Manual

Convolution with a Bessel PSF in ImageJ

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1 Introduction

This *ImageJ* plugin convolves 2D images or movies (image stacks) with a 2D Bessel point spread function (PSF).

The convolution kernel of size $w \times h$ reads[2]:

$$\begin{aligned} PSF(x,y) &= \left(\frac{2J_1(a\sqrt{x^2+y^2})}{\sqrt{(x^2+y^2)}}\right) \\ a &= \frac{2\pi\, NA}{\lambda} \end{aligned} \tag{1}$$

with $x \in [-w/2, w/2]$ and $y \in [-h/2, h/2]$ the coordinates measured from the center of the kernel. w and h are equal to the user defined parameter r_{max}. $J_1(x)$ stands for the Bessel function of order one. The implementation of this function is taken from [1]. The convolution is performed by ImageJs `ImageProcessor` classes.

2 Installation

Copy the `mosaic_plugins.jar` file to the ImageJs `plugins` directory. Restart ImageJ. The plugin can be launched from the `Mosaic` submenu in ImageJs plugin menu.

The plugin handles 8-bit, 16-bit and 32-bit grayscale images or stacks.

Prerequisits: At least Java 5.0 and ImageJ 1.36.

3 How to use the plugin

Open the image or an image stack in ImageJ to process. Make sure that pixel width and height is set correctly in the image properties dialog. Use the `Ctrl-p` shortcut to open this dialog. Please note that the plugin only recognizes the metric system.

Start processing by selecting the `BesselPSF Convolver` entry in the `plugin`→`mosaic` menu. You might process only one slice or even the whole stack.

Please note that there is no undo for this operation.

The parameters to enter in the dialog before the calculation starts are:

- **Numerical Apparture** The numerical apparture NA of the objective lens.
- **Wavelength** The wavelength λ of the light emitted by the specimen and gathered at the sensor.
- **Max Radius** The maximal radius r_{max} of the convolution kernel. For all pixel not in that range, the effect is neglected. Please note that the calculation time is proportional to r_{max}^2.

4 Disclaimer

References

[1] T. Pang. *An Introduction to Computational Physics*. Cambridge University Press, Cambridge, 1997.

[2] D. Thomann, D. R. Rines, P. K. Sorger, and G. Danuser. Automatic fluorescent tag detection in 3d with super-resolution: application to the analysis of chromosome movement. *J Microsc*, 208(Pt 1):49–64, October 2002.