Writeup Template
You can use this file as a template for your writeup if you want to submit it as a markdown file, but feel free to use some other method and submit a pdf if you prefer.

Vehicle Detection Project

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.

[//]: # (Image References)
[image1]: ./examples/car_not_car.png
[image2]: ./examples/HOG_example.jpg
[image3]: ./examples/sliding_windows.jpg
[image4]: ./examples/sliding_window.jpg
[image5]: ./examples/bboxes_and_heat.png
[image6]: ./examples/labels_map.png
[image7]: ./examples/output_bboxes.png
[video1]: ./project_video.mp4

[Rubric](https://review.udacity.com/#!/rubrics/513/view) Points
Here I will consider the rubric points individually and describe how I addressed each point in my implementation.

Writeup / README

1. Provide a Writeup / README that includes all the rubric points and how you addressed each one. You can submit your writeup as markdown or pdf. [Here](https://github.com/udacity/CarND-Vehicle-Detection/blob/master/writeup_template.md) is a template writeup for this project you can use as a guide and a starting point.

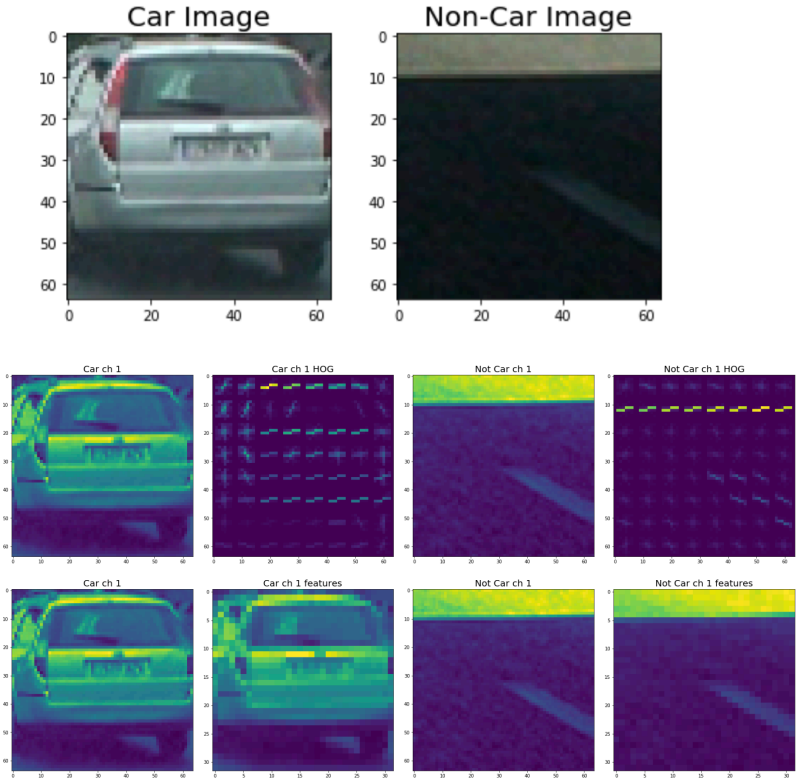
You're reading it!

Histogram of Oriented Gradients (HOG)

1. Explain how (and identify where in your code) you extracted HOG features from the training images.

The code for this step is contained in the first code cell of the IPython notebook and the method is defined as get_hog_features().

I started by reading in all the `vehicle` and `non-vehicle` images. Here is an example of one of each of the `vehicle` and `non-vehicle` classes:



HOG Output

2. Explain how you settled on your final choice of HOG parameters.

I settled on my final choice of HOG parameters based upon the performance of the SVM classifier produced using them. I considered not only the accuracy with which the classifier made predictions on the test dataset, but also the speed at which the classifier is able to make predictions. There is a balance to be struck between accuracy and speed of the classifier, and my strategy was to bias toward speed first, and achieve as close to real-time predictions as possible, and then pursue accuracy if the detection pipeline were not to perform satisfactorily.

3. Describe how (and identify where in your code) you trained a classifier using your selected HOG features (and color features if you used them).

I trained a linear SVM in in Training Classifier block of my notebook. After extracting HOG features, I am splitting the whole dataset into training(80%) and test(20%) dataset in order to train my model using Linear SVM classifier. It took my around 14 seconds to fully train my model in local CPU. My model finally gave a test accuracy of 99.3%.

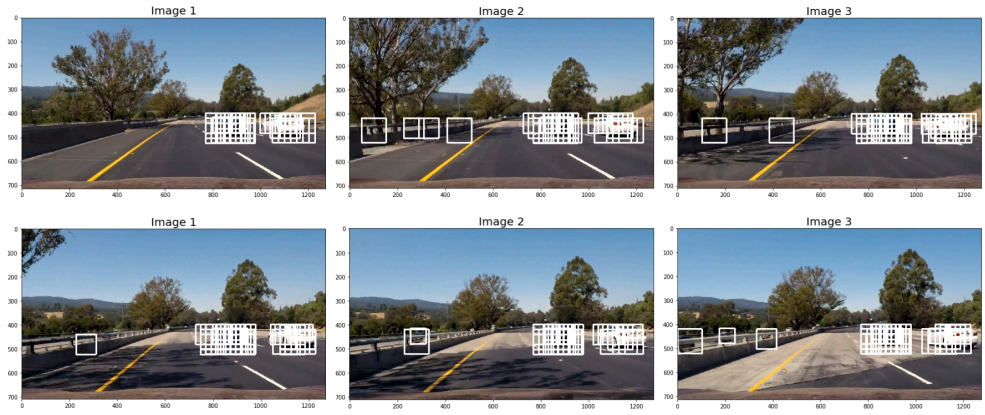
Sliding Window Search

1. Describe how (and identify where in your code) you implemented a sliding window search. How did you decide what scales to search and how much to overlap windows?

