Filtragem Espacial (parte 1)

ES235 - Aula 04

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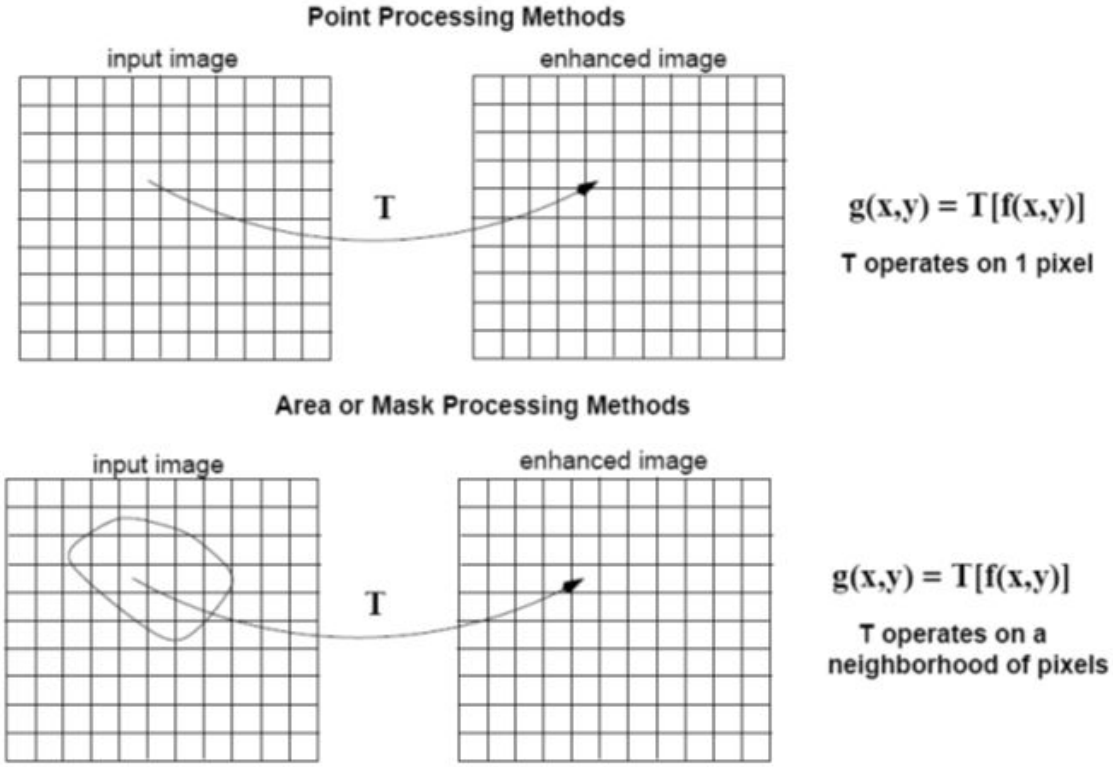
Problemas Comuns em Imagens

- Pouco contraste devido à falta de iluminação ou dispositivo de captura
- Ruído do sensor de captura
- Efeitos de serrilhamento (aliasing) devido à amostragem inadequada
- Borramento devido a movimentos

