R09945020 朱彥如

Homework 10

Implement 2 Laplacian Mask, Minimum Variance Laplacian, Laplacian of Gaussian, and Difference of Gaussian(inhibitory sigma=1, excitatory sigma=3, kernel size 11x11).
Please list the kernels and the thresholds(for zero crossing) you used.
Threshold Values listed below are for reference:

- Laplace Mask1 (0, 1, 0, 1, -4, 1, 0, 1, 0): 15
- Laplace Mask2 (1, 1, 1, 1, -8, 1, 1, 1, 1)
- Minimum variance Laplacian: 20
- Laplace of Gaussian: 3000
- Difference of Gaussian: 1

The requirements above are accomplished by Python with the help of matplotlib package, cv2 package, numpy package and math package. The input image is padded first for the out-of-range problem occurring when the the masks are applied on the boundary pixels.

I made the mask() function, whose inputs are are a 3D (RGB layers) image, a threshold value, and a kernel array. The formulas below are the core calculation of the function.

$$label[l,p] = \begin{cases} count = convolution(img[r:r', c:c'], kernel) \\ return\ 1,\ if\ count \geq threshold \\ return\ -1,\ if\ count \leq -threshold \\ return\ 0,\ otherwise \end{cases}$$

$$return\_img[l,p] = \begin{cases} return\ 0, \\ \quad if\ (label[l,p] = 1) \cap (\exists p = -1,\ s.t.\ p \in neighbors\ of\ label[l,p]) \\ return\ 1,\ otherwise \end{cases}$$

Laplace Mask1 (0, 1, 0, 1, -4, 1, 0, 1, 0): 15

To create the image with Laplace Mask1, I use mask() function function with the threshold value, 15 and the kernel array (0, 1, 0, 1, -4, 1, 0, 1, 0).

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

Laplace Mask2 (1, 1, 1, 1, -8, 1, 1, 1, 1): 15

To create the image with Laplace Mask1, I use mask() function function with the threshold value, 15 and the kernel array (1, 1, 1, 1, -8, 1, 1, 1, 1).

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & -8 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

R09945020 朱彥如

Minimum-variance Laplacian: 20

To create the image with Laplace Mask2, I use mask() function function with the threshold value, 20 and the kernel array shown below.

$$\frac{1}{3}\begin{bmatrix} 2 & -1 & 2 \\ -1 & -4 & -1 \\ 2 & -1 & 2 \end{bmatrix}$$

Laplace of Gaussian: 3000

To create the image with Laplace of Gaussian, I use mask() function function with the threshold value, 3000 and the kernel array shown below.

$$\begin{bmatrix} 0 & 0 & 0 & -1 & -1 & -2 & -1 & -1 & 0 & 0 & 0 \\ 0 & 0 & -2 & -4 & -8 & -9 & -8 & -4 & -2 & 0 & 0 \\ 0 & -2 & -7 & -15 & -22 & -23 & -22 & -15 & -7 & -2 & 0 \\ -1 & -4 & -15 & -24 & -14 & -1 & -14 & -24 & -15 & -4 & -1 \\ -1 & -8 & -22 & -14 & 52 & 103 & 52 & -14 & -22 & -8 & -1 \\ -2 & -9 & -23 & -1 & 103 & 178 & 103 & -1 & -23 & -9 & -2 \\ -1 & -8 & -22 & -14 & 52 & 103 & 52 & -14 & -22 & -8 & -1 \\ -1 & -4 & -15 & -24 & -14 & -1 & -14 & -24 & -15 & -4 & -1 \\ 0 & -2 & -7 & -15 & -22 & -23 & -22 & -15 & -7 & -2 & 0 \\ 0 & 0 & -2 & -4 & -8 & -9 & -8 & -4 & -2 & 0 & 0 \\ 0 & 0 & 0 & -1 & -1 & -2 & -1 & -1 & 0 & 0 & 0 \end{bmatrix}$$

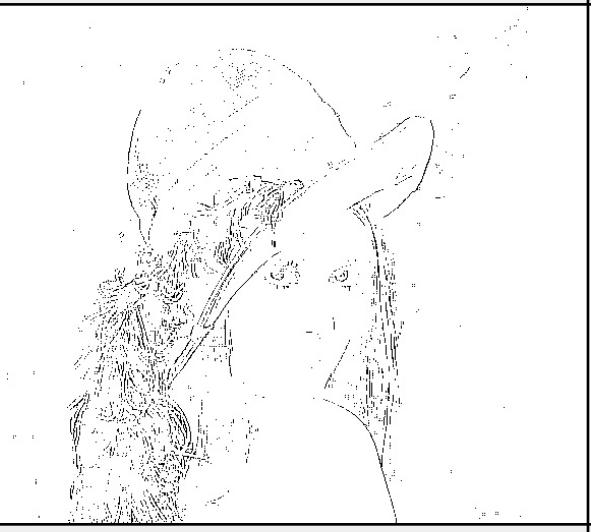
Difference of Gaussian: 1

To create the image with Difference of Gaussian, I use mask() function function with the threshold value, 1 and the kernel array shown below.

$$\begin{bmatrix} -1 & -3 & -4 & -6 & -7 & -8 & -7 & -6 & -4 & -3 & -1 \\ -3 & -5 & -8 & -11 & -13 & -13 & -13 & -11 & -8 & -5 & -3 \\ -4 & -8 & -12 & -16 & -17 & -17 & -17 & -16 & -12 & -8 & -4 \\ -6 & -11 & -16 & -16 & 0 & 15 & 0 & -16 & -16 & -11 & -6 \\ -7 & -13 & -17 & 0 & 85 & 160 & 85 & 0 & -17 & -13 & -7 \\ -8 & -13 & -17 & 15 & 160 & 283 & 160 & 15 & -17 & -13 & -8 \\ -7 & -13 & -17 & 0 & 85 & 160 & 85 & 0 & -17 & -13 & -7 \\ -6 & -11 & -16 & -16 & 0 & 15 & 0 & -16 & -16 & -11 & -6 \\ -4 & -8 & -12 & -16 & -17 & -17 & -17 & -16 & -12 & -8 & -4 \\ -3 & -5 & -8 & -11 & -13 & -13 & -13 & -11 & -8 & -5 & -3 \\ -1 & -3 & -4 & -6 & -7 & -8 & -7 & -6 & -4 & -3 & -1 \end{bmatrix}$$

R09945020 朱彥如

Results

	
Laplace Mask1 (0, 1, 0, 1, -4, 1, 0, 1, 0): 15	**Laplace Mask2 (1, 1, 1, 1, -8, 1, 1, 1, 1): 15**
	
Minimum-variance Laplacian: 20	**Laplace of Gaussian: 3000**
	
Difference of Gaussian: 1	