Challenges of Using Haar Cascade for Vehicle Classification

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Abstract.With the advancements in technology detection of object has become a crucial step of enhancements of modules. Although very meticulous research in this domain is going on there are a lot of innovative robust algorithms have been proposed over the time but one of the notable and basic algorithms for detection which has always been the first choice of fresher is Haar-Cascade object detector. The presented research uses Haar-Cascade detector for vehicle detection and uncovers a significant amount of information. The challenges to be targeted while using the algorithm are also mentioned in detail. The Haar-Cascade classifier is trained for 10 videos in which the classifier attains up to 85% accurate results whereas testing the same classifier with some other dataset attains accuracy of 55%. Moreover, there are different limitations that are to be targeted which include light intensities, speed with which the object is moving.

Keywords: Haar-Cascade, Adaboost, Integral image

1 Introduction

To recognize the environment image processing played important role in artificial intelligence. First data is approved by multiple methods to interpret with the help of artificial intelligence then easily use the knowledge of environment. There are two main steps are used, first is data gathering (images, videos etc.) and second is to analyze it after in last convert it into various form that will interpreted by computer. Vehicle and pedestrian type classifications play an important role in traffic system. In the regular traffic management techniques such as wireless sensor networks and static camera are very less efficient and only for daylight usage.The fundamental stepsfor traffic management software are the classification of vehicles and pedestrian. Recent years the number of surveillance systems increased because of hardware and least production costs as well as high resolution video cameras in those systems. Data produced by video sources is massive to examine by human operators, for that purpose researchers adopt the Intelligent Transportation System.

In 2001,Paul Viola and Michael Jones published a paper named as "RAPID OBJECT DETECTION USING BOOSTED CASCADE OF SIMPLE FEATURES" in which they recommended an object detection method known as haar feature base cascade classifier object detecting method. This approach depend upon algorithm of machine learning , train cascade function for both type images (+ve and –ve) that helps to identify objects from the rest of images. Images (negative and positive) are used in particular classifier to proposed object detection system and file is generated where the extracted data containing features and thresholds will be stored. The proposed system must be capable of detecting objects either face or eyes from the image that was provided to the system. A cascade classifier, Adaboost machine learning, an integral image and Haar-like features are the main characteristics of object detection method.

2 Related Work

The study [1], Using haar cascade classifier and mixture of Gaussians (MoG) method; real time system developed for the purpose of classifying and detecting the vehicles. Having high-speed processor and computationally low costly. The research was performed to demonstrate that it is such a real-time algorithm. Boxes were Flickering, while detecting the vehicles which caused problems in counting vehicles. Lane detection and obstacle warning system can also be done in future.

The study [2], of the algorithm contains two steps. One is generating hypothesis another is verifying hypothesis.

First of all generating the hypothesis; it detects objects and with the help of features such as: intensity, vertical edges and shadow. Next step is verifying the hypothesis , symmetry of vehicle edge features helps to determines whether the detected object is a vehicle or other object. This approach gets strong edge features which is an effective approach to detect and remove shadow. It uses one camera to detect objects. Changes in road environment also cause errors.

The study [3], will address one such possibility, named help of haar cascade classifier. This research was mainly focusing on detection and counting of vehicles and this research provides semi-encircled region for statistical and for all people . Classifier was not properly produced and false positives were comparatively more than the true positives.

This study [4], is based on a two-stage machine vision based pedestrian detection method. In first step the Haar-like features are determined and calculated using integral map and the cascaded classifiers for pedestrian detection are trained using Adaboost. While segmentation of pedestrian areas from provided image is done, judgment is done for confirming that whether those areas have any pedestrian or no.

The study [5], is based on part-based classification approach with Haar-cascade and HOG-SVM for identification of candidates for pedestrian detection system. It also increases robustness by using feature-based tracking. Some datasets were tested and the results show that system is aligned with other up to date systems available in previous papers. High speed performance is also shown by real time datasets. The detection rate was lower as only 72% and the false positives were about 10%.

This study [6], uses a video processing technique for detection and tracking of vehicles. Video sensor is used to detect, track and calculate the number of vehicles. Haar-Cascade classifier method is used for detecting vehicles and for tracking and counting vehicles in Indonesian highway optical flow method is used. Detection region is used to localize the process of detection, tracking and counting the number of vehicles. The accuracy of the system was observed to be 89.40%. Vehicles that look very close parallel are not properly detected by Haar-cascade. System was unable to properly detect large vehicle. Vehicle shadow also caused errors in system.