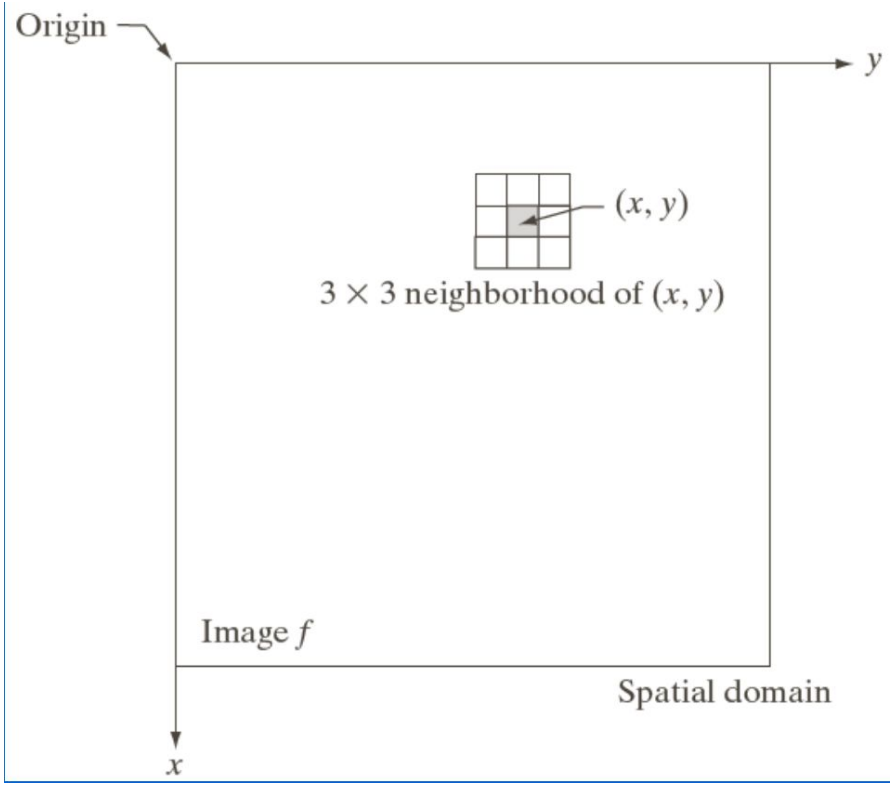
Definição

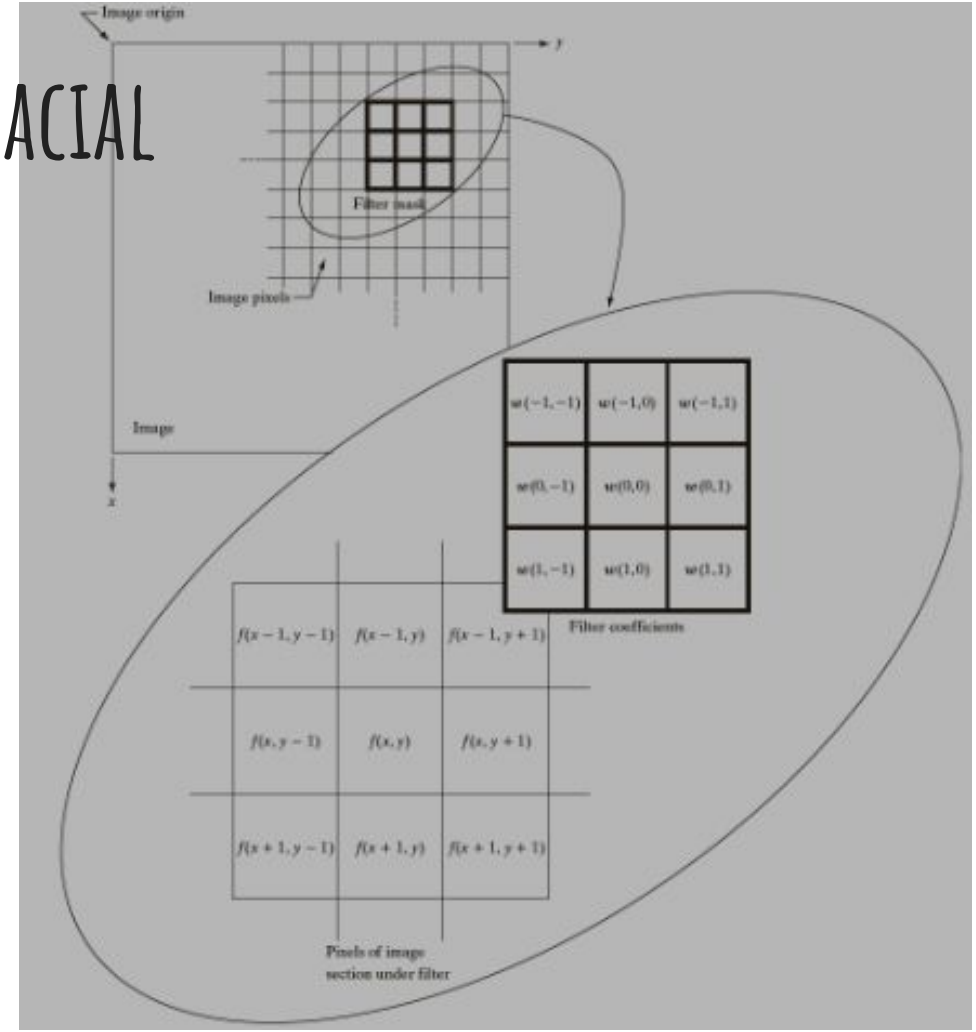
- Filtragem é o processo de substituição de um pixel por outro valor com base em alguma operação ou função.
- As operações ou funções aplicadas na imagem original podem ser chamadas de filtros, máscaras, kernels, templates, janelas…
- A filtragem espacial manipula diretamente os pixels no plano da imagem.

