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Log Gabor Filter Based Feature Detection in Image Verification Application

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Abstract: ***In recent years due to low-cost, flexibility, and potential toward collision avoidance the Vehicle and Non Vehicle identification based on image processing bring more attention. In particular, vehicle verification is especially challenging on account of the heterogeneity of vehicles in color, size, pose, etc. Image based vehicle verification is usually addressed as a supervised classification problem. Specifically, descriptors using Gabor filters have been reported to show good performance in this task. However, Gabor functions have a number of drawbacks relating to their frequency response. The main contribution of this paper is the proposal and evaluation of a new descriptor based on the alternative family of log-Gabor functions for vehicle verification, as opposed to existing Gabor filter-based descriptors. These filters are theoretically superior to Gabor filters as they can better represent the frequency properties of natural images. In this paper the classifications is done using SVM and Random Forest .in this Random Forest will classify vehicle and non vehicle and Human on road. Whereas SVM deals with only vehicle and non vehicle.***

Keywords: Gabor filter, log gabor filter, SVM, Random Forest, Gaussian shaped function

1. Introduction

Recently, the numbers of vehicles have increased tremendously and hence it is not easy to control the traffic by mere human assistance. Driver assistance system is the emerging technology .The main aim is to reduce accidents. The main advantage of the system is low cost, flexibility, increased processing capabilities etc. Image processing is the basic key behind this idea. There are two stages in this. The first step is hypothesis generation and the second step is hypothesis verification. The first step is based on color, texture, edge etc. In the second stage we are testing whether the hypothesis is true or not. In dealing with the system, the processor speed determines the efficiency.

The system is a real time vehicle identification system .The vehicles and non-vehicles are trained .The widespread descriptors include Gabor filters principal component analysis [2],and histograms of oriented gradients[3],[4].Gabor filters are general purpose filters and is mainly used for image based vehicle identification[5-6].The feature extraction technique uses a 2D Gabor filter bank and produces robust 3D face vector[5].A video based traffic monitoring system[6] ,automatic parking management system[7], license plate recognition system[8-10],toll collection system[8]vehicle orientation detection[9] etc. are some of the works related to this field. In the license plate recognition system,[10],neural

Network based classification is done. The system will apply error back propagation algorithm to analyze vehicle image. Lotufo [20],uses optical character recognition technique.E.R.Lee*e.t.al*.[10] used neural network for color extraction and template matching to recognize character.Yoshimura*e.t.al*.,[10],used Gabor jets propagation to form a feature vector for recognizing low resolution gray scale character.

The main contribution of this paper is the design of a descriptor based on log-Gabor functions for vehicle verification instead of state-of-the-art descriptors based on Gabor functions. To our knowledge these functions have not been previously used for vehicle representation purposes. The purpose of this study is thus to experimentally demonstrate the referred theoretical superiority of log-Gabor filters over standard Gabor filters in this field. Additionally, an in-depth analysis of the required filter bank configuration in the particular field of vehicle imaging is performed both for Gabor filters and log-Gabor filters. Indeed, a shortcoming of the existing works in the vehicle classification through Gabor filters is that they mirror the standard configurations of Gabor filters proposed by pioneering papers, even if those are devoted to general applications. For instance, many authors resort to the four-scale and six orientation scheme proposed by [6] for texture retrieval. The analysis performed allows maximizing the accuracy of both Gabor and log-Gabor based descriptors and to compare the performance of the proposed log-Gabor filters with respect to the state-of-the art Gabor filter based approach under a fair and optimal reference frame work. This paper is organized as follows. In Sections II and III the fundamentals of Gabor and log-Gabor filters are respectively reviewed. Section IV provides details on the filter bank configuration and on feature extraction. Section V provides an exhaustive analysis of the performance of the Gabor filter based descriptor. Finally, in Section VI, extensive experiments are enclosed measuring the performance of the proposed log-Gabor function based descriptor, and comparing it to state of-the-art Gabor filter based approach and to other related methods. Experiments show that log-Gabor filters significantly outperform traditional Gabor filters for vehicle verification. In this paper the descriptor uses classifiers to classify the classes of image. There is two techniques Random Forest and Support Vector Machine (SVM). SVM deals with the two types of classes only vehicle and Non Vehicle whereas the Random Forest deals with Vehicle, Non Vehicle and Human on Road classes.

