Vehicle Detection Using HOG based SVM

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Overview

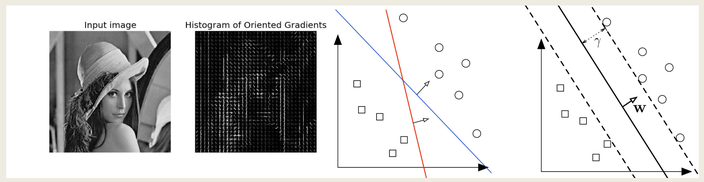
- Detection of Vehicle to Advance safety vehicle driving system
- Decreases Traffic Accidents
- Using Histogram of Oriented Gradients to detect vehicles in various backgrounds
- Using SVM for traning, sliding window and mean shift clustering for detection

Background and Impact

- Intelligent Driver Assistance and Autonomous Vehicle
- Reduce injuries and traffic accidents
- Enables safe driving under Internet of Things
- Key to Intelligent Transportation Systems

Main CV Methods

- Histograms of Oriented Gradients(HOG): Edge Detection and Feature Extraction
- SVM: Trained to classify inputs based on features
- Sliding Window: Window with various sizes
- Mean Shift Clustering: Merge windows of identical vehicle
- Nearest Neighbor: Merge windows of identical vehicles



Prototype

HOG

1. Detect edges to describe the content of the image.
2. Compute magnitude m(u,v) and orientation θ(u,v) at (u,v).

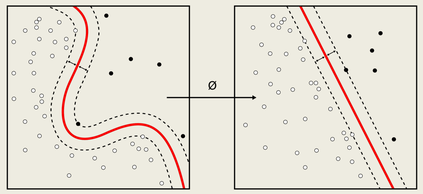
$$m(u,v) = \sqrt{f_u(u,v)^2 + f_v(u,v)^2}$$

$$\theta(u,v) = \tan^{-1}\frac{f_u(u,v)}{f_v(u,v)}$$

3. Derive Orientation Histogram, perform normalization with every overlapping block

SVM

1. Input extracted features to the learning algorithm
2. Use kernel method to transform input data
3. Find optimal boundary between possible output



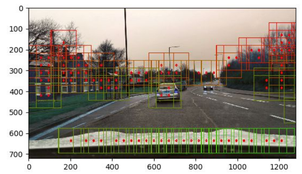
4. Train SVM model on 64x64 patches that either contain a vehicle or do not contain a vehicle

Merge

1. Utilize a sliding window that has various sizes and only scan portion of image above horizon and below certain limit
2. Feed windows to SVM model to obtain “vehicle” and “not vehicle” labels
3. Several windows containing identical vehicle can be obtained on image
4. Use mean shift clustering and nearest neighbor to merge the windows of identical vehicle to one large window

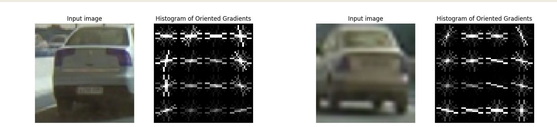
$$k(x) = \begin{cases} c(1-\|x\|) & \|x\| < 1 \\ 0 & otherwise \end{cases}$$

$$m(x) = \frac{\sum_{i=1}^{n} x_i k\left(\left\|\frac{x - x_i}{h}\right\|^2\right)}{\sum_{i=1}^{n} k\left(\left\|\frac{x - x_i}{h}\right\|^2\right)} - x$$



Results

HOG Extraction:



Detection:

Conclusion

- Good detection results on static image
- Vehicles will have non-linear movements
- Background could be cluttered, which deteriorates detection
- Could apply Particle Filter for tracking vehicles

Reference

Cao, Xianbin, et al. “Linear SVM Classification Using Boosting HOG Features for Vehicle Detection in Low-Altitude Airborne Videos.” *2011 18th IEEE International Conference on Image Processing*, 2011, ieeexplore.ieee.org/abstract/document/6116132.

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