Wallis filter extension for ENVI

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Background

The Wallis filter is a particular adaptive filter and it has been introduced as a generalization of the statistical differencing algorithm. It produces an edge crispening and a *local* contrast enhancement, by applying an operator which is spatially variant, because it is based on the estimates of means and variances over some neighbourhood around each pixel. This kind of filter is particularly useful, for instance, when images present both bright and shadow regions.

The algorithm can be expressed according to the following formulation [2],

$$out(i,j) = (in(i,j) - \mu_k(i,j)) \cdot \frac{G_f S}{G_f \sigma_k(i,j) + S} +$$
$$+ BM + (1 - B)\,\mu_k(i,j)$$

where, *in* and *out* are the input image and the filtered one, i and j are the pixel coordinates, μ_k and σ_k are the local mean and the local standard deviation, estimated on a kernel k centred in the (i,j)-pixel, S and M are the target standard deviation and the target mean, finally G_f is a maximum gain factor that prevents overly large output values and B is a background factor, allowing the choice between the target mean and the current local mean [1].
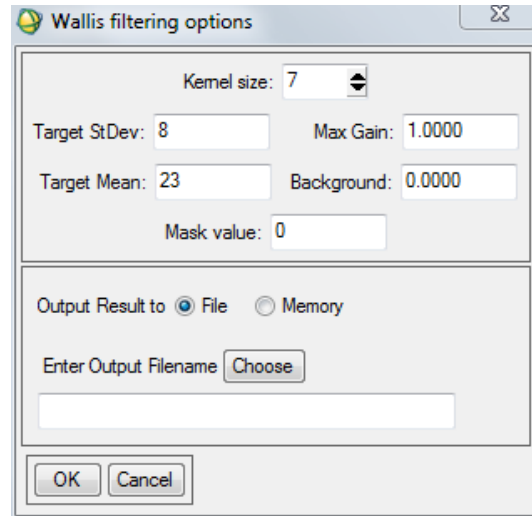

Figure 1: Parameter setting window.

Extension usage

The present extension can be run by clicking on the "Filter → Adaptive → Wallis" button, in the ENVI Classic menu, or by clicking "Wallis filter" in the "Extensions" toolbox, in the ENVI 5 Standard interface.

First of all, the user is requested to choose a single band of an opened image and it can optionally select a mask; then the parameter setting window is prompted (fig. 1).

The *Kernel size* parameter set the dimension of the squared neighbourhood used to compute the local statistics. This parameter must be an odd number varying between 3 and 51. As *Target StDev* and *Target Mean* values, the statistics for the whole image are suggested by de-

fault, but the user can modify them.

The *Maximum Gain* and the *Background* factors correspond to the G_f and B parameters of the Wallis filter equation. B must vary between 0 and 1, meaning a pure local or a pure target mean add-back. G_f must be a positive number. Some examples of different factor choices are shown in figure 2.

Finally, the *Mask value* field is enabled only if the user selected a mask. It sets the value to be assigned to the masked pixels.

The filtered image can be saved as an ENVI Standard file or be output to memory.

Calling from ENVI-IDL

The Wallis filtering procedure can also be called from an ENVI-IDL batch program, through the following procedure:

```
envi_apply_wallis_filter, $
  o_fid=variable, $
  dims=variable, pos=variable, $
  m_fid=variable, m_pos=variable, $
  r_fid=variable, /in_memory, $
  f_name=string, $
  kernel_size=integer, $
  target_std=double, $
  target_mean=double, $
  maximum_gain=double, $
  background_factor=double, $
  masked_value=variable
```

Keywords:

o_fid the input image fid;

dims a five elements vector, containing spatial dimensions of the input band;

pos a scalar integer designating the position of the selected band;

m_fid the fid of an optional mask band;

m_pos a scalar integer designating the position of the optional mask band;

r_fid the returned fid of the filtered image, or -1 in case of errors;

in_memory to specify that the output should be stored in memory;

f_name a string with the output file name;

kernel_size an integer value between 3 and 51, defining the dimension of the kernel by which computing the local statistics;

target_std the target standard deviation to be used in the filtering;

target_mean the target mean;

maximum_gain a positive real value;

background_factor a real value between 0 and 1;

masked_value if a mask is passed to the procedure, this optional keyword specifies the value to be assigned to the masked pixels.

