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Image-Based Descriptors Conflation for Voiture Detection

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Abstract

Robust and consistent vehicle detection based on image analysis is a challenging task given vehicles with its types, size, shape, colour, texture, speed, flow and at different location. This paper proposes a conflation of different descriptors and classifiers for better accuracy in the detection of vehicles. For that GF, LG, HOG have been used. Practically, Gabor filters broadly used for feature extraction with different scale and orientation, but it has minimum bandwidth response. Log-Gabor filter provide better response than Gabor filter even with high and uneven frequency. It was theoretically proven. Reduced-HOG provides better performance in some scenarios than LG like far regions. This approach can be used for different applications and learning approach.

1. Introduction

In most recent years, many accidents happened by other cars and trucks due to recent growth of vehicles in roadways. Several researches have been done over the past some years among automotive manufacturers, universities and suppliers for improving safety and accident prevention. Therefore vehicle (obstacle) detection arises as the key challenge for ADAS. It is focused on techniques such as **pattern recognition, feature extraction, etc.** some of assistance applications are: **Lane Departure Warning, Collision Warning, Pedestrian Protection, Headlights Control, etc.** Most shared approaches in the vehicle detection is visual-based techniques to analyse vehicles from images or videos [2]. Vehicles view will varied based on the camera positions (such as panning, tilting, rotation and camera heights), lighting conditions and background situations. Includes vehicle colours, sizes, poses, orientations, shapes, shadow, motion, vertical edges, vehicle count and flow. For the above problems, different features and learning algorithms used for locating vehicles. Primarily many techniques used to extract motion features for detecting moving vehicles from video sequences.

1.1. **Gestalt of vehicle exposure**

In vehicle detection, have to concentrate on vehicle colour, size, shape, texture, poses, speed, and location etc. while detecting vehicles to know about different regions.

Some vehicles are Close regions, Overtake regions, and Middle/distant regions. Vehicles have various colours under different weather and lighting conditions. For that some traditional methods are used. Apart from that, a colour transform model used to identify vehicle colours from background and multichannel classifier used to verify each vehicle hypothesis [1]. And also On-road vehicle detection has to differentiate between vehicles versus nonvehicle. Some traffic scenarios like simple scenes, complex urban scenes, and scenes assuming varying weather conditions used Monocular precrash vehicle detection system includes two main steps: a multiscale driven hypothesis generation step and an appearance-based hypothesis verification step. Used statistical Gabor features extracted using a filter bank with four scales and six orientations, and SVMs (*G46S*). [4] Evolutionary Gabor filter optimization (EGFO) approach used for optimizing the parameters of a set of Gabor filters in the context of vehicle detection responding stronger to features present in vehicles than to nonvehicle, resulting filter evaluated using SVMs[8]. Distribution-based classification approach and a set of texture trials based on center-symmetric autocorrelation are smeared to rotation-invariant texture classification and evaluate its performance by CSAR model [9]. Vehicle category, location and velocity information for each vehicle are provided [10]. Circular Gabor filter (CGF) method used for rotation invariant texture segmentation [11]. Strong edges and lines at different orientation and scales in vehicles are concentrated for that dividing original image into sub image [3]. Shadow of vehicles images are nod to detect vehicle in [12]. Optical flow of vehicles in the detection [13]. Vehicles colour detection methodologies on knowledge-based [14].

Vehicles pose and the structure were recuperated by fitting the image with PCA model [15]. Object pose estimated by successive recognition from complex road scenes [2]. Diverse Density to verify each vehicle candidate method used to find the vehicle position with a scheme of vehicles' wheel as features.

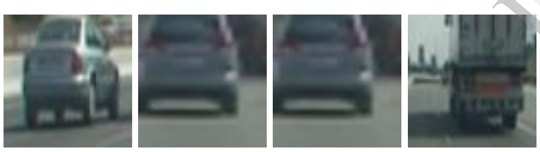

Figure 1. Examples of vehicle samples contained in the GTI database. Samples in the left, right, far, middle region.

Figure 2. Examples of non-vehicle samples contained in the GTI database. Samples in the left, right, far, middle region.

Above figures shows the differences between the sample of vehicles (car, van, truck, etc.), in terms of color, shape, pose, size (based on fixed camera location and its viewpoint effect), and the effect of brightness and different weather conditions, which makes finding vehicle and nonvehicle highly challenging.

