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Brain Image Segmentation Technique Using Gabor filter parameter

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Abstract: - This paper imparts the recognition of Gabor filter techniques using nine different types of brain images. This paper is based on the identification analysis on the output of noisy and filtered images by using Gabor filter technique. This technique is acquiring the noisy images is built on the three types of images: Gaussian, Poisson and Speckle. In conclusion an algorithm is established that implement all the types of filtering technique on the input image and arithmetic parameters are calculated as per the comparison between output and input images. These arithmetic parameters are exhibit distinctly and they are compared for both the noisy and filtered images. For the calculation of the performance of Gabor filters mathematical parameters like signal to noise ratio, correlation coefficient and Structure similarity are used and the MATLAB codes required in calculating these parameters are developed. These parameters are used to calculate the image quality of the output image obtained from Gabor filter technique, based on the values of these parameters the results of all the output images is discussed.

I. INTRODUCTION

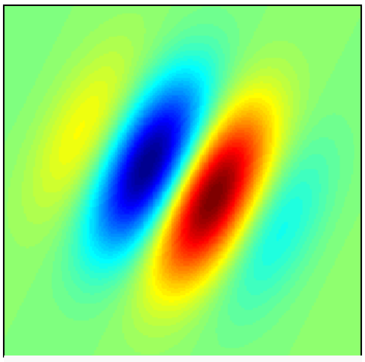
This paper work is carried out to study the analysis of Gabor filtered output images and the noisy images. For this analysis, we are examining the values of various quality parameters like SNR, Correlation and SSIM. For acquiring the noisy images, we are using three types of noises, Gaussian, Poisson and Speckle noises. For all the images, we are choosing a specific area of the original images and this area is different in the segmentation propose. For segmentation analysis, we are using the comparison of three output images as: Original image segmentation, Gabor filtered output segmentation and noised output segmentation.

These three output images are having the same dimensions for their comparison. The several parameters of the Gabor filter involve a major role in selecting the output image. The size, phase, orientation and frequency of the output image are selected by the Gabor filter. The image features are determined by applying an proper Gabor filter with adaptively chosen size, orientation, frequency and phase for each pixel.

An image property called phase divergence is used for the selection of the appropriate filter size.Essential features related to the change in brightness, texture and position are extracted for each pixel at the selected size of the filter. 2-D Gabor filter is easier to tune the direction and radial frequency band-width, and easier to tune center frequency, so they can instantly get the best resolution in spatial domain and frequency domain. Gabor filter outputs can be designed as Gaussian's and establish algorithm for choosing optimal filter specification.

II. GABOR FILTERS

In image processing, a **Gabor filter**, 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. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. The Gabor filters are self-similar: all filters can be generated from one mother wavelet by dilation and rotation.



A two-dimensional Gabor filter

Its 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 filter has a real and an imaginary component representing orthogonal directions. The two components may be formed into a complex number or used individually.

Complex

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

Real

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

Imaginary

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

where

$$x' = x\cos\theta + y\sin\theta$$

and

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

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 and γ is the spatial aspect ratio, and specifies the ellipticity of the support of the Gabor function.

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 biorthogonal 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, 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.

$h(x, y) = s(x, y)g(x, y)$
$s(x, y)$: Complex sinusoid
$g(x, y)$: 2-D Gaussian shaped function, known as envelope

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

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

Where $s(x, y)$ is a complex sinusoid, known as the carrier, and $g(x, y)$ is a 2-D Gaussian-shaped function, known as the envelope.

The real part and imaginary part of this sinusoid are the parameters and define the spatial frequency of the sinusoid in Cartesian coordinates. This spatial frequency can also be expressed in polar coordinates as magnitude Fo and direction Wo:

$$F_0 = \sqrt{u_0^{\ 2} + v_0^{\ 2}}$$

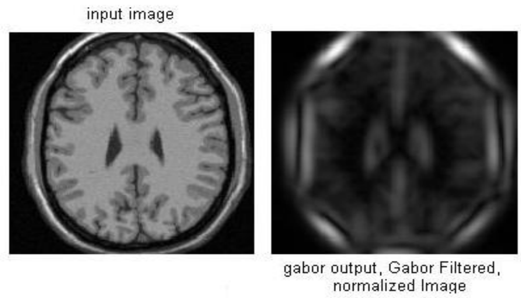
i.e. $$\omega_0 = \tan^{-1}\left(\frac{v_0}{u_0}\right)$$

$$u_0 = F_0 \cos\omega_0$$

$$v_0 = F_0 \sin\omega_0$$

III. MATERIALS AND METHODS IMAGES AS INPUTS

Gabor filters needs some types of images as the input. These images require the process of computer algorithms as per the input image. These computer algorithms yield two types of images from Computer Algorithm: noisy image and magnitude image. The magnitude image is comparing with the noisy image, which gives the advantages of Gabor filters in various parameters. There are ten original standard images:-



Noises Gaussian noise- This type of noise adds normal distributed noise to the original image. The noise is independent of the image it is applied to. The value of the pixel is altered by the additive Gaussian noise as Where n is the noise, being distributed normally with variance v. the noisy pixels which are generated are anywhere between black and white, distributed according to the Gaussian curve. The width of the curve is adjusted with the mean and the variance parameter.

