Dynamic background removing using Gabor Filter

Joshi Jignesh[1]
[1]Computer Science & Engineering
[1]Gujarat Technological University

Abstract--- In computer vision, image segmentation is the process of partitioning a digital image into multiple segments. The goal of background removing is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Background removing is typically used to locate objects and boundaries (lines, curves, etc.) in images. Identifying moving objects could be a crucial task for several computer vision applications; it provides a classification of the pixels into either foreground or background. A typical approach wont to deliver the goods such classification is background removal. In this paper confirm that the Gabor Filter used to remove dynamic background for given image.

Keywords: Gabor filter, background modelling, foreground detection, performance evaluation, object detection.

I. INTRODUCTION

Computer systems have been developed to pretend most biological systems which have the ability to cope up with changing environments such as moving objects. Recognition and tracing of moving objects can be viewed as lower level tasks to understand higher level task. Detecting moving objects is a precarious task for many computer applications; Classification of the pixels into either background or foreground. The most mutual approach used to get such classification is background removal of image. As noted by Elhabian *et al.*[2], there are numerous problems that must be addressed by a good background removal algorithm to appropriately identify moving objects. A good background removal algorithm should handle the rearrangement of background objects, non-stationary background objects e.g. waving trees, and image changes due to camera motion which is common in outdoor applications e.g. wind load. A background removal system should adjust to illumination changes whether steady changes or rapid changes, whether global or local changes such as shadows and inter-reflections. A foreground object might have similar characteristics as the background, it become difficult to distinguish between them. A foreground object that becomes motionless cannot be distinguished from a background object that moves and then becomes motionless e.g. sleeping person. A common problem faced in the background initialization phase is the existence of foreground objects in the training period, which seal the actual background, and on the other hand often it is impossible to clear an area to get a clear view of the background, this puts serious limitations on system to be used in high traffic areas. Some of these problems can be handled by very computationally expensive methods, but in many applications, a short processing time is required. Even though there exist numerous of background removal algorithms, maximum of them follow a simple flow diagram, passing over four key steps, which are (1) Pre-processing, (2) Background modelling, (3) Foreground detection, (4) Data validation.

Pre-processing means simple image processing tasks that change the raw input video into a format that can be processed by subsequent steps. Background modelling means background maintenance. Foreground detection means background subtraction. Data validation also stated to as post-processing, used to eliminate those pixels that do not relate to actual moving objects. Although the terms background subtraction and background modelling are often used interchangeably, they are separate and distinct processes. Background modelling refers to the process of creating, and subsequently maintaining, a model of the appearance of the background in the field of view of a camera. Background subtraction refers to the process in which an image frame is compared to the background model in order to determine whether individual pixels are part of the background or the foreground. So it is also referred to as foreground detection.

An image may be defined as a two-dimensional function, $f(x, y)$, where x and y are two-dimensional coordinates, and the plenty of f at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x, y, and the plenty values of f are all finite, distinct quantities, we call the image a digital image. The area of digital image processing refers to treating digital images by means of a digital computer. Digital image is composed of a set of elements, each of which has a precise position and value. These elements are referred to as image elements, picture elements, pixels and pels. Pixel is the term most commonly used to indicate the elements of a digital image.

There are no clear-cut boundaries in the continuum from image processing at one end to computer visualization at the other. However, one useful pattern is to consider three types of computerized processes in this field [1]: low-level, mid- level, and high-level processes. Low-level processes contain simple basic operations such as image preprocessing to decrease noise, contrast improvement, and image sharpening. A low-level procedure is considered by the fact that both its inputs and outputs are images. Mid-level processing on images involves tasks such as segmentation (partitioning an image into regions or objects), description of those objects to reduce them to a form suitable for computer processing, and classification (recognition) of individual objects. A mid-level process is characterized by the fact that its inputs generally are images, but its outputs are attributes extracted from those images (e.g., edges, contours, and the identity of individual objects). Finally, higher-level processing involves "making sense" of an ensemble of recognized objects, as in image analysis, and, at the far end of the continuum, performing the cognitive functions normally associated with vision.

Texture is one of the most basic characteristics of a visible surface. Both biological systems and computational vision models use texture for perceptual tasks such as segmentation of surfaces, classification of surface materials and computation of shape. Psychophysical studies have shown that texture discrimination occurs preattentively: namely, it operates in parallel over large regions of the visual field and occurs early in visual processing. Texture segmentation is a very fundamental problem in computer vision and image processing. The problem of segmenting an image based on textural cues that is on differences in the spatial arrangement of gray values of neighboring pixels is referred as the texture segmentation problem. To overcome this problem we propose Gabor Filter for extract texture feature of image. By using texture feature extraction of Gabor Filter we remove dynamic background of image to identify texture feature of object.

The rest of the paper is structured as follows. In Section II the theory underlying Gabor filter construction and their use in dynamic background removing is briefly reviewed. In Section III Experiment of Gabor filter on image. The paper concludes with some final comments in Section IV.