Filtragem no Domínio Espacial

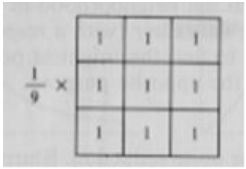


Filtragem no Domínio Espacial





Filtragem no Domínio Espacial

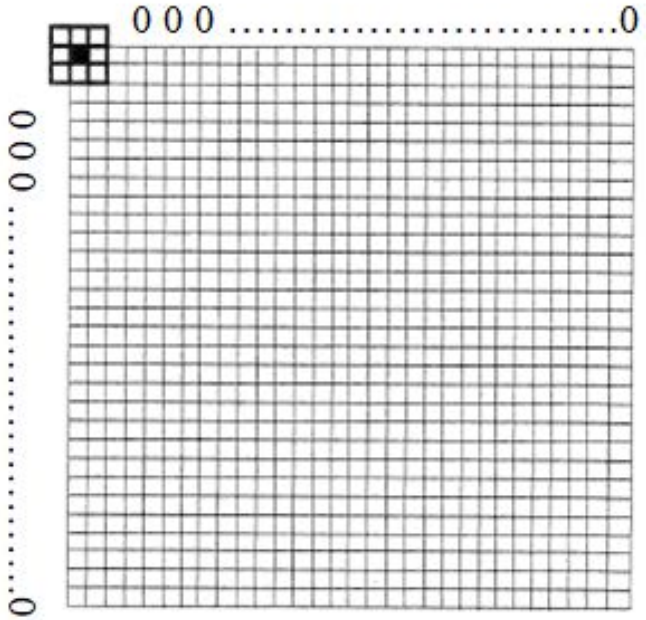


0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	90	90	90	90	90	0	0
0	0	0	90	90	90	90	90	0	0
0	0	0	90	90	90	90	90	0	0
0	0	0	90	0	90	90	90	0	0
0	0	0	90	90	90	90	90	0	0
0	0	0	0	0	0	0	0	0	0
0	0	90	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

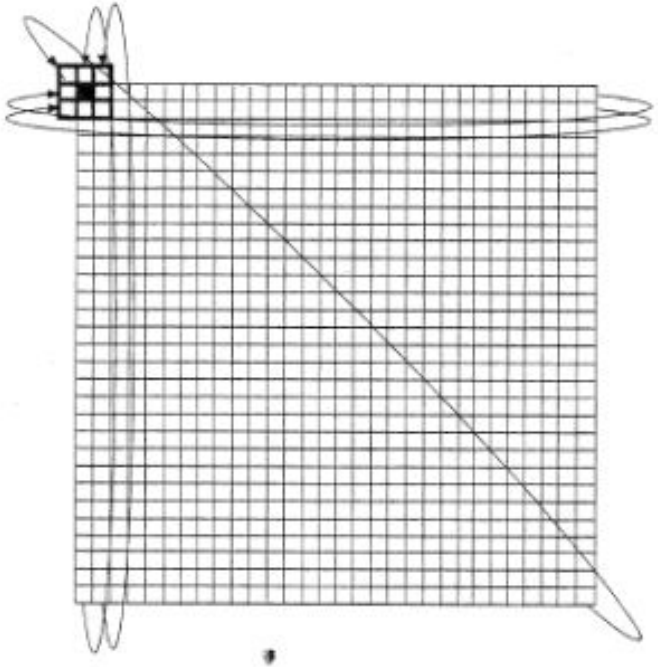
	0	10	20	30	30	30	20	10	
	0	20	40	60	60	60	40	20	
	0	30	60	90	90	90	60	30	
	0	30	50	80	80	90	60	30	
	0	30	50	80	80	90	60	30	
	0	20	30	50	50	60	40	20	
	10	20	30	30	30	30	20	10	
	10	10	10	0	0	0	0	0	

