



EIE4512 - Digital Image Processing

Week 3 Tutorial

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Content

1. linear spatial filtering
2. non-linear spatial filtering
3. average smoothing VS gaussian smoothing
4. laplacian VS gradient
5. small task: implement one spatial filter by yourself



1. linear spatial filtering

- ▶ Correlation
 - ▶ Correlation is the process of moving a filter mask over the image and computing the sum of products at each location
- ▶ Convolution
 - ▶ Similar to correlation except that the mask is first flipped both horizontally and vertically.
 - ▶ If filter is symmetric, then convolution is equivalent to correlation!

https:

`//www.mathworks.cn/help/images/ref/imfilter.html`

		Padded f		
		0 0 0 0 0 0 0 0 0 0		
		0 0 0 0 0 0 0 0 0 0		
		0 0 0 0 0 0 0 0 0 0		
Origin	$f(x, y)$	0 0 0 0 0 0 0 0 0 0		
0 0 0 0 0 0		0 0 0 0 0 1 0 0 0 0		
0 0 0 0 0 0	$w(x, y)$	0 0 0 0 0 0 0 0 0 0		
0 0 1 0 0 0	1 2 3	0 0 0 0 0 0 0 0 0 0		
0 0 0 0 0 0	4 5 6	0 0 0 0 0 0 0 0 0 0		
0 0 0 0 0 0	7 8 9	0 0 0 0 0 0 0 0 0 0		
(a)	(b)			
Initial position for w	Full correlation result	Cropped correlation result		
[1 2 3]	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0		
[4 5 6]	0 0 0 0 0 0 0 0 0 0	0 9 8 7 0		
[7 8 9]	0 0 0 0 0 0 0 0 0 0	0 6 5 4 0		
0 0 0 0 0 0 0 0 0 0	0 0 0 9 8 7 0 0 0 0	0 3 2 1 0		
0 0 0 0 0 1 0 0 0 0	0 0 0 6 5 4 0 0 0 0	0 0 0 0 0 0		
0 0 0 0 0 0 0 0 0 0	0 0 0 3 2 1 0 0 0 0			
0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0			
0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0			
0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0			
(c)	(d)	(e)		
Rotated w	Full convolution result	Cropped convolution result		
[9 8 7]	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0		
[6 5 4]	0 0 0 0 0 0 0 0 0 0	0 1 2 3 0		
[3 2 1]	0 0 0 0 0 0 0 0 0 0	0 4 5 6 0		
0 0 0 0 0 0 0 0 0 0	0 0 0 1 2 3 0 0 0 0	0 7 8 9 0		
0 0 0 0 0 1 0 0 0 0	0 0 0 4 5 6 0 0 0 0	0 0 0 0 0 0		
0 0 0 0 0 0 0 0 0 0	0 0 0 7 8 9 0 0 0 0			
0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0			
0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0			
0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0			
(f)	(g)	(h)		

2. non-linear spatial filtering

- ▶ Order-statistic filter
 - ▶ based on ordering (ranking) the pixels contained in the image area encompassed by the filter, and then replacing the value of the center pixel with the value determined by the ranking result.
 - ▶ median filter is the best-known filter in this category.
- ▶ MATLAB API: <https://ww2.mathworks.cn/help/images/ref/medfilt2.html>

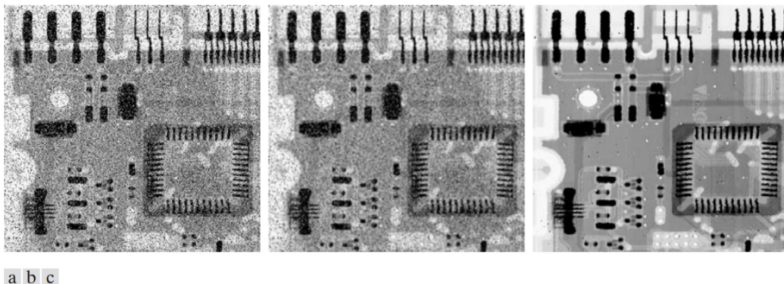


FIGURE 3.35 (a) X-ray image of circuit board corrupted by salt-and-pepper noise. (b) Noise reduction with a 3×3 averaging mask. (c) Noise reduction with a 3×3 median filter. (Original image courtesy of Mr. Joseph E. Pascente, Lixi, Inc.)



3. average smoothing VS gaussian smoothing



Averaging



Gaussian

4. laplacian VS gradient



Laplacian



Sobel



5. small practise: implement one spatial filter by yourself

practise detail:

- ▶ step 1. generate a 15×15 average filter mask
- ▶ step 2. use filter mask to finish spatial filtering
- ▶ step 3. implement binary thresholding

You can use MATLAB or Python.

15 x 15 averaging

image thresholding

