

normally distributed . The I generated a label array assuming output of car features to be one

and non-car features to be zero.
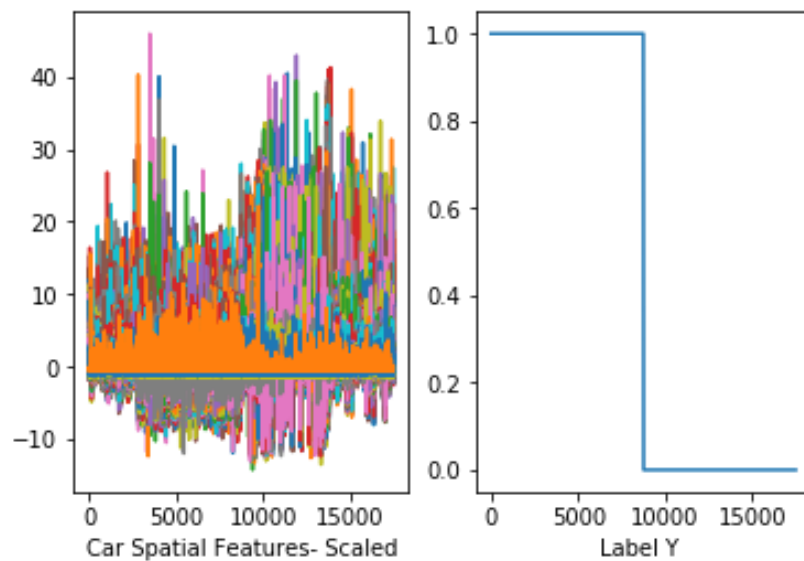
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Non-scaled features

Car Spatial Features   Non-Car Spatial Features
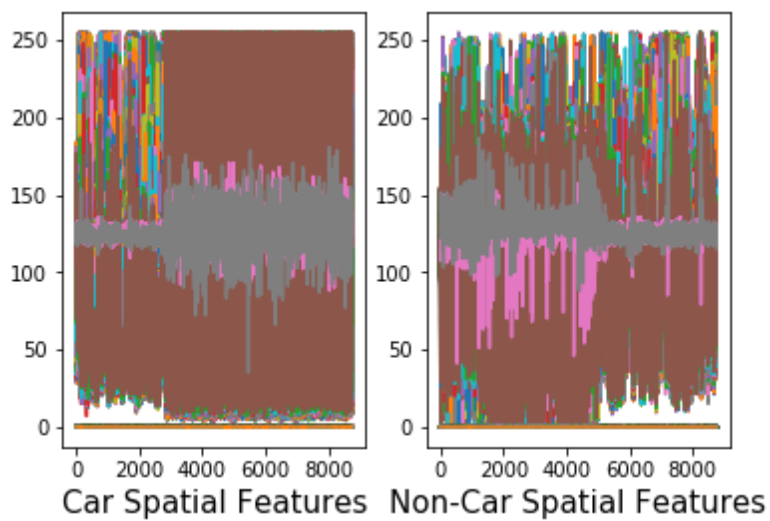
Scaled combined car and not car features and label Y

Car Spatial Features- Scaled   Label Y

Train a classifier

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I planned to use Linear Support Vector Machine(SVM) for classification.

I split the data and train the classifier. I got an accuracy of 99.26%.

```
Using: 8 orientations 8 pixels per cell and 2 cells per block
Feature vector length: 5472
4.28 Seconds to train SVC...
Test Accuracy of SVC =  0.9926
```

Sliding Window Search

A sliding window is rectangular region of fixed width and height that "slides" across an image.

For each of these windows, we analyse the window region and apply an image cla

ssifier to determine if the window has an object that interests us. I implemented sliding search

