CENG 391 Introduction to Image Understanding

1 November, 2016

Homework 2

Due Date: 15 November 2016, 23:55

Programming Assignment — Bilateral Filter

Bilateral filter was introduced to smoooth images while preserving edges. Like Gaussian smoothing filters, each pixel is replaced by a weighted average of its neighbors. But unlike them, image content is taken into account. In Gaussian smoothing filters, the effect of a pixel on the other one only depends on the spatial distance between them. In addition to this, also the difference between intensity values determines the effect on a pixel in bilateral filter.

In Figure 1, filter that is represented by blue color is the filter for spatial differences and it is actually Gaussian smoothing filter. The other filter which is represented by green color, is the filter for intensity differences.

The bilateral filter is defined by the following formula: (taken from https://en.wikipedia.org/wiki/Bilateral_filter)

$I^{filtered}(x) = \frac{1}{W_p} \sum_{x_i \in \Omega} I(x_i) g_i(||I(x_i) - I(x))||) g_s(||x_i - x||)$

where W_p is the normalization term and defined as follows:

$W_p = g_i(||I(x_i) - I(x))||) g_s(||x_i - x||)$.

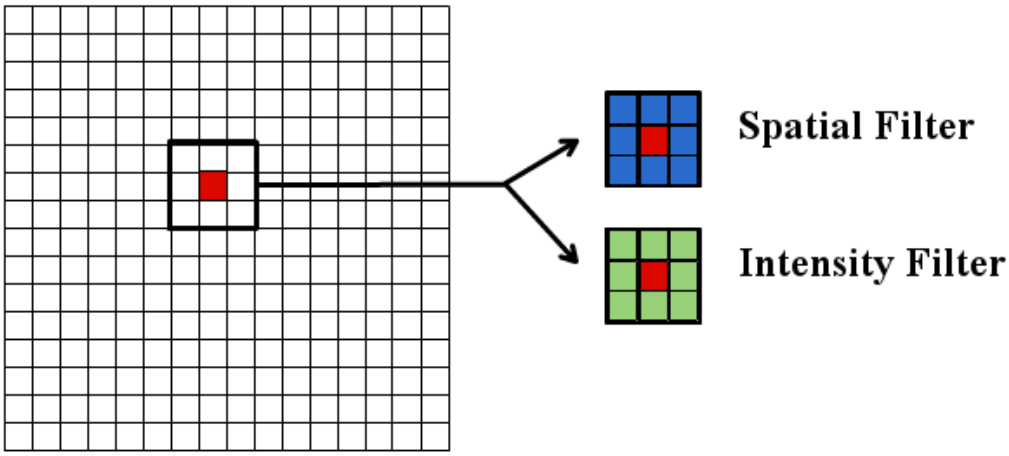

Figure 1: Bilateral filter representation.

Here;

- $I^{filtered}$ is the filtered image that is bilateral filter applied,
- I is the input image,
- x are the spatial coordinates of the pixel to be filtered,
- Ω is the window centered in x,
- g_i is the intensity kernel for smoothing differences in intensities.
- g_s is the spatial kernel for smoothing differences in coordinates.

Both g_i and g_s are Gaussian function which is shown in the below:

$G_\sigma(x)) = \frac{1}{2\pi\sigma^2} \exp -(\frac{x^2}{2\sigma^2}))$

You should define window with a size of **5x5** and there are two different sigma values and take them as $\sigma_i = 12.0$ and $\sigma_s = 16.0$:
σ_i: Sigma for the intensity kernel.
σ_s: Sigma for the spatial kernel.

In this assignment, you should read an image named as **"in_img.jpg"** as grayscale and implement bilateral filter on your own. For the given input image, you should have two outputs. One is the filtered image obtained by your own bilateral filter implementation and the other one is the filtered image after you apply OpenCV implementation(**"bilateralFilter()"**).

NOTE: Take window size 5x5, $\sigma_i = 12.0$, and $\sigma_s = 16.0$.

Besides, other required files, you should send two output images named as **"filtered_image_own.png"** and **"filtered_image_OpenCV.png"**.