2. Image Analysis

Frequency or phase modulated waveforms can be used to achieve much wider operating bandwidths. Linear Frequency Modulation (LFM) is commonly used. In this case, the frequency is swept linearly across the pulse-width, either upward (up-chirp) or downward (down-chirp). Figure below shows a typical example of an LFM waveform. LFM can be mathematically written as Image analysis accepts a digital image as input and produces data or a report of some type. The produced data may be the features that represent the object or objects in the input image. To produce such features, different processes must be performed that include segmentation, boundary extraction, silhouette extraction, and feature extraction. The produced features may be quantitative measures, such as moment invariants, and Fourier descriptors, or even symbols, such as regular geometrical primitives.

2.1. Image Restoration

Image restoration refers to a group of techniques that are oriented toward modeling the degradation and applying the inverse process in order to recover the original image. Each component in the imaging system contributes to the degrading of the image. Image restoration techniques try to model the degradation effect of each component and then perform operations to undo the model, to restore the original image (3). There are two different modeling approaches for degradation: the a priori approach and the a posteriori approach. These two approaches differ in the manner in which information is gathered to describe the characteristics of the image degrading. The a priori approach is to try to model each source of noise in the imagery system by measuring the system's responses to arbitrary noises. In many cases, deterministic models cannot be extracted and stochastic models are used instead. The a posteriori approach is adopted when a great deal of information is known about the original image.

2.2. Object Recognition

Object recognition includes the process of determining the object's identity or location in space. The problem of object or target recognition starts with the sensing of data with the help of sensors, such as video cameras and thermal sensors, and then interpreting these data in order to recognize an object or objects. We can divide the object-recognition problem into two categories: the modeling problem and the recognition problem. Modeling is the process of representing a real system in an abstract manner, in order to study its different features. It is widely used in all fields of engineering. Patterning is a process to extract features and recognize objects and patterns from a given image.

3. Gabor Filter

A Gabor filter is a linear filter whose impulse response is defined by a harmonic function multiplied by a Gaussian function. Because of the multiplication-convolution property (Convolution theorem), the Fourier transform of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function. Gabor filters are directly related to Gabor wavelets, since they can be designed for number of dilations and rotations. However, in general, expansion is not applied for Gabor wavelets, since this requires computation of bi-orthogonal wavelets, which may be very time-consuming. Therefore, usually, a filter bank consisting of Gabor filters with various scales and rotations is created. The filters are convolved with the signal, resulting in a so-called Gabor space. This process is closely related to processes in the primary visual cortex. The Gabor space is very useful in e.g., image processing applications such as iris recognition and fingerprint recognition. Relations between activations for a specific spatial location are very distinctive between objects in an image. Furthermore, important activations can be extracted from the Gabor space in order to create a sparse object representation. The Gabor Filters have received considerable attention because the characteristics of certain cells in the visual cortex of some mammals can be approximated by these filters. In addition these filters have been shown to posses optimal localization properties in both spatial and frequency domain and thus are well suited for texture segmentation problems. Gabor filters have been used in many applications, such as texture segmentation, target detection, fractal dimension management, document analysis, edge detection, retina identification, image coding and image representation. A Gabor filter can be viewed as a sinusoidal plane of particular frequency and orientation, modulated by a Gaussian envelope [1-5].

$$h(x,y) = s(x,y)g(x,y)$$

$s(x,y)$: Complex sinusoid

$g(x,y)$: 2-D Gaussian shaped function, known as envelope

$$s(x,y) = e^{-j2\pi(u_0 x + v_0 y)}$$

$$g(x,y) = \frac{1}{\sqrt{2\pi}\,\sigma} e^{-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2}\right)}$$

3.1. Eliminating the DC Response

Depending on the value of f_0 and a, the filter may have a large DC response. A popular approach to get a zero DC response is to subtract the output of a low-pass Gaussian filter,

$$h(t) = g(t) - cw(bt) = ke^{j\theta} w(at)s(t) - cw(bt)$$

Thus $$\hat{h}(f) = \hat{g}(f) - \frac{c}{b}\hat{w}\left(\frac{f}{b}\right)$$

To get a zero DC response we need

$$\frac{c}{b}\hat{w}(0) = \hat{g}(0)$$

$$c = b\hat{g}(0) = b\frac{k}{a}e^{j\theta}\hat{w}\left(\frac{f_0}{a}\right)$$

where we used the fact that, $\hat{w}(f_0) = \hat{w}(-f_0)$ Thus,

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$$h(t) = g(t) - b\,\hat{g}(0) = ke^{j\theta}(w(at)s(t) - \frac{b}{a}\hat{w}(\frac{f_0}{a})w(bt))$$

$$\hat{h}(f) = \frac{k}{a}e^{j\theta}(\hat{w}(\frac{f-f_0}{a}) - \hat{w}(\frac{f_0}{a})\,\hat{w}(\frac{f}{a})$$