1.2. Texture segmentation

The image is segmented based on the regions of texture. Supervised (parameters of textures and noise) and unsupervised (not only partitions, also parameters estimation) texture segmentation are types. Practically used mainly and has more challenging. Image is segmented using Gabor filter by extracting features. While detecting the object in an image, texture is the basic clue and main part. Texture in an image is segmented by the process of feature extraction with the help of filters. Unsupervised texture segmentation based on multi-channel filtering approach used for texture segmentation based on HVS operation. Pixels classified Based on the texture properties to localizing the boundaries between different textures on one textured image plane. In [11], rotation invariant texture segmentation method based on circular Gabor filters discussed.

1.3. Feature Extraction

In vehicle detection, **feature extraction** is a form of dimensionality reduction. Simplifying the amount of resources required to describe a set of data may large and to find accurately. While analysis with a large number of variables generally requires a large amount of memory and power of computation or a classification algorithm which over fits the training sample and take a broad view poorly to new samples. Methods of constructing combinations of the variables to get around these problems. Still describing the data with sufficient accuracy. Dimensionality reduction techniques include: principal component analysis, nonlinear dimensionality reduction, semi definite embedding, and multilinear subspace learning.

Feature extraction done using texture segmentation. Involves **edge detection, corner detection, blob detection, ridge detection.** Extraction of features in images involves finding features of the segmented image. Performed on a binary image produced from a threshold operation. Communal features include: Area, Perimeter, Center of mass, Compactness. It counts the number of pixels in the labelled blob. For dealing with still images, wavelet transform used to extract texture features for tracing possible vehicle candidates from roads. Then and there, each vehicle candidate is corroborated using a PCA (principal component analysis) classifier. Additionally, Gabor filters used to extract different textures and then tested each vehicle candidate using a SVM (support vector machines) classifier [3].

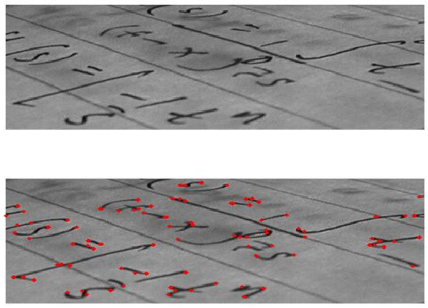

Figure 3. Corner detection in feature extraction.

2. Descriptors Review

Visual features descriptions in images, videos, algorithms, or such descriptions need in any applications. They describe some important characteristics such as the shape, the color, the texture or the motion. To find out the connection between pixels confined in a digital image is the initial step. **General information descriptors** and **Specific information domain descriptors** are the two groups mainly used to give a description about color, shape, regions, textures, motion, objects and events in the scene. Descriptors with Gabor filter function, log Gabor filter and HOG are varied.

2.1. Gabor Filter

It is a linear band pass filter used for edge detection. Frequency and orientation illustrations of Gabor filters have been found to be predominantly appropriate for texture representation and refinement. The function of 2D Gabor filter is:

f_gabor(x) = cos (frequency*x) * Exp (-(x*x)/ (sigma*sigma))

This function consists of three parts: the cosine part (distance and frequency), the Gaussian function (distance and sigma) and a constant (equal to 1). In the spatial domain, a 2D Gabor filter is a Gaussian kernel function moderated by a sinusoidal plane wave. Its impulse response is well-defined by a sinusoidal wave (a plane wave for 2D Gabor filters) increased by a Gaussian function. Based on the multiplication-convolution property, the Fourier transform of a Gabor filter's impulse response is the intricacy of the Fourier transform of the harmonic function and the Gaussian function. This filter has a real and an imaginary component to represent in orthogonal directions. The two components may be designed into a complex number or used exclusively.

Gabor filters have been broadly used for image-based vehicle verification. For feature extraction from an image, Gabor filter bank at different scales and orientations is used. In [4], Gabor filter enactment is investigated for two different configurations as 3 scales and 5 orientations and 4 scales and 6 orientations. A bank of 8 Gabor filters with 2 different wavelengths and 4 different orientations is used in [5]. Other texture representations based on Gabor filters are examined in [6]. Even though Gabor filters have been widely applied for a comprehensive applications, they involve a number of drawbacks. First, the bandwidth of a Gabor filter is characteristically limited to one octave (otherwise it harvests as well high DC component), thus a large number of filters is required to attain wide spectrum coverage. The amplitude of ordinary images falls off in average by a factor of roughly $1/f$ .The above is contrast to the Gabor filters properties: on the one side, a Gabor response quintessence on the lesser frequencies that results in laid off information of the filters; on the other hand, the high frequency tail of the images is not apprehended [7].