II. Gabor Filter as Dynamic Background Remover

This section briefly reviews the basic ethics of dynamic background removing using Gabor filter. It commences by introducing the Gabor filters and proceeds by highlighting some characteristics of the filters, which affect the Gabor background representation and consequently the recognition performance of Gabor filter based recognition techniques.

A. *Gabor filter*

Gabor filters are among the most popular tools for texture feature extraction. Their use in automatic background recognition system is motivated by two major factors: their computational properties and their biological consequence. In image processing, a Gabor filter, named after Dennis Gabor, is a linear filter used for edge detection. Frequency and orientation representations of Gabor filters are similar to those of the human visual system, and they have been found to be particularly appropriate for texture representation and discrimination.

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. 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 possess 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, and 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 [3].

Formally, a 2D Gabor filter in the spatial domain is defined by the following expression [3]:

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

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

In this equation, λ represents the wavelength of the sinusoidal factor, θ represents the orientation of the normal to the parallel stripes of a Gabor function, ψ is the phase offset, σ is the sigma of the Gaussian envelope, γ is the spatial aspect ratio.

- *Explanation of parameters*

1) *Wavelength (λ):* This is the wavelength of the cosine factor of the Gabor filter kernel and herewith the preferred wavelength of this filter. Its value is specified in pixels. Valid values are real numbers equal to or greater than 2. The value λ=2 should not be used in combination with phase offset ψ =-90 or ψ =90 because in these cases the Gabor function is sampled in its zero crossings. In order to prevent the occurrence of undesired effects at the image borders, the wavelength value should be smaller than one fifth of the input image size.

2) *Orientation(s) (θ):* This parameter specifies the orientation of the normal to the parallel stripes of a Gabor function. Its value is specified in degrees. Valid values are real numbers between 0 and 360.

3) *Phase offset(s) (ψ):* The phase offset ψ in the argument of the cosine factor of the Gabor function is specified in degrees. Valid values are real numbers between -180 and 180. The values 0 and 180 correspond to center-symmetric 'center-on' and 'center-off' functions, respectively, while -90 and 90 correspond to anti-symmetric functions. All other cases correspond to asymmetric functions.

4) *Aspect ratio (γ):* This parameter, called more precisely the spatial aspect ratio, specifies the ellipticity of the support of the Gabor function. For γ = 1, the support is circular. For γ < 1 the support is elongated in orientation of the parallel stripes of the function. Default value is γ = 0.5.

5) *Bandwidth (b):* The half-response spatial frequency bandwidth b (in octaves) of a Gabor filter is related to the ratio σ / λ, where σ and λ are the standard deviation of the Gaussian factor of the Gabor function and the preferred wavelength, respectively, as follows:

$$b = \log_2 \frac{\frac{\sigma}{\lambda}\pi + \sqrt{\frac{\ln 2}{2}}}{\frac{\sigma}{\lambda}\pi - \sqrt{\frac{\ln 2}{2}}}, \quad \frac{\sigma}{\lambda} = \frac{1}{\pi}\sqrt{\frac{\ln 2}{2}} \cdot \frac{2^b+1}{2^b-1}$$

III. Experiment

In order to verify the performance of proposed method, our experiments are performed on images. For each image different parameter of Gabor filter are tested. Following values are considered for different parameter of Gabor filter. Wavelength (λ): 20, Orientation (θ): 90, Phase Offset (ψ): 180, Aspect ratio (γ): 0.3, Bandwidth (b): 1.8

Fig. 1: Original rhino image (gray image)

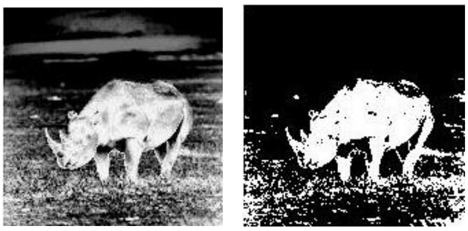

Fig. 2: (a) Gabor Filter Output (b) Black & White Output at threshold value 0.65

Fig. 1. Shows Original rhino image in gray image format. In Fig. 2. (a) Shows Gabor filter output of given input image and Fig. 2. (b) Shows Black & White image means pixel value “0” or “1” at threshold value 0.65

The ROC curve is also plotted for output image compare with ground truth at different threshold values shown in figure 3.

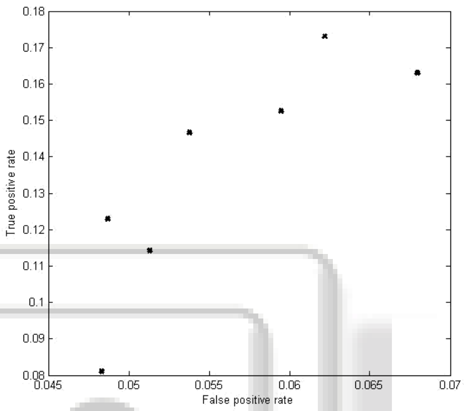

Fig. 3: ROC values at different thresholds

IV. Conclusion

Complex 2D Gabor filters have been successfully used in many applications of extracting texture feature. Using this feature of Complex 2D Gabor filters, we applied these to remove dynamic background and detect object or foreground. Output images and ROC values show that the proposed method should use for removing dynamic background.

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