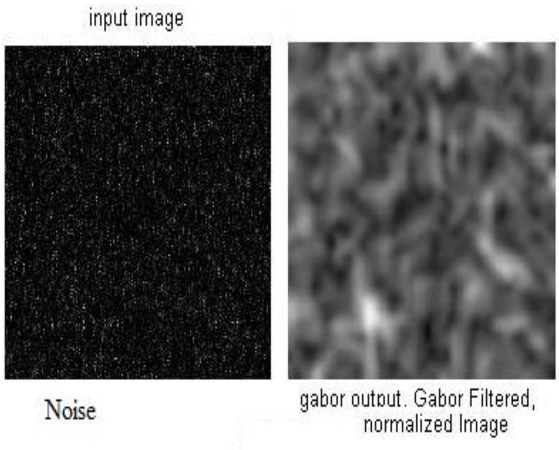
Poisson noise- Poisson noise is generated from the data instead of adding artificial noise to the data. If I, the original image, is double precision, then input pixel values are interpreted as means of Poisson distributions scaled up by. Poisson noise generates a noise sequence of integer numbers having a Poisson probability distribution,

Speckle noise- Speckle adds multiplicative noise to the image according to the following formula: where n is an array with the size of an array with the size of the original image, filled with random values resulting from a normal distribution (Gaussian distribution) with mean 0 and are controlled by the variance. With this type of noise, noise generation is dependent on the original image, hence the product in the formula. Quality metrics there are various quality metrics in our work. By evaluating the values of those parameters we can compare the values of the noisy and the magnitude images of the output. The values of those parameters lead to best results as per the details of various values by comparing the noisy and the magnitude output values. These are the various working parameters:

SNR- SNR stands for signal to noise ratio. SNR is defined as the ratio of the net signal value to the RMS noise. Where the net signal value is the difference between the average signal and background values, and the RMS noise is the standard deviation of the signal value.

Correlation- The operation called correlation is closely related to convolution. In correlation, the value of an output pixel is also computed as a weighted sum of neighboring pixels. The correlation coefficient matrix represents the normalized measure of the strength of linear relationship between variables correlation coefficient. Correlation indicates the strength and direction of linear relationship between 2 signals and its value lie between +1 and -1. The correlation is 1 in the case of a linear relationship, -1 in the case of a decreasing linear relationship and some value in between for all other cases, including the degree of linear dependence between the 2 signals. The closer the coefficient is to either -1 or +1, the stronger the correlation between the signals.

SSIM- SSIM stands for structural Similarity. The SSIM index is a method for measuring the similarity between two images. The SSIM index is a full reference metric, in other words, the measuring of image quality based on an initial uncompressed or distortion-free image as reference. SSIM is designed to improve on traditional methods like PSNR and MSE, which have proved to be inconsistent with human eye perception. The SSIM metric is calculated on various windows of an image.



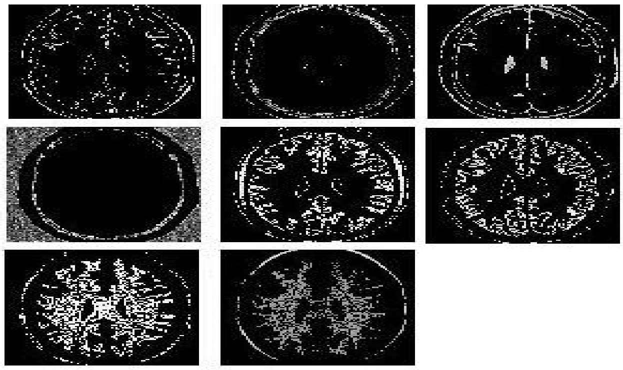
IV. WORKING ALGORITHM USING MATLAB

This working Algorithm is the way of doing our work. This is a step by step procedure that how we implement the images and how we evaluate the working parameters. The main algorithm, followed in order to fulfill the aim of our work, is as follows:

Step 1: Read the original standard image.
Step 2: Apply the Gabor Filter to the original standard image and storing the mainly outputs for the Noisy image and the Magnitude image.
Step 3: Resize the output noisy and output magnitude images as per the original standard image size as the size of the original image may be. To evaluate various parameters from the original and the output image it is necessary to maintain the same size of the images.
Step 4: Before calculating the values of the various parameters, it is necessary to convert that output image to 1-Dimensional image because that standard image doesn't work by using the parameters formula in their original form.
Step 5: Calculate the value of the quality metrics parameters by using the MATLAB command: SNR (I, J), Correlation (I, J), [mssim ssim_map] = ssim_index (I, J) his command gives the values of the SNR, Correlation and SSIM where I is the original image and J is the output image.
Step 6: After run of all the parameters, all the values of parameters are calculated by changing the Variances and changing the frequency of the Gabor filters. The best value results are collected and plotted all with respect to their particular Variances.
Step 7: The result analysis shows that Segmentation result of image with noise and without noise shows less different.