References

[1] Pratt, W. K., *Digital Image Processing Fourth Ed.*, John Wiley & Sons, 2007.

[2] Wallis, R., *An approach to the space variant restoration and enhancement of images*, Symp. on current mathematical problems in image science, Monterey CA, 1976.

B = 0.0

B = 0.5

B = 1.0

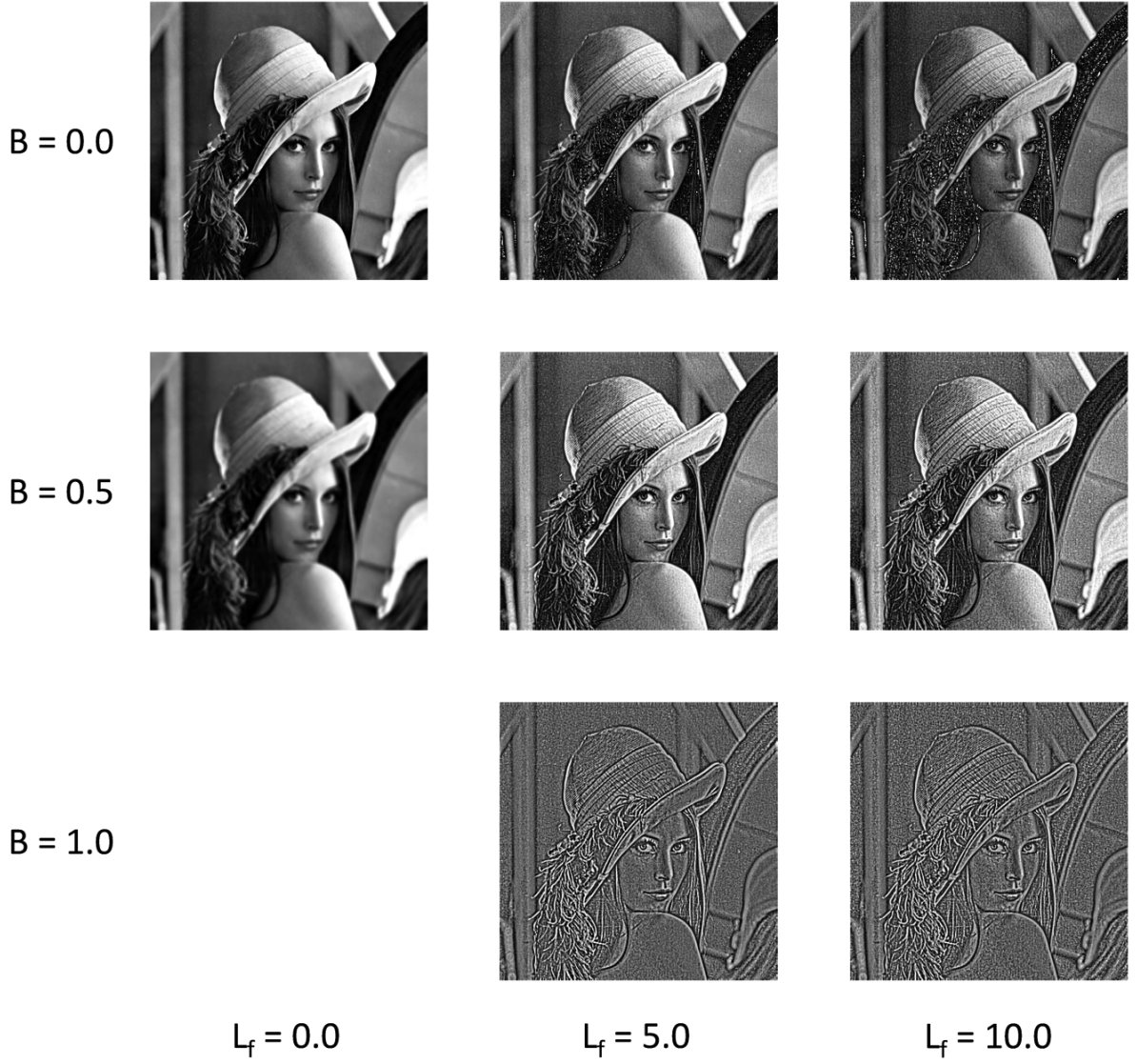L_f = 0.0 L_f = 5.0 L_f = 10.0

Figure 2: Examples of Wallis filter results with different parameter sets.