This research [7], aims to create a system for detection of pedestrian movement while they are passing through zebra crossing and intimate the drivers in advance. To achieve this goal, a dataset of 1000 real time images were taken from CCTV footage, which were monitoring the roads. Images were tested using a Haar based classifier and training of system was done with positive and negative images as Haar cascade works on positives and negatives. This system provided 90% accurate results.

A computer vision based system was designed to detect cars in real world environment. The datasets are required to train and validate the system which should contain negative and positive images. Some false detection was observed but this method works faster so, it acts as primordial filter of promising regions of the image, while more effectively tests that demand more time can be employed later. This approach requires respective datasets for training and testing. System does not give proper results for other datasets than the trained ones. More false detection was also observed [8].

This research presents a vehicle counter system based on traffic datasets of particular type of vehicles using Haar cascade classifier. The visual shape of vehicle was presented by Haar-like features and the strong classifier was made using Adaboost machine learning algorithm by combination of specific classifier and cascade filter which removes background region of the image very quickly. This system was tested over 8 real time video datasets and accuracy rate was so high. The biggest recall value

was 0.986 and 0.978 is average precision value. Scale factor was affecting the detection rate [9].

This approach was implemented to detect vehicles in presence of trees and buildings. Boosting technique was implemented to detect vehicles. The system was tested in real surveillance videos with different lightening conditions. The results from the experiments show the accuracy to be about 94%, completeness to be 92% and the quality of the system to be 87%. This approach is robust and applications show that the system is efficient to detect vehicles [10].

A comprehensive experiment was performed to detect pedestrian using modern features that was extracted locally (such as; oriented gradients histograms, region covariance and also local receptive fields). A new simple method which used covariance features was proposed by our findings. For computing faster, weak classifiers are selected and trained in Euclidean space. The weak classifiers designed were analytically based on AdaBoost with weighted Fisher linear discriminate. To have efficiency in detection phase the cascade classifier structure was constructed. The proposed system is faster while having little drop in detection performance [11].

In this research examined the lots of feature classifier combinations relating to ROC performance and efficiency. Local versus global moreover non adaptive versus adaptive features were investigated as demonstrated by local receptive fields (LRFs), PCA coefficients and Haar-wavelets. Support Vector Machines (SVMs) was considered like a classifier, k nearest neighbor classifier as well as feed forward neural networks . Correlation was investigated between training sample size and classification performance. Bootstrapping or cascade techniques were employed in order to increase number of manually labeled data to adjust the sample size. SVMs and LRF together perform best as it was tested by the experiments performed. Competitive results can be achieved by using boosted cascade of Haar wavelets with some computational costs. When training sample size was increased the performance, gain achieved was much greater. The performance gain was resulted by automatic generation of non-pedestrian examples that ran into saturation after little iteration. The results were gained as 5% of false positives with "bootstrapped" SVM on LRFs with 90% of detection rate. But most real world's applications need more performance as it is very far apart. As indicated from this research, more research is needed for addressing this important and complex problem [12].

3 Methodology

3.1 Haar Cascade Object Detection:

Collection of images positive as well as negative formed a haar like feature which will further used in method of object detection and this is firstly performed via paul viola as well as micheal jones, mainly used to identify the objects in new images. Train classifier; after training results are extracted like features and threshold after then saved within file. When system did the training session it will be able identifying objects from given inputs.

This object detection method includes rectangular features such as Haar like features, an integral image, AdaBoost machine learning and cascaded classifier.

Haar like features.

This feature focused rectangular areas on exact position inside detection window; this feature increased calculation speed and able to estimate all size object. It expressed two or else three, black and white joins. The four-sided figure feature specifies edge lies sandwiched between dark area along with light area.

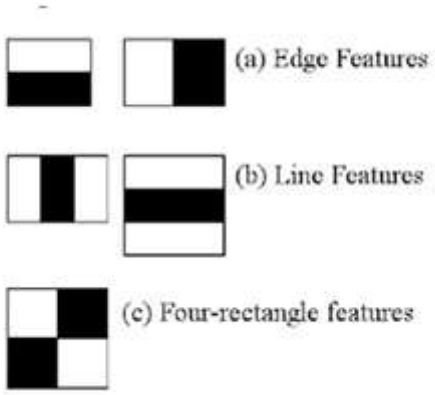

Fig. 1. Haar-like Features for Object Detection

Working principle of features as convolution kernel, detect features existence inside image. From each feature obtain one value whose computation depends upon subtraction of summation pixels below white rectangle from summation pixels below black rectangle.