V. RESULTS

Image Analysis of segmentation with noise with Gabor filter



Noisy Image Segmentation

Image Analysis of segmentation without noise with Gabor filter

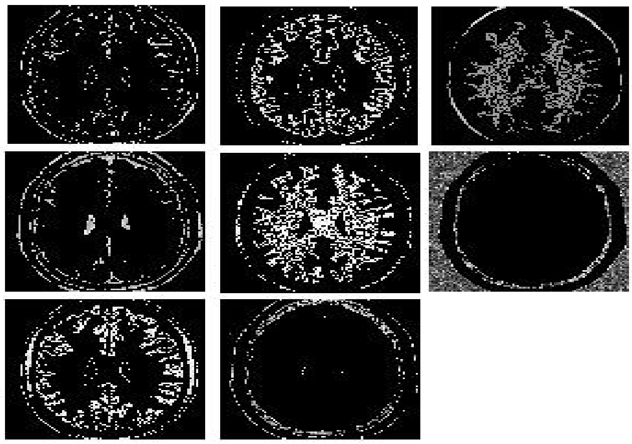


Image Segmentation without noise

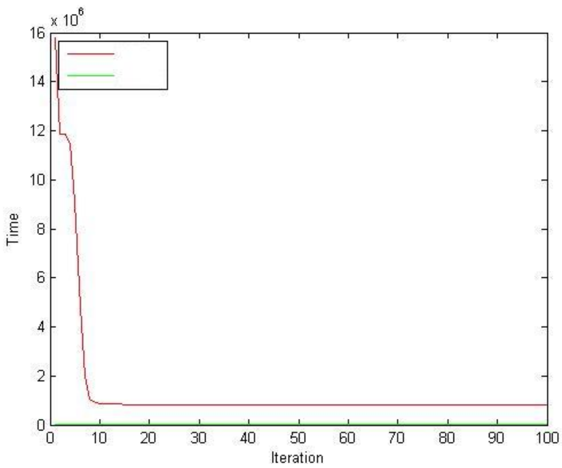
VI. EFFECT OF GABOR FILTER FOR IMAGE SEGMENTATION

These are the comparison of Image segmentation for various images. There are nine segmentation results for every image. These are the segmentation of Original image and the best values output for Noisy and filtered images.

Number of iteration applied to every image is not less than 100 counts.

Segmented image similarity is around 84% as compare between the original input images.

Time taken for iteration process is less different between noisy image and noiseless images.



REFERENCE

[1] Hans G. Feichtinger, Thomas Strohmer: "Gabor Analysis and Algorithms", Birkhäuser, 1998; ISBN 0-8176-3959-4

[2] Karlheinz Gröchenig: "Foundations of Time-Frequency Analysis", Birkhäuser, 2001; ISBN 0-8176-4022-3

[3] John Daugman: "Complete Discrete 2-D Gabor Transforms by Neural Networks for Image Analysis and Compression", IEEE Trans on Acoustics, Speech, and Signal Processing. Vol. 36. No. 7. July 1988, pp. 1169–1179

[4] "Online Gabor filter demo". Retrieved 2009-05-25.

[5] Movellan, Javier R. "Tutorial on Gabor Filters". Retrieved 2008-05-14.

[6] "Procedural Noise using Sparse Gabor Convolution". Retrieved 2009-09-1

[7] J. G. Daugman. Uncertainty relation for resolution in space, spatial frequency, and orientation optimized by two-dimensional visual cortical filters. *Journal of the Optical Society of America A*, 2(7):1160–1169, July 1985.

[8] 3D surface tracking and approximation using Gabor filters, Jesper Juul Henriksen, South Denmark University, March 28, 2007

[9] Daugman, J.G. (1980), "Two-dimensional spectral analysis of cortical receptive field profiles", *Vision Res.* **20** (10): 847–56,PMID 7467139

[10] J.P. Jones and L.A. Palmer. An evaluation of the two-dimensional gabor filter model of simple receptive fields in cat striate cortex. J. Neurophysiol., 58(6):1233-1258, 1987

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