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Vehicle detection system through image Analysis using log-gabor filter

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Abstract- Vehicle detection based on image analysis has attracted increasing attention in recent years due to its low cost, flexibility, and potential toward collision avoidance. 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. As a second contribution, and in contrast to existing approaches, which transfer the standard configuration of filters used for other applications to the vehicle classification task, an in-depth analysis of the required filter configuration by both Gabor and log-Gabor descriptors for this particular application is performed for fair comparison. The extensive experiments conducted in this paper confirm that the proposed log-Gabor descriptor significantly outperforms the standard Gabor filter for image-based vehicle verification.

Keywords- Image Analysis, Background subtraction, Log Gabor Filter, Classifier,Feature Extraction

I. INTRODUCTION

Vehicle detection based on image analysis[9] has attracted increasing attention in recent years due to its low cost, flexibility, and potential toward collision avoidance[1].In this project, there 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[4]. As a second contribution, and in contrast to existing approaches, which transfer the standard configuration of filters used for other applications to the vehicle classification task, an in-depth analysis of the required filter configuration by both Gabor and log-Gabor descriptors for the application is performed for fair comparison.On road vehicle detection is the main problem for some applications such as advance driver assistance system(ADAS)[3]. We mainly concentrate on vehicle verification stage. Image based vehicle verification is generally addressed as a supervised classification problem[2]. The number of visual surveillance have greatly increased, and this system have developed into intellectual systems that automatically detect, track and recognize objects in video[5]. Gabor wavelets optimize the theoretical limit of joint resolution between space and frequency domain, they do not have zero-mean, which induces a DC component in the coefficient of any frequency band[7]. At first an image is segmented into regions by using not only color information but also Gabor filter outputs of a grayscale image[8]. It has been suggested that Log-Gabor filters, which are based on Gaussian transfer functions[6] symmetrical on the log-frequency scale, can more efficiently encode natural images[11]. Detected images could be analyzed to extract the background automatically. Each image contains background of the highway and the moving vehicles[9]. Our work falls in the category of ridge feature based matching where features are extracted by using a bank of filters[10]. Potential toward collision avoidance the Vehicle and Non Vehicle identification based on image processing bring more attention[6].

II.EXISTING SYSTEM

Most of the reported methods address vehicle detection[9] in two stages, namely hypothesis generation and hypothesis verification[3]. In the former, a quick search is performed so that potential locations of the vehicles in the image are hypothesized. The search is typically based on some expected feature of vehicles, such as color, shadow, vertical edges[3], or motion. The aim of the second stage is to verify the correctness of the vehicle candidates provided by the hypothesis generation stage. Traditionally, fixed or deformable models have been used for vehicle verification; However, the increase of processors speed in the last years has

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enabled the use of learning-based methods for real-time vehicle verification. In particular, this is usually addressed as a two-class supervised classification problem in which a set of samples are trained in search of specific feature descriptors of the vehicle and the nonvehicle classes. Some widespread descriptors include Gabor filters, principal component analysis (PCA)[2],and histograms of oriented gradients (HOG)[10].

III. DISADVANTAGES OF EXISTING SYSTEM

First, the bandwidth of a Gabor filter is typically limited to one octave (otherwise it yields a too high DC component)[2], thus a large number of filters is needed to obtain wide spectrum coverage.

Its impulse response is defined by a sinusoidal wave (a plane wave for 2D Gabor filters) have real and imaginary components Real and Imaginary.

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma)=\exp\left(-\frac{x'^2+\gamma^2y'^2}{2\sigma^2}\right)\cos\left(2\pi\frac{x'}{\lambda}+\psi\right)$$

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma)=\exp\left(-\frac{x'^2+\gamma^2y'^2}{2\sigma^2}\right)\sin\left(2\pi\frac{x'}{\lambda}+\psi\right)$$

Where $x'=x\cos\theta+y\sin\theta$ And $y'=-x\sin\theta+y\cos\theta$

λ - wavelength of the sinusoidal factor, θ - orientation of the normal to the parallel

ψ - phase offset, σ - sigma of the Gaussian envelope , γ - spatial aspect ratio.In addition, as suggested, the amplitude of natural images (defined as the square root of the power spectrum) falls off in average by a factor of roughly 1/f[4]. This is in contrast to the properties of Gabor filters[8] on the one hand, a big extent of the Gabor response concentrates on the lower frequencies, which in turn results in redundant information of the filters; on the other hand, the high frequency tail of the images is not captured. If the standard deviation of these Gaussians[6] becomes more than about one third of the centre frequency the tails of the two Gaussians will start to overlap excessively at the origin, resulting in a nonzero DC component.