Calculation of features was done by Paul viola and Michael Jones by using 24x24 Window over image.

This show that Haar features' parameters scale type, position, real-time system face difficulties for huge amount of features about to 160,000+ in a image.

Solution for this problem, they came up with tricks and also outcomes:

Pixels below both black and white regions added when total area is found computationally not capable in favor of real time apps; technique that used to decrease the problem through INTEGRAL IMAGE.

For real time apps,it is impossible practically to evaluate these features. They recommended remove redundant features in addition to select main features only, achieved by ADABOOST.

Integral image.

For computation the Haar like rectangle feature ,we use the integral image well-known summed area table.

Sum of pixels is stored in the array. The feature computing process is a proficient and quick process. To achieve the value of each pixel add the pixels to its top left.

Formula is

$$Ii(x,y) - \sum i(x,y) \quad (1)$$

Where ii(x,y) →integral image with(x,y) pixel location

i(x,y) → original image

Using integral image calculation is more sufficient.

Within rectangle D summation of the pixels used to calculate from the four array references. Value of integral image at point 1, equals to sum of all pixels block A. similarly for point 2 is equal to A+B, point 3 equals to A+C and point 4 will be A+B+C+D. the values of corner of the rectangle are used to compute the summation of pixels in rectangle, results in 4 computations.

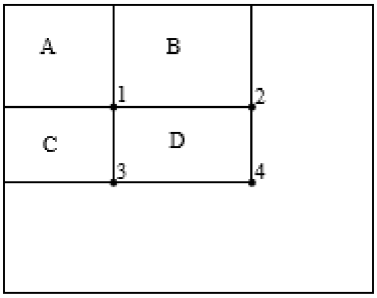

Fig. 2. Summed Area of Integral Image

In figure original image is shown by blue color grid and results after integral change is shown by purple color grid. For performing processes upon shaded region of original image the combined all pixels completely, suitable answer of twenty after approximately six memory accesses.

Integral image utilizes because it involved only one access (if we were in border). But when we are not at the location of corner, we require to be at four array accesses, not depending upon the region's size.

Probably decreases the computation complexity from O (1)

ADABOOST MACHINE LEARNING.

Definition of machine learning.

Term machine learning means by detecting patterns from data, it adapts the data into information.

System after learning stage, it will be smart and capable to give correct answer of each questions and situations.

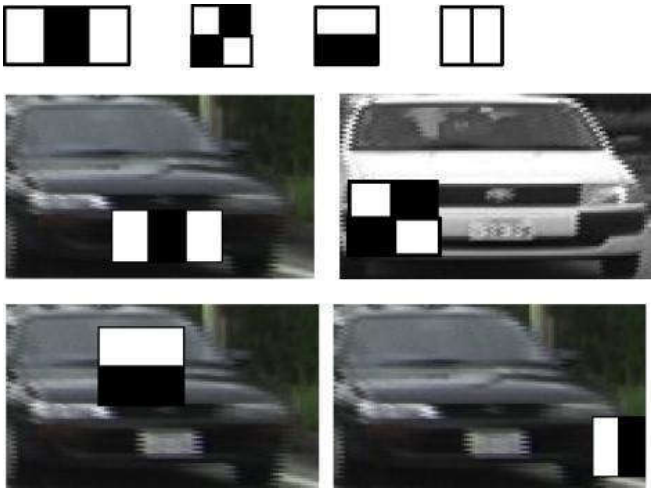

Fig. 3. Relevant Features for Vehicle Detection

One of the machine learning technique is adaptive boosting suggested via Yoav freund and schapire ;helps to select the tiny blocks of features and to train classifier. Basically adaboost easily discover finest feature from whole about to 160,000+. Each feature used upon training images. Best threshold value helps to classify window either it is +ve or -ve. Decrease no: of faults, feature with Minimum error rate. all features object and non-object images are gather in a place.

Total combination of assembled feature is established by evaluating and making decision that window containing object or not.

Each and every weak classifier will become strong classifier by weighted combination.