Filtragem no Domínio Espacial

Completar com zeros



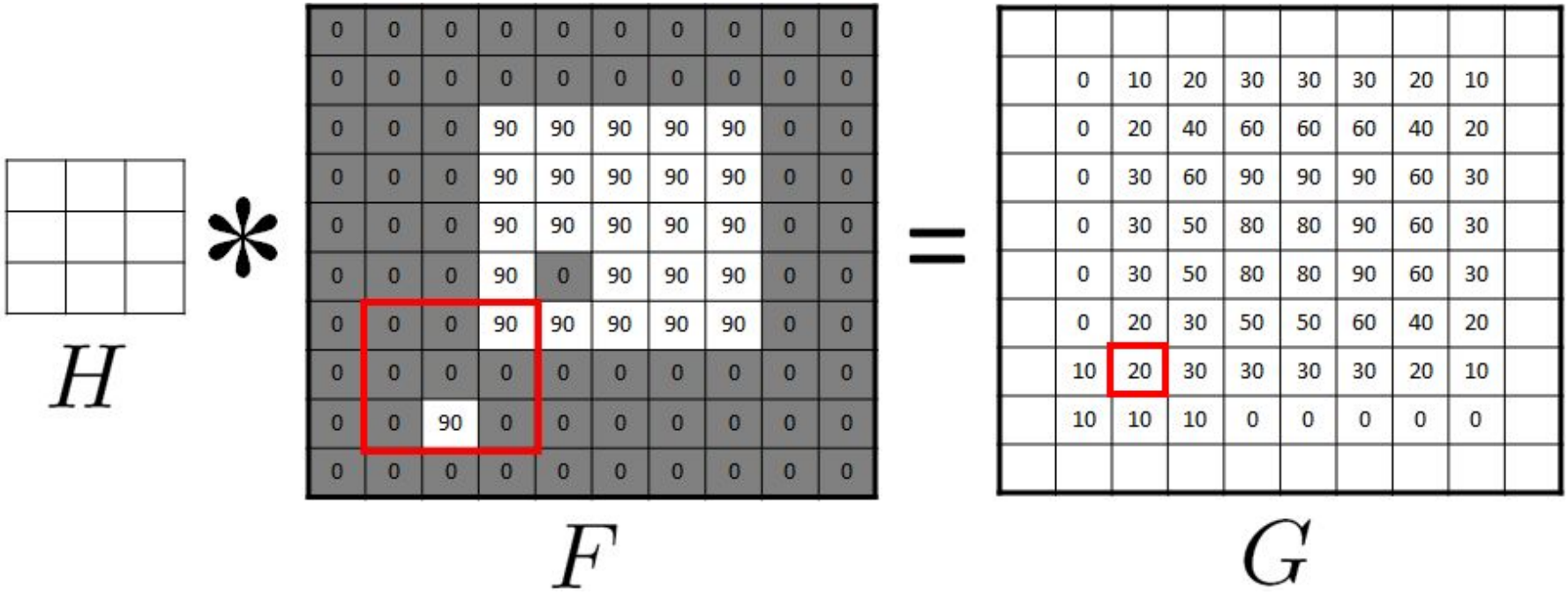
Acesso circular



Aplicações

- Enhancement: melhora contraste
- Smoothing: remove ruído
  - Salt and pepper (pixels brancos e pretos)
  - Impulse noise (ocorrências aleatórias de pixels brancos)
  - Gaussian noise (ocorrências aleatórias mas a intensidade vem de uma distribuição gaussiana)
- Template matching: detecta padrões conhecidos