It is convenient, to let b=a, in which

$$h(t) = ke^{j\theta}\, w(at)(s(t) - \hat{w}(\frac{f_0}{a})$$

$$h(f) = \frac{k}{a}e^{j\theta}\,(\hat{w}(\frac{f-f_0}{a}) - \hat{w}(\frac{f_0}{a})\,\hat{w}(\frac{f}{a}))$$

4. Log-Gabor Filters

As stated in Section I, the properties of Gabor filters involve two important drawbacks. On the one hand, their bandwidth must be limited in order to prevent a too high DC component. Hence, a larger number of filters is needed to cover the desired spectrum. On the other hand ,their responses symmetrically distributed around the center frequency, which results in redundant information in the lower frequencies that could instead be devoted to capture the tail so images in the higher frequencies.
An alternative to the Gabor filters is the log-Gabor function Introduced [2]. The frequency response flog-Gabor filters in polar coordinates [3]

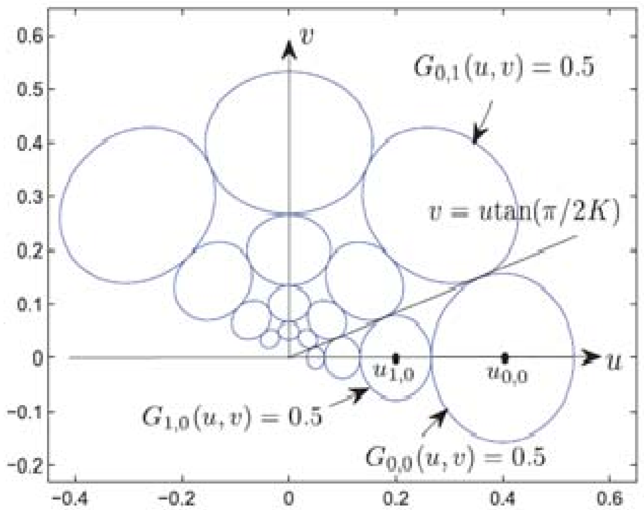


Figure 1: Frequency response of the Gabor filter bank. The contours indicate the half-peak magnitude of the filter responses in the Gabor filter family. The filter parameters used here are K=4,N=4,a=2,and$F$0=0.4.

Results in redundant information in the lower frequencies that could instead be devoted to capture the tails of images in the higher frequencies.

An alternative to the Gabor filters is the log-Gabor function Introduced [4]. The frequency response of log-Gabor filters in polar coordinates is given by [5]

$$LG_{m,n}(f,\theta) = \begin{cases} \exp\left\{-\frac{(\log(f/F_m))^2}{2(\log\beta)^2}\right\}\exp\left\{-\frac{(\theta-\theta_n)}{2\sigma_\theta^2}\right\} & f \neq 0 \\ 0 & f = 0. \end{cases} \quad (5)$$

5. Random Forest

Random forests are defined as “a combination of tree predictors such that each tree depends on the random vector sampled independently and with the same distribution for all the trees in the forest “.Image recognition is emerging as an active research area with numerous commercial and law enforcement applications. Although existing methods perform well under certain conditions, the illumination changes, occlusions and recognition time are still challenges problems. Random forest deal with the above challenges in image recognition. Random forest is a tree based classifier the consists of many decision trees. Each tree gives a classification an d the output is the aggregate of these classifications. The proposed algorithm first extracts features from the image using the Gabor wavelet transform and then uses the Random Forest algorithm to classify the images based on the extracted features. But the Gabor wavelet transform leads to high feature dimensions which increases the cost of computation. The proposed algorithm makes use of a Random Forest that selects a small set of most discriminate Gabor wavelet features. Only this small set of features is now used to classify the images resulting in a fast vehicle recognition technique. Finally, the problem of occlusion images is tackled by taking advantage of the randomness in forest building. In a randomized tree, the split at each node happens by using only randomly selected subset of all the features. Therefore, any occlusions are likely to affect only a small portion of the trees. In this paper the Random Forest technique is used to classify three types of classes; they are 1. Human on the road 2.Plain road 3. Vehicle on the road. These three different classes are classified by the Random Forest method. It will set these classes as three sub classes and compares with the required image by its features.

6. Support Vector Machine (SVM)

SVM stands for Support vector Machine. The first half set of the data is set as vehicle and the next half as non-vehicle. The solution to an SVM is global and unique. Two more advantages of SVMs are that have a\ simple geometric interpretation and give a sparse solution. The computational complexity of SVMs does not depend on the dimensionality of the input space. SVMs use structural risk minimization. SVMs are less prone to over fitting.