Adaboost make a strong classifier depend upon linear combination of weak classifiers

$$f(x)=\alpha f1(x)+ \alpha f2(x)+ \alpha f3(x)+ \alpha f4(x)+\ldots.. \quad (2)$$

f(x) →strong classifier define either window contains face or not.

f1(x)….fn(x)→ weak classifier

α’ → linear combination co-efficient

Main scheme is collecting multiple weak classifiers where we cannot easily detect the object and non-objects but with the help of strong classifier’s weighted-combination is derived for detecting object or features then sketch boundary area between objects and non-objects. Threshold values help to draw that boundary provided by adaboost. Weak classifier value either 1 or 0.

A progression of trails is played by adaboost, iteration of selecting a weak classifier occur and get weight deciding it significances.

Adaboost algorithm.

Initialize from unform magnitude values on training patterns

For T times

weigh up weighted error for each one feature and select best one (having lowest rate of error).

Incorrect classifier has extra weight

Correct classifier has low weight 9 absolute classifier is combination of the weak ones and weighted accordingly rate of error.

When you run each T for every iteration; you'll add one good classifier of best performance in that step and find the weight

Formula is

$$\propto_t = \log 1/\beta_t \ (3)$$

$\propto_t$ is linear combination co-efficient for each classifier (weight).

And,

$$\beta_t = \frac{\epsilon_t}{1-\epsilon_t} (4)$$

ϵ_t is error in every iteration.

The final strong classifier is given by:

$$h(x) = \begin{cases} 1 & \sum_{t=1}^{T} \propto_t h_t(x) \geq \frac{1}{2} \sum_{t=L}^{T} \propto_t \\ 0 & Otherwise \end{cases} (5)$$

CASCADED CLASSIFIER.

The main purpose of Paul Viola and Michael Jones's object detection algorithm is "Observe detector every time via identical figure using different sizes. Picture contains more number of non-object or negative images and less number of positive images (objects) normally but our computation skills should be strong enough that we focus upon arranging the negatives quickly. For that reason, we use the cascaded classifier made up of stages, which is consists of strong classifier. Collecting each and every element into a small amount of phases, few features will be added at each and every stage that will give results that the subordinate window either eye or else none. Subordinate window is liable an event that be unsuccessful at any level.

4 Results and conclusion

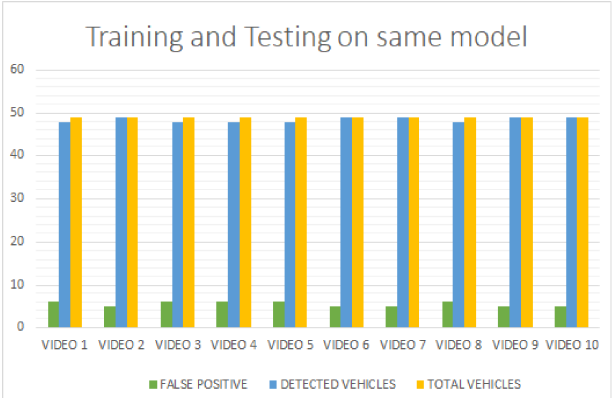

Fig. 4. Training and testing same model

In this research we used haar cascade classifier in order to detect vehicles. To perform this work we firstly needed to make classifier for which we have used already trained cascade classifier with positives (images containing objects) and negatives (without object or background) the trained classifier is used by referring xml file in the code implementation of prototype. We tested this classifier over 10 respective videos which were used while training the classifier ,the result show a very good accuracy in detection about 85% with false positives about 12% and missed objects about 3% and certain flickering of boxes was also observed.

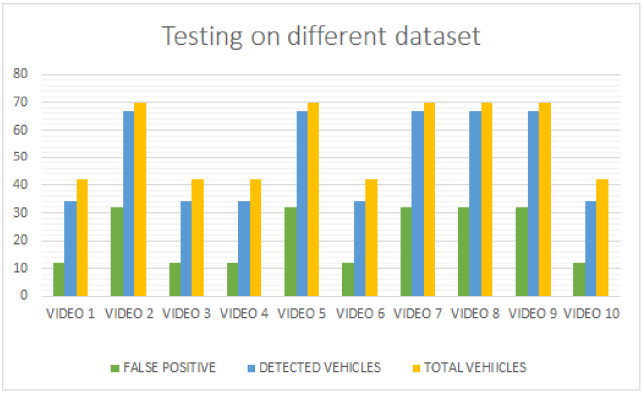

Fig. 5. Testing on different model

Then we tested our proposed system on other dataset videos rather than trained ones, a large difference was observed from previous one. The accuracy diminished to 55% with large false positives about 38% and 7% of objects were missed and flickering of boxes was also observed.

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