Filtro de Média



Filtro de Média

Original

$$*\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} =$$

Identical image

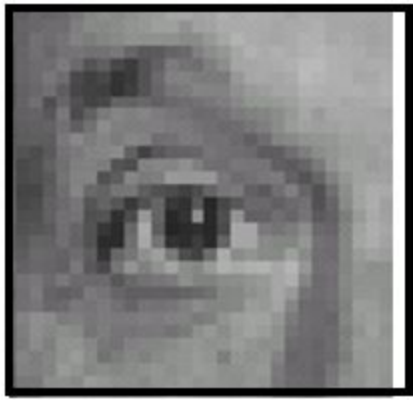
Filtro de Média

Original

$*$

0	0	0
1	0	0
0	0	0

$=$

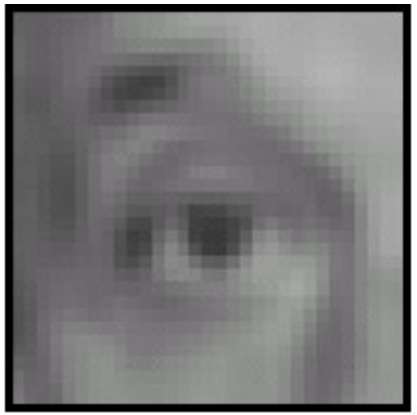


Shifted left
By 1 pixel

Filtro de Média

Original

$$* \quad \frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} =$$



Blur (with a mean filter)

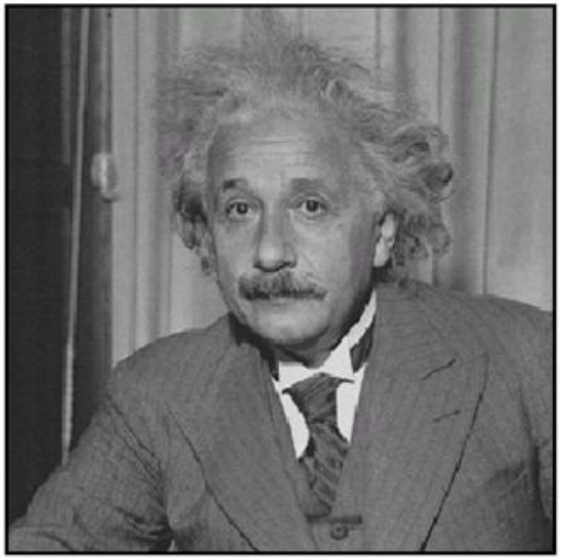
Filtro de Média

Original

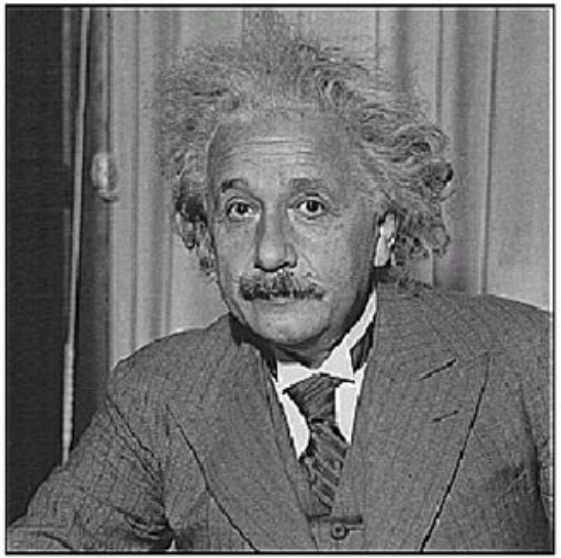
$$* \left(\begin{bmatrix} 0 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 0 \end{bmatrix} - \frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \right) =$$

Sharpening filter
(accentuates edges)

