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Bi-Exponential Edge-Preserving Smoother

An [ImageJ](#) plugin that smooths an image without altering its edges.

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Figure 1. Original.



Figure 2. A smoothed image with preserved edges takes a cartoonish appearance.

General Description

The smoothing is applied by the way of a bi-exponential filter, itself realized by a pair of one-tap recursions. It is therefore very fast; moreover, its computational cost is truly independent of the amount of smoothing. Meanwhile, the preservation of edges is obtained by a range filter akin to the range filter found in a bilateral filter. More technical details are available [here](#).

The plugin allows one to control the amount of smoothing, the type of range filter, its broadness, and to iterate the filter several times if desired. We illustrate in Figure 2 a possible outcome of this filter. Here, we iterated the BEEPS 10 times with a Gaussian range filter,  $\sigma = 10$ , and the spatial decay  $\lambda = 0.1$ .

I. Download

This distribution is dated September 9, 2011. It includes the source files, along with a jar file that contains the precompiled classes.

- [BEEPS.jar](#) (51,712 bytes)
- [BEEPS.jar](#) (19,403 bytes)
- [BEEPS.jar](#) (22,332 bytes)

II. Related Work

This set of Java classes is based on the following paper:

P. Thévenaz, D. Sage, M. Unser, "Fast bi-exponential edge-preserving smoothing," IEEE Transactions on Image Processing, in press. Other relevant on-line publications are available at [http://bigwww.epfl.ch/thevenaz/beeps/](#).

BEEPS has been written as a plugin for [ImageJ](#). Please read the ImageJ documentation to learn how to install plugins.

III. Technical Explanations

The bi-exponential edge-preserving smoother (BEEPS) is an image-processing filter that transforms an input image into an output image of the same size. The goal of the BEEPS is to iron out irrelevant details of the image without compromising strong edges. Thus, its effect is similar to that of a bilateral filter, except that the BEEPS is much faster than the bilateral filter. It is controlled by tuning a so-called range filter, along with the amount of spatial smoothing.

In this plugin, the range filter is either Gaussian-like or sech-like. (The sech function is the usual hyperbolic secant). In both cases, the contribution of the range filter is controlled by its standard deviation: a large standard deviation corresponds to a broad range filter that has a weak effect and allows for the smoothing of all but the strongest edges; a small standard deviation corresponds to a narrow range filter that has a strong effect and forbids the smoothing of most edges.

The amount of spatial smoothing is controlled by the decay of a bi-exponential filter. Useful decays belong to the interval  $[0, 1]$ . When the decay is slow (near 0), the filter has a long-range reach and the spatial smoothing is strong. When the decay is fast (near 1),

the filtering is localized and the spatial smoothing is weak. Please note that the decay  $\lambda$  that controls this plugin corresponds to  $(1 - \lambda)$  in the associated [paper](#).

IV. User Manual

The plugin requests at least one open image at launch. All image types are accepted, except [RGB Color](#) and [Lab Color](#). In the case of a RGB Stack or a HSB Stack, the processing will be performed independently on all channels.

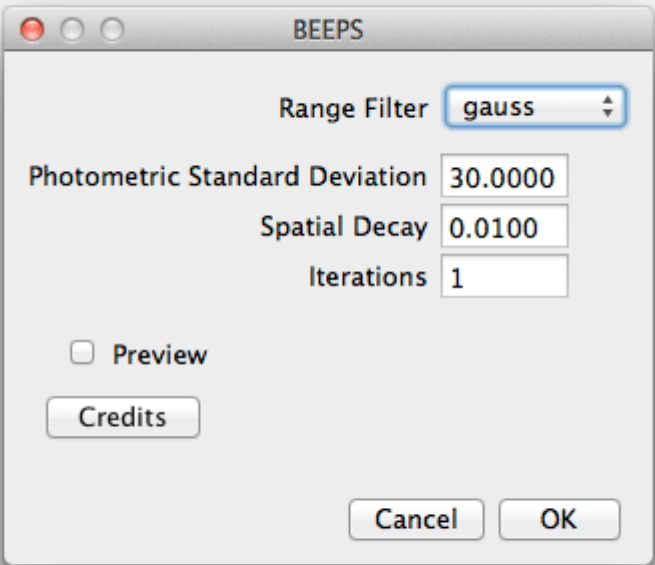


Figure 3. Initial dialog.

At launch, a dialog window will appear (see Figure 3). The role of its various components is as follows:

- **Range Filter:** Selection of the type of range filter. The choice "gauss" corresponds to the function  $s(u, v) = \exp(-(u - v)^2 / (2 \sigma^2))$ . The choice "sech" corresponds to the choice  $s(u, v) = \text{sech}(n(u - v) / (2 \sigma))$ .
- **Photometric Standard Deviation:** Broadness of the range filter. The number provided is the value of the variable  $\sigma$  in the formula of the range filter.
- **Spatial Decay:** Decay of the impulse response of the spatial filter. The impulse response of the filter is  $h(\lambda) = (\lambda / (2 - \lambda)) (1 - \lambda)^{1/\lambda}$ . The number provided is the value of the variable  $\lambda$ . Please note that  $\lambda$  in this plugin is a decay, while  $\lambda$  in the associated [paper](#) is a contra-decay.
- **Iterations:** Number of iterative applications of the BEEPS. A value 1 means that the filter is applied just once—it does not imply that there would be one additional iteration beyond the initial application.
- **Preview:** When ticked, provides a preview of the effect of the filter. The type of range filter is always "gauss" for this preview.
- **Credits:** Brings a text panel that documents the plugin and provides the legal notice.

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