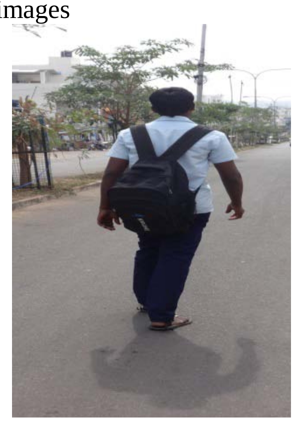
7. Simulation and Results

The tool used in this paper is MATLAB. It is because; it is the simplest code and is compatible with other software and to easy to set up while dealing with hard ware and processor kit. Log Gabor filter obtained various orientation and verification is done using SVM and Random Forest to obtain the results.

1. Plane road input images

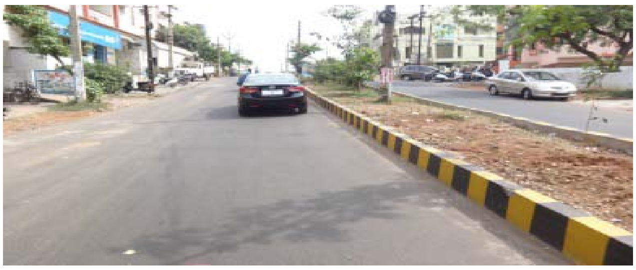
Command window results: Plane Road

2. Human input images



Command window results: Human

3. Vehicle input images



Command window results: vehicle

8. Conclusion

In this Random forest method and SVM are playing key role vehicle and non vehicle. In this Random forest method the classes are different according to their classification it deals with vehicle, non vehicle and identification. For application the database required more images of different classes. To compare required image with database images we use an log

Gabor filter. The Log Gabor filter is better than the Gabor filter due to increased bandwidth and reduction in DC components. The Log Gabor filter functions have better theoretical properties than traditional Gabor filters, but they had not been previously used for vehicle identification. They adapt better than Gabor functions to the inherent frequency content of natural images and are able to cover large spectrum with same filters. Moreover, the cost can be reduced by reducing the filter bank. Random Forest is effective compare to SVM as classifier. Random forest can classify huge amount of data in to different classes.

References

[1] Z. Sun, G. Bebis, and R. Miller, “On-road vehicle detection: A review,” IEEE Trans. Pattern Anal. Mach. Intell., vol. 28, no. 5, pp. 694–711, May 2006.
[2] C. Rotaru, T. Graf, and J. Zhang, “Color image segmentation in HSI space for automotive applications,” J. Real-Time Image Process., vol. 3, no. 4, pp. 311–322, Dec. 2008
[3] L.-W. Tsai, J.-W. Hsieh, and K.-C. Fan, “Vehicle detection using normalized color and edge map,” IEEE Trans. Image Process., vol. 16, no. 3, pp. 850–864, Mar. 2007.
[4] C. Hoffmann, “Fusing multiple 2D visual features for vehicle detection,” in Proc. IEEE Intell. Veh. Symp., 2006, pp. 406–411.
[5] J. Hwang, K. Huh, and D. Lee, “Vision-based vehicle detec- tion and tracking algorithm design,” Opt. Eng., vol. 48, no. 12, pp. 127201-1–127201-12, Dec. 2009.
[6] T. Wang, N. Zheng, J. Xin, and Z. Ma, “Integrating millimeter wave radar with a monocular vision sensor for on-road obstacle detection applications,” Sensors, vol. 11, no. 9, pp. 8992–9008, Sep. 2011.
[7] K. Yamaguchi, A. Watanabe, and T. Naito, “Road region estimation using a sequence of monocular images,” in Proc. 19th Int. Conf. Pattern Recognit., 2008, pp. 1–4.
[8] J. Lou, T. Tan, W. Hu, H. Yang, and S. J. Maybank, “3-D model-based vehicle tracking,” IEEE Trans. Image Process., vol. 14, no. 10, pp. 1561–1569, Oct. 2005.
[9] Z. Zhang, T. Tan, K. Huang, and Y. Wang, “Three-dimensional deformable-model-based localization and recognition of road vehicles,” IEEE Trans. Image Process., vol. 21, no. 1, pp. 1–13, Jan. 2012.
[10] J. Zhou, D. Gao, and D. Zhang, “Moving vehicle detection for automatic traffic monitoring,” IEEE Trans. Veh. Tech., vol. 56, no. 1, pp. 51–59, Jan. 2007.
[11] T. Gandhi and M. M. Trivedi, “Video based surround vehicle detection, classification and logging from moving platforms: Issues and approaches,” in Proc. IEEE Intell. Veh. Symp., Jun. 2007, pp. 1067–1071.

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