Sharpening Filter



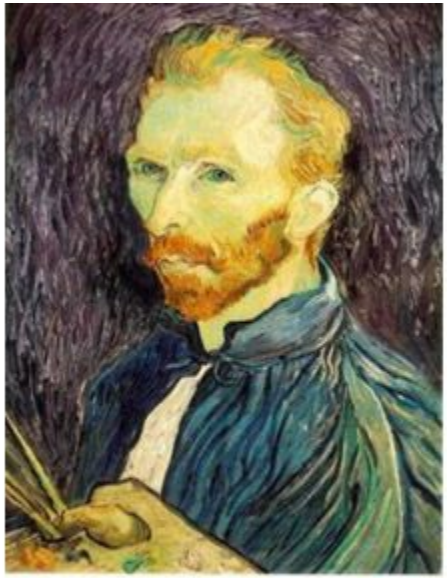
before



after

Filtro Gaussiano

=

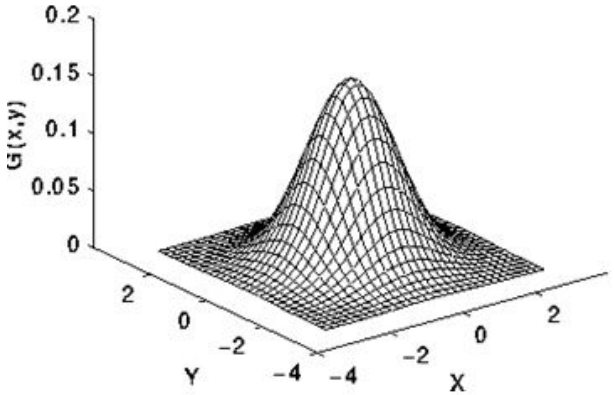


$\otimes$ $G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$

Filtered image | Input image | Filter function

Filtro Gaussiano

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

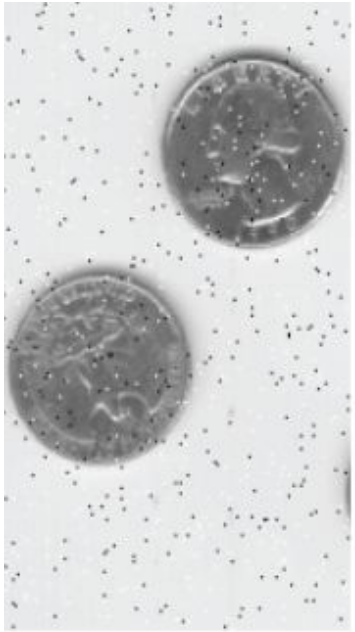


$$\frac{1}{273}$$

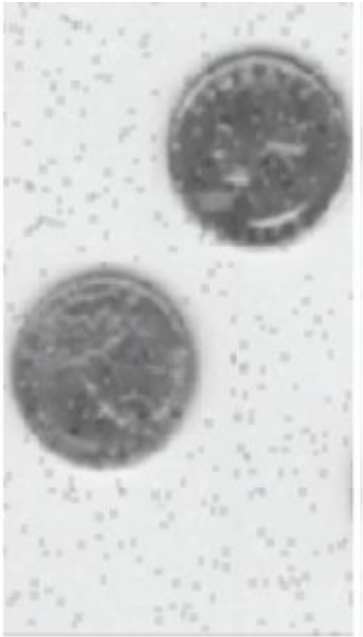
1	4	7	4	1
4	16	26	16	4
7	26	41	26	7
4	16	26	16	4
1	4	7	4	1

Discrete approximation to Gaussian function with $\sigma = 1.0$

Filtro Gaussiano



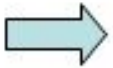
input



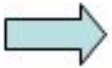
Gaussian filter

Filtro de Mediana

	97	103	83	82	81	
	98	103	105	108	97	
	99	255	102	101	95	
	101	103	107	255	93	
	93	101	112	108	107	

