Measurement of Fibre angular orientation distributions

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***Abstract*—This paper studies the application of the discrete Fourier transform (DFT) to predict angular orientation distributions from images of fibers and cells. Angular distributions of fibers in biological tissues, cell and fiber orientation distributions are important since they define their mechanical properties and function.**

We used Hamming window for the elimination of errors that are caused due to edges to predict angular distributions accurately.The knowledge of the errors allows one to verify the suitability of the method for a particular application. We found that the DFT method is most accurate for slender fibers, and this method was applied to predict orientation distribution of cells and acting fibers in bio-artificial tissue constructs.

***Keywords*—Fourier Analysis,Angular oriental Distributions**

I. Introduction

The DFT of an image contains information in the form of a set of amplitudes corresponding to horizontal and vertical frequencies, which we use in this work to define orientations of features in the image. The magnitudes of amplitudes corresponding to a particular set of frequencies relate to the sizes of the features in the image: lower frequencies define larger features and higher frequencies define smaller features. The locations of peaks in the DFT relate to the orientation of the corresponding features. To obtain useful information about angular orientation of certain features on the image it is necessary to select only the relevant portions of the DFT, or filter the DFT. This work studies the effectiveness of two-dimensional (2D) DFT in characterizing cell or fiber orientation.

A. Methodology

The analys is of the images was based on a standard 2D discrete Fourier Transform (DFT), X, performing the usual DFT shift that centers the low frequencies

$$\mathrm{X(u,v)} = \sum_{n=1}^{N}\sum_{m=1}^{M}(x(m,n)e(-2\pi j(add(\frac{(u-1)(m-1),}{M}\frac{(v-1)(n-1)}{N})))$$

when x(m,n) is the amplitude of the pixel at (m,n) in a (M,N) image and j = sqrt(-1).We deine the radial frequency u-radial as

$$u_r = \sqrt{\mathrm{u}^2 + v^2}$$

and, the angular co-ordinate with respect to the horizontal zero frequency line

$$\theta = \tan^{-1}\left(\frac{v}{u}\right)$$

Thus, we can define the following transformation:

$$\widehat{X}(u_r,\theta) = X(u_r\cos(\theta); u_r\sin(\theta))$$

The power of the DFT, P, is the square of the amplitudes of the DFT components,

$$\mathrm{P}(u_r,\theta) = |\widehat{X}(u_r,\theta)|^2$$

We found the angular amplitude of the DFT, A(theta), by summing the power in an annular band of radial frequencies.

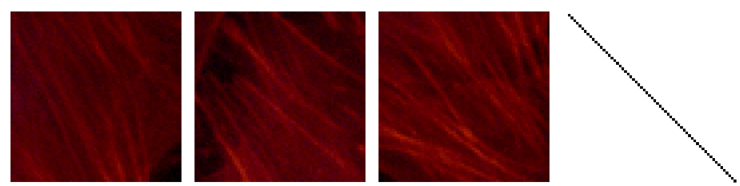
$$\mathrm{A}(\theta) = \sum_{u_r=u_{r1}}^{u_{r2}} P(\mathrm{u}_r,\theta)$$

To fit this function to data we calculated the vector average of the responses, defined by

$$\mathrm{a} = \sum_{i=1}^{M} A_i\cos(\theta_i), b = \sum_{i=1}^{M} A_i\sin(\theta_i)$$

Thus the final output angular distribution is

$$\mu_{meas} = tan^{-1}\left(\frac{b}{a}\right)$$



II. Conclusion

We apply Hamming-Window for eliminating the errors in the edges and then by performing the above tranformations we did measure the fibre angular orientations by the use of lung cancer cell fibre images of 64-by-64 pixels and obtained the output angles as 95.09, 109.88, 110.39 degrees and also we did show our accuracy of the method by using a test image where we estimated the angle of a line inclined at angle closer top 135-degress where we observed the output as 137.1 degrees

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References

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