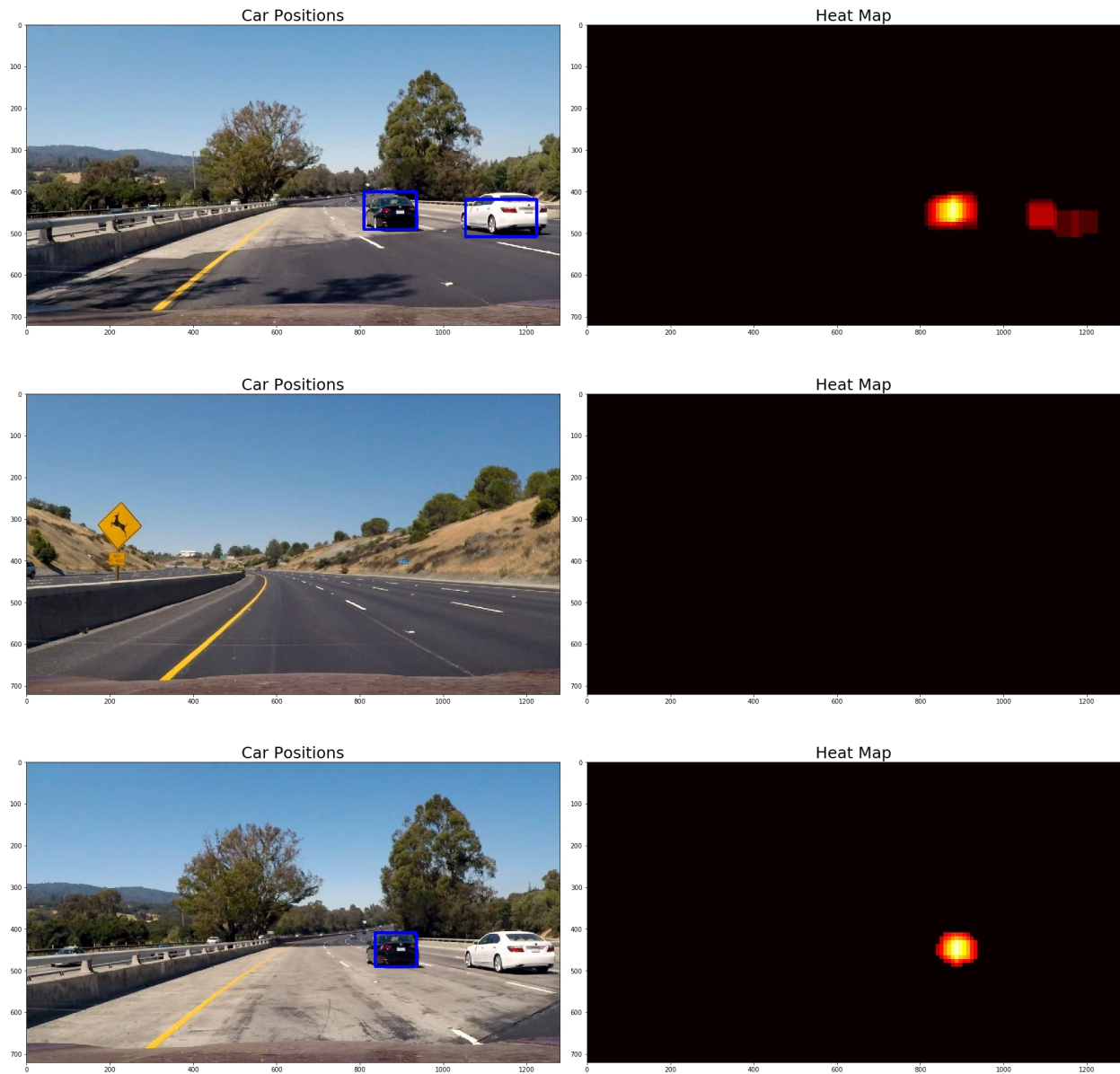using findcars(function) and drew bounding boxes around positive detections/

False detection

I used heatmaps to combine the bounding boxes and threshold to remove false positives.

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More efficient HOG sub sampling Sliding window search and create pipeline to process video

The hog sub-sampling is more efficient method for doing the sliding window approach. It only extracts hog features once and then can be sub-sampled to get all of its overlaying windows. Each window is defined by a scaling factor where a scale of 1 would result in a window that's 8 x 8 cells then the overlap of each window is in terms of the cell distance. This means that a cells_per_step = 2 would result in a search window overlap of 75%. Its possible to run this same function multiple times for different scale values to generate multiple-scaled search windows. The hog sub-sampling helps to reduce calculation time for finding HOG features.

Please see repository for processed video results. It does reasonably well.

Discussion

Major challenge I faced was detection accuracy. Even after using heat map and setting threshold, I was unable to get rid of all the false positives. I tried my pipeline on different videos and it didn't perform nearly as well as I thought it would. Lighting condition and speed of vehicles seem to effect results.