TEXTURE BASED IMAGE SEGMENTATION USING GABOR FILTERS

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Abstract

The paper deals with image segmentation which results in the subdivision of an image into its constituent regions or objects. The result of image segmentation is a set of segments that collectively cover the entire image or a set of contours extracted from the image. Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity or texture. Specifically it deals with texture segmentation of an image to find out the different types of textures present in the image. In this paper, a type of procedure has been followed to carry out texture segmentation.A multi-resolution technique using wavelet transform has been considered. Many texture-segmentation schemes are based on a filter-bank model,where the filters called Gabor filters are derived from Gabor elementary functions.Circular Gabor filters are analyzed.

***Index Terms**. multi-resolution, image segmentation, Gabor filters*

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1. INTRODUCTION

Texture segmentation aims at localizing the boundaries between different textures on one textured image plane by classifying pixels based on their texture properties.. There are several research focuses in the field of texture analysis, mainly including texture classification, texture segmentation, texture synthesis, shape from texture, etc Multichannel Gabor function has been recognized to be a very useful tool in computer vision and image processing, especially for texture analysis

2. GABOR FILTER

Gabor filter is a linear filter whose impulse response is defined by a harmonic function multiplied by a Gaussian function .Gabor filters can be applied to many image-processing applications, such as texture segmentation, document analysis, edge detection, retina identification and image representation An advantage of these filters is that they satisfy the minimum space-bandwidth product per the uncertainty principle. Hence, they provide simultaneous optimal resolution in both the space and spatial-frequency domains. Gabor filters are used to solve problems involving complicated images comprised of textured regions. The problem of segmenting textured images is considered in this paper.[1]The center frequency of each fillter is selected to correspond to a peak in the texture power spectrum, and filter bandwidths were determined by the center frequency.

It is optimally localized as per the uncertainty principle in both the spatial and frequency domain i.e. Ix.Iω being close to h ,the metric of uncertainty . This implies Gabor filters can be highly selective in both position and frequency, thus resulting in sharper texture boundary detection .Gabor filter related segmentation paradigm is based on filter bank model in which several filters are applied simultaneously to an input image .The filters focus on particular range of frequencies .If an input image contains two different texture areas, the local frequency differences between the areas will detect the textures in one or more filter output sub-images . Each Gabor filter is specified by a Gabor Elementary function(GEF) . GEFs can perform a joint space decomposition . Gabor filters are extensively used for texture segmentation because of their good spatial and spatial-frequency localization.

2.1Gabor Elementary Functions (GEF’s)

Gabor Elementary Functions(GEF’s)GEF’s is defined by Gabor.
A GEF is given by

$$h(x,y) = g(x',y')\exp\left[j2\pi(Ux+Vy)\right]$$

Where

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

represent rotated spatial-domain rectilinear coordinates. Let (u,v) denote frequency-domain rectilinear coordinates, (U,V) represents a particular 2-D frequency. The complex exponential is a 2-D complex sinusoid at frequency

$$F = \sqrt{U^2 + V^2}$$

and

$$\varphi = \tan^{-1} V/U$$

specifies the orientation of the sinusoid. The function g(x,y) is the 2-D Gaussian

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

Where σx and σy characterize the spatial extent and bandwidth of the filter. Thus, the GEF is a Gaussian that is modulated by a complex sinusoid.

The GEF acts as a bandpass filter . In most cases, letting σx = σy = σ is a reasonable design choice .

Now define the Gabor Filter Oh by

$$m(x,y) = O_h\,(i(x,y)) = |\,i(x,y) \otimes h(x,y)\,|$$

where i is the input image and m is the output. This results in a new version of

Gabor filters--circular Gabor filters (CGF). The circular Gabor filter is defined as follows:

G(x, y) = g(x, y)exp(**2**πiF(x**2** + y**2**))

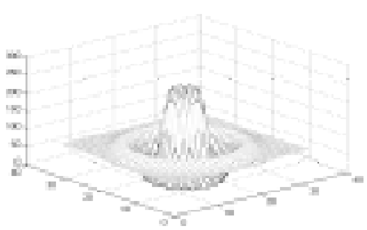

Figure 1.Circular Gabor function in the spatial domain

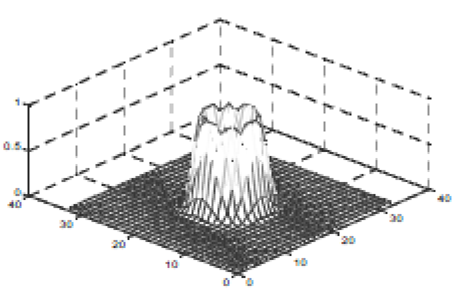

Figure 2. Circular Gabor function in the spectrum domain

3. ALGORITHM

Step 1 – Select values for U, V, σx , σy .

Step 2 – Convert the input image into a 2-D matrix, say i(x,y) .