Transfer function of a high bandwidth even-symmetric Gabor filter. The two Gaussians that make up the function overlap at the origin, resulting in a significant DC component. At the limiting situation where the centre frequency is equal to three standard deviations[2], the bandwidth will be approximately one octave[4]. A frequency ratio expressed in octaves is base-2 logarithm(binary algorithm) of the ratio ,This can be seen as follows: For a Gaussian[6], the points where its value falls to half the maximum are at approximately plus and minus one standard deviation, these points defining the cutoff frequencies[7]. Thus the upper and lower cut-off frequencies will be at approximately 4σ and 2σ respectively, giving a bandwidth of one octave. This limitation on bandwidth means that we need many Gabor filters to obtain wide coverage of the spectrum.

IV. PROPOSED SYSTEM

In this paper, an alternative representation of images for vehicle classification using log-Gabor filters instead of Gabor filters is proposed and evaluated. Log-Gabor filters are designed as Gaussian functions on the log axis[5], which is in fact the standard method for representing the spatial frequency response of visual neurons. A one dimensional Log-Gabor function has the frequency response:

$$G(f)=\exp\left(\frac{-\left(\log(f/f_0)\right)^2}{2\left(\log(\sigma/f_0)\right)^2}\right)$$

where $f0$ and σ are the parameters of the filter, $f0$ will give the center frequency of the filter.

σ affects the bandwidth of the filter. It is useful to maintain the same shape while the frequency parameter is varied. To do this, the ratio($\sigma/f0$) should remain constant.

The Gabor filter has a non-zero response at DC frequency, whereas the Log-Gabor always is zero[2]. Because of this, the Gabor filter tends to over-represents lower frequencies. This is particularly evident in the log domain. Following the change of variable

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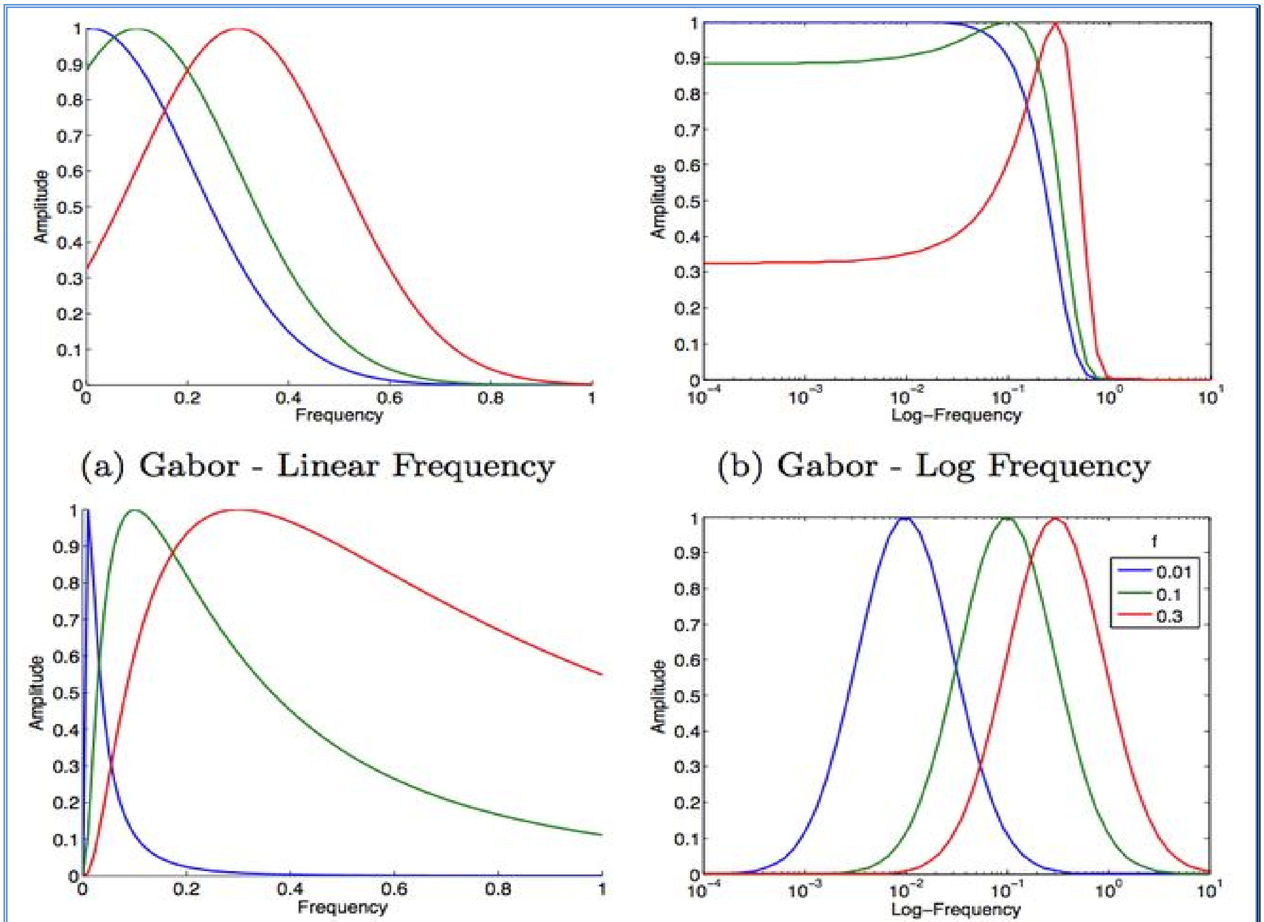
rule, a one dimensional Log-Gabor function has thus the modified frequency response:

$$G(f) = \frac{f_0}{f} \exp\left(\frac{-\left(\log(f/f_0)\right)^2}{2\left(\log(\sigma/f_0)\right)^2}\right)$$

In both definitions, because of the zero at the DC value, In practice the filter is first designed in the frequency domain. Their symmetry on the log axis results in a more effective representation of the uneven frequency content of the images: redundancy in lower frequencies is reduced, and the response of the filter in the linear frequency axis displays a tail in the higher frequencies that adapts the frequency fall-off of natural images[2]. Furthermore, log-Gabor filters do not have a DC component[4], which allows an increase in the bandwidth, and hence fewer filters are required to cover the same spectrum.



(a) Gabor - Linear Frequency (b) Gabor - Log Frequency

(c) Log-Gabor - Linear Frequency (d) Log-Gabor - Log Frequency

Fig.1 Frequency response of the Gabor compared with the Log-Gabor

There are two important characteristics to note. Firstly, log-Gabor functions[6], by definition, always have no DC component, and secondly, the transfer function of the log Gabor function has an extended tail at the high frequency end. Field's studies of the statistics of natural images indicate that natural images have amplitude spectra that fall off at approximately 1/w. To encode images having such spectral characteristics one should use filters having spectra that are similar. Field suggests that log Gabor functions, having extended tails, should be able to encode natural images more efficiently than, say, ordinary Gabor functions, which would over-represent the low frequency components and under-represent the high frequency components in any encoding. Another point in support of the log Gabor function is that it is consistent with measurements on mammalian visual systems which indicate we have cell responses that are symmetric on the log frequency scale.