2.2. Log Gabor Filter

Log-Gabor function is alternative to Gabor functions can be viewed on both linear and frequency scales. The transfer function of log Gabor function on the linear frequency scale:

$$G(w) = e^{(-\log(w/w_o)2) / (2(\log(k/w_o)2)}$$

It always have no DC component and the transfer function has an extended tail at the high frequency end allotted in medium and high pass filter, and thus Gabor function has small DC component and has difficulty in transfer function in frequency domain.

Log filters = prefilter + laplacian

Log Gabor having extended tails, can represent both low frequency and high frequency component. DFT (discrete Fourier transform) used to calculate spatial form of the filter. Gabor filter bandwidth limited to one octave and log Gabor has one to three octave that illustrate it capture spectral information with a compact spatial filter. When compare to standard Gabor filter, it required reduced number of filters as shown in [16]. Log Gabor filter achieves enhanced performance than the Gabor filter in frequency and spectrum coverage. And also related with other methods like PCA and HOG. In that log Gabor accomplishes better than PCA in all kind of image regions. In classification, the time required by HOG is 17 times greater than log Gabor. HOG verification is costly and not economical. In far regions reduced-HOG is better than log Gabor [17]. Log Gabor wavelet technique shows excellent results in terms of mathematical error and perceptual quality compare with other methods [18].

2.3. Reduced HOG

HOG are the feature descriptor used for object detection. In the portion of an image, it counts occurrences of gradient orientation. Calculated on a condensed grid of similarly spaced cells and for enhanced correctness uses overlapping confined contrast normalization. Normalization results in better invariance to changes in radiance or shadowing. Except object orientation, maintains invariance to geometric and photometric transformations. Mainly SVM classifier used for finding particular object in an image. Types are rectangular HOG (R-HOG) and circular HOG (C-HOG).

Initially used for human detection and then further developed to detect vehicles, animals. Has a disadvantage of dimensionality reduction, can reduce drawback by using boosting HOG. Works in low contrast image also and urban video segments provide high false alarm rate and detection accuracy [19]. In [20], by selecting the parameters, HOG features are extracted. The parameters are cell size, number of orientation bins, that helps to improvise the performance for close/middle region and other region. HOG has excellent performance in detection but its computational requirements for real time operation is high cost. Hypothesis generation and tracking normally consume maximum of the available time. The drawbacks overwhelmed by the number of cells and/or orientation bins must be condensed in order to also reduce the feature vector and thus the classification time [17].

3. Solution through Descriptors Conflation

Gabor filter has been used primarily nowadays for vehicle detection but it concentrate on minimum frequency merely, not well in further frequencies. Then the other family from Gabor functions, log Gabor filter used for high and uneven frequencies. HOG is improved in far regions than log Gabor filter. So that by conjoining those three descriptors to get enhanced performance.

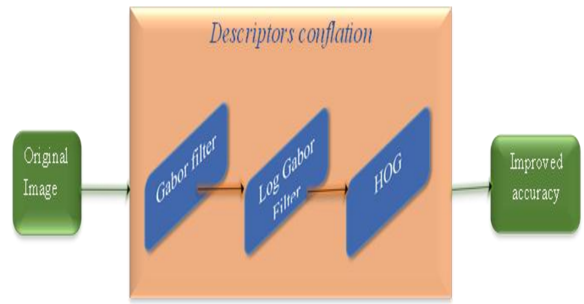

Figure 4. Process Diagram

Above diagram represents the following steps:

- ***Still Image***

  The original image is taken from the video captured by camera. That image given as input.

- ***Gabor Filter***

  After that, original image is delivered to the descriptors conflation. First through the Gabor filter, in that minimum frequency range in the image is detected.

- ***Log Gabor filter***

  And then, next to the log Gabor filter, here high and uneven frequency areas are detected.

- ***HOG***

  Finally, then to HOG descriptor for detecting in far region objects.

- ***Output***

  Getting enhanced accuracy rate with this conflation.

4. Conclusion

The vehicle detection based on image analysis is a difficult mission considering vehicles with its types, size, shape, colour, texture, pose and at different location based on camera positions. Conflation of different descriptors (GF, LG, and HOG) and classifiers are proposed for better accuracy. Gabor filters broadly used practically but it response well in minimum bandwidth than other frequency. However, most of the existing methods used Gabor filter. Another family Log-Gabor filter provide greater performance in high and uneven frequency than Gabor filter. It was theoretically proven. In far regions Performance of Reduced-HOG is even better than LG. In future research overall number of filters can be reduced.

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