Step 3 – Calculate the value of h i.e. the impulse response of the filter, (which is also a

2-D matrix) by the following formula .

$$h(x,y) = \frac{1}{2\pi\sigma_x\sigma_y}\exp\left\{-\frac{1}{2}\left[\left(\frac{x}{\sigma^x}\right)^2 + \left(\frac{y}{\sigma^y}\right)^2\right]\right\}\exp\left[j2\pi(Ux + Vy)\right]$$

Step 4 – Compute the convolution of i(x,y) with h(x,y) , say it is m(x,y), which is the

matrix corresponding to the output image

$$m(x,y) = O_h\,(i(x,y)) = |\,i(x,y) \otimes h(x,y)\,|$$

where Oh is the filter .

Step 5 – Obtain the output image . If it cleanly discriminates the two textures then stop , else goto step 1 to select other values of U, V, σ and repeat the procedure.

Selection of Parameters

For a circular Gabor filter, F and σ must satisfy the condition with respect to bandwidth b as

F*σ = λ (2b + 1) / (2b – 1)

Lower frequencies may provide good texture segmentation results. Frequency may be chosen from the interval of[-0.5 – 0.5] by an image of size N. The highest and

the lowest frequency is FH and FL respectively.

FH = 0.25 + 2(I – 0.5)/N 0.25 < = FH < 0.5 (3.9)

FL = 0.25 + 2(I-0.5)/N 0 < FL < 0.5

4. RESULTS

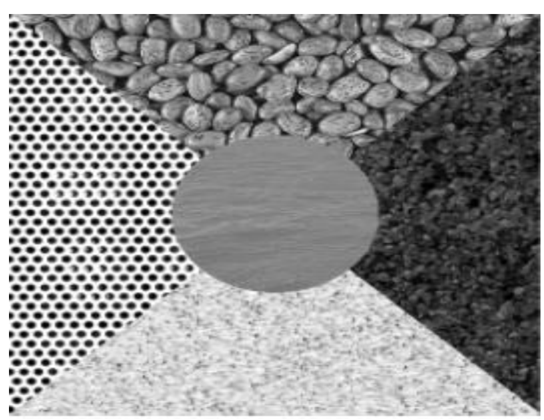

Figure 3.Original image

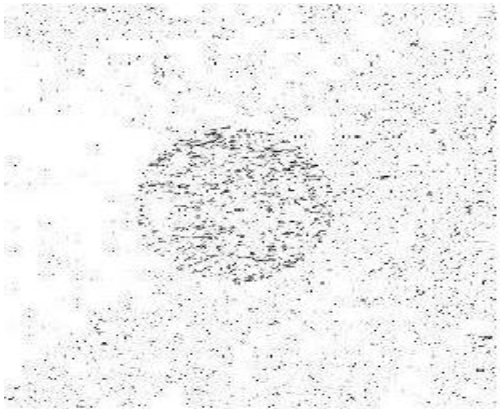

Figure 4. σ =1, U=0.7, V=0.9

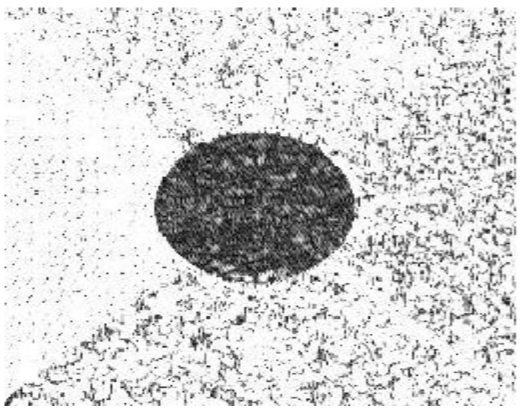

Figure5 σ =2, U=1.2, V=1.8

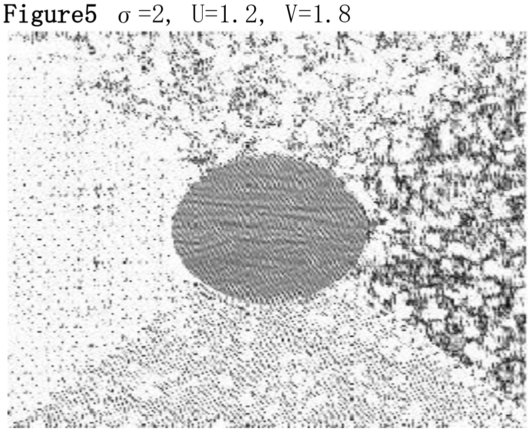

Figure 6. σ =3, U=1.7, V=2.2

5. CONCLUSION

Texture segmentation is based on partitioning an image into different regions of similar textures based on a specified criterion. The projection of images onto circular Gabor filters is rotation invariant in nature.The new Gabor prefilter design method is optimal in the sense that the resulting prefilter maximizes the ratio of expected average output energy for the two textures. This results in large differences in the brightness of regions composed of different textures in the Gabor pre-filtered image.

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BIOGRAPHY

Amanpreet Kaur received her B.Tech degree in Computer Science & Engineering from Guru Nanak Dev University, Amritsar, India in 2009.Currently she is pursuing M.Tech in Computer Science & Engineering from Punjab Technical University, Jalandhar, India. She has one and a half years of Teaching Experience and her research interests include Digital Image Processing.