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V. DATAFLOW DIAGRAM

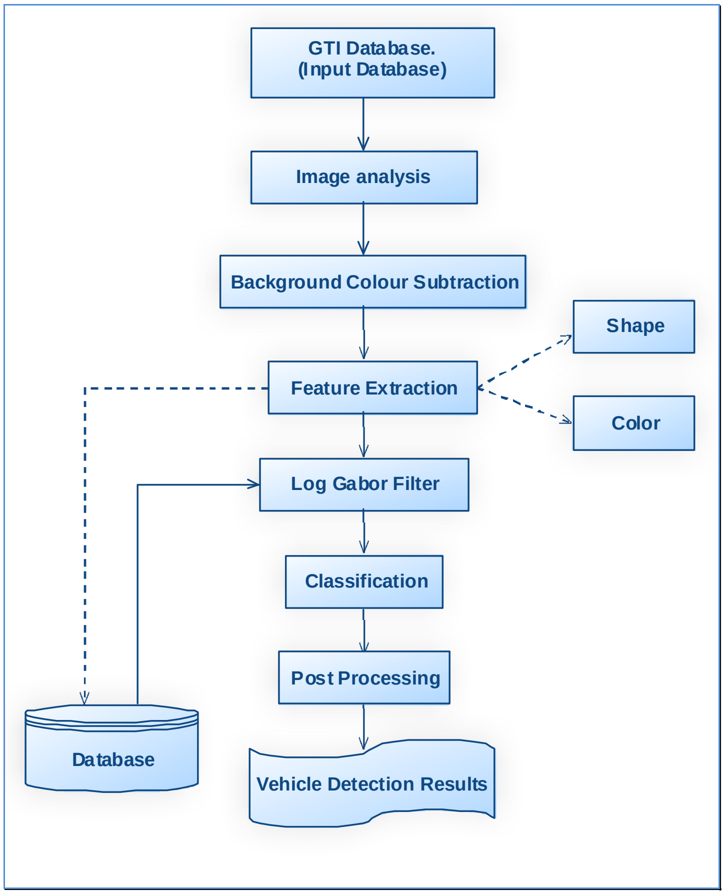

Fig.2 Architecture

VI. ADVANTAGES OF PROPOSED SYSTEM

Log-Gabor filter banks[5] are proven to yield better results than Gabor filter banks using the same number of filters due to their more effective coverage of the spectrum, and to scale better as the number of filters decreases.

The extensive experiments enclosed in this paper confirm the theoretical superiority of these filters over Gabor filters in this field.

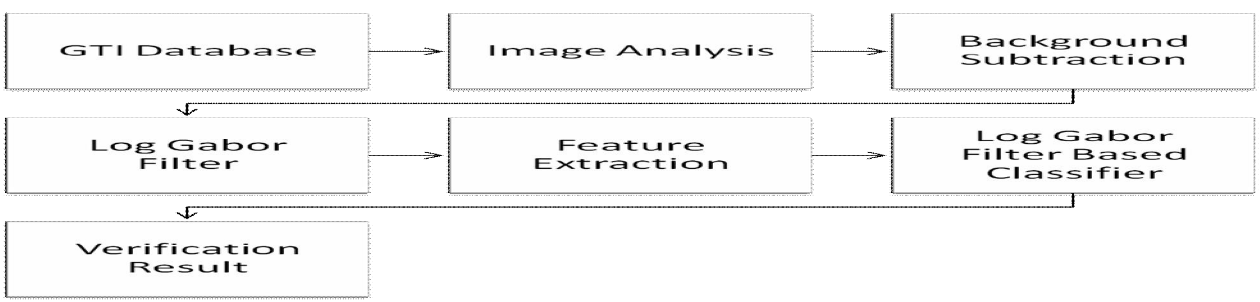

Fig.3 Simulation Model

VII. MODULES

Input Module, Feature Extraction Module, Applying Various Filters, Gabor Filter Based Classifier

A. Module Description

1) *Input Module:* In this module, we design the user interface for providing the input for the project. The user can select the image input from the dataset images consisting of vehicle and non-vehicle images.
2) *Feature Extraction Module*: In this module, we perform the operation of feature extraction[3]. Several strategies can be taken to define the feature vector from the result of Gabor filtering. A set of simulations have been performed on the GTI vehicle database to derive the combination of parameters of the Gabor filter bank that yields best vehicle classification performance.
3) *Applying Various Filters Module:* In this module, we apply various filters to the input image. The log-Gabor functions adapt better than Gabor functions to the inherent frequency content of natural images and are able to cover a larger spectrum with the same number of filters. Thus, it is especially interesting to observe their behavior when decreasing the number of filters[4] in the bank
4) *Log-Gabor filters Module:* In this paper, an alternative representation of images for vehicle classification using log-Gabor filters instead of Gabor filters is proposed and evaluated. Log-Gabor filters are designed as Gaussian functions on the log axis[3], which is in fact the standard method for representing the spatial frequency response of visual neurons. Their symmetry on the log axis results in a more effective representation of the uneven frequency content of the images: redundancy in lower frequencies is reduced, and the response of the filter in the linear frequency axis displays a tail in the higher frequencies that adapts the frequency fall-off of natural images. Furthermore, log-Gabor filters do not have a DC component, which allows an increase in the bandwidth[5], and hence fewer filters are required to cover the same spectrum.

a) b) c)

Fig.4 a) Original color image b)Gabor Filter: Combined output c) Last final segmented image

VIII. CONCLUSION

Instead of using Gabor filters we use Log-Gabor Filters as they can better represent the frequency properties of natural images.

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