I implemented sliding window technique in Sliding Window block of my notebook. The method combines HOG feature extraction with a sliding window search, but rather than perform feature extraction on each window individually which can be time consuming, the HOG features are extracted for the entire image and then these full-image features are subsampled according to the size of the window and then fed to the classifier.
I took 64 as sample rate with 8 cells and 8 pixels per cell.

2. Show some examples of test images to demonstrate how your pipeline is working. What did you do to optimize the performance of your classifier?

The first implementation did not perform as well, so I began by optimizing the SVM classifier. So I started experimenting with different color channels and found that SVM classifier performed best on YUV channel.



Video Implementation

1. Provide a link to your final video output. Your pipeline should perform reasonably well on the entire project video (somewhat wobbly or unstable bounding boxes are ok as long as you are identifying the vehicles most of the time with minimal false positives.)

Link: https://streamable.com/dh4vn

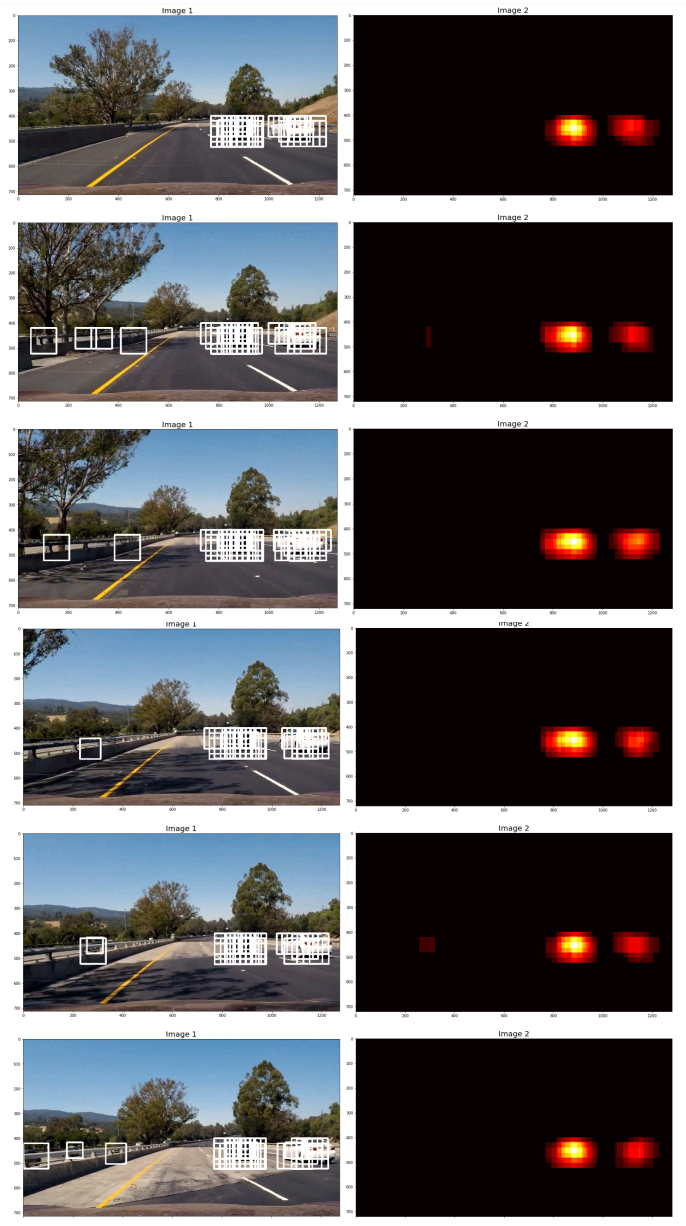
2. Describe how (and identify where in your code) you implemented some kind of filter for false positives and some method for combining overlapping bounding boxes.

I recorded the positions of positive detections in each frame of the video.
From the positive detections I created a heatmap and then thresholded that map

to identify vehicle positions. I then used `scipy.ndimage.measurements.label()` to identify individual blobs in the heatmap. I then assumed each blob corresponded to a vehicle. I constructed bounding boxes to cover the area of each blob detected.

Here's an example result showing the heatmap from a series of frames of video, the result of `scipy.ndimage.measurements.label()` and the bounding boxes then overlaid on the last frame of video:

Here are six frames and their corresponding heatmaps:



Here the resulting bounding boxes are drawn onto the last frame in the series:

Discussion

1. Briefly discuss any problems / issues you faced in your implementation of this project. Where will your pipeline likely fail? What could you do to make it more robust?

In this whole project I took an old approach where I extracted HOG features and then train a simple classifier to detect vehicle in a video frame.I have realized that the speed at which this model detects vehicles is quite slow.So I wanted to take a deep learning approach and started working on a model using YOLO2(You Only Look Once) which can localize and detect objects faster way. Although I haven't got any luck by directly using the trained tiny_yolo.weights model.So I am now planning to train my own YOLO model for vehicle detection.