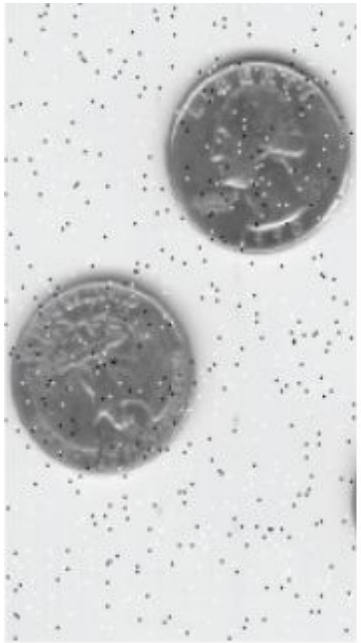


101
102
103
103
105
107
108
255
255

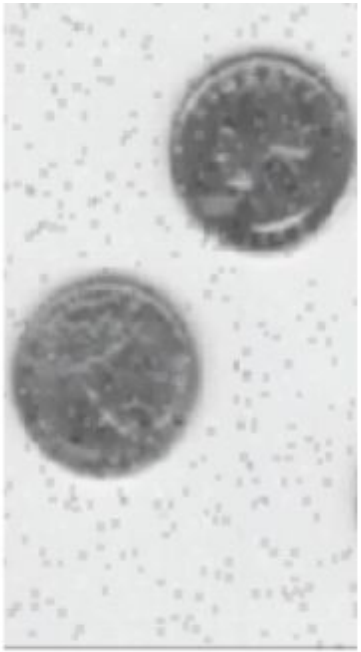


	97	103	83	82	81	
	98	103	105	108	97	
	99	255	105	101	95	
	101	103	107	255	93	
	93	101	112	108	107	

Filtro de Mediana



input



Gaussian filter

Median filter

Filtro de Mediana

input

Median 7X7

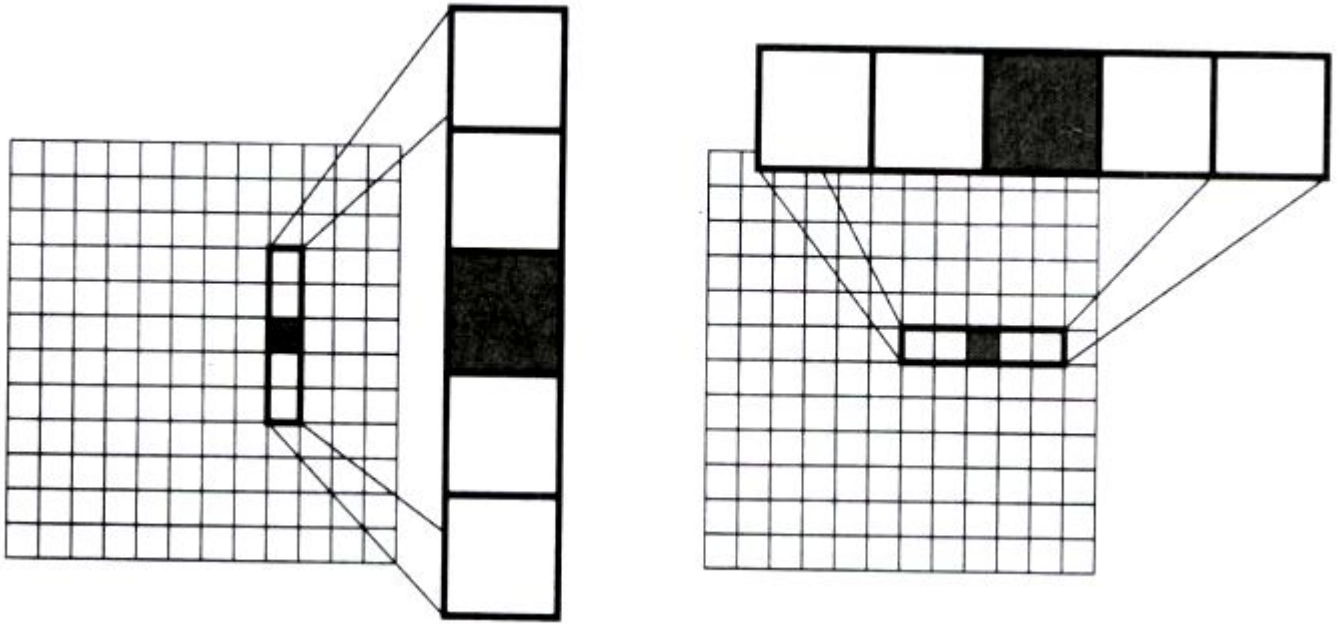
Comparação entre Filtro de Média, Mediana e Gaussiano

- Mean: blurs image, removes simple noise, no details are preserved

- Gaussian: blurs image, preserves details only for small σ.

- Median: preserves some details, good at removing strong noise

Filtros Separáveis



Filtros Separáveis

Filtering with a 2D Gaussian can be implemented using two 1D Gaussian horizontal filters as follows:

- first filter with an 1D Gaussian
- take the transpose of the result
- convolve again with the same filter
- transpose the result

Filtering with two 1D Gausians is faster !!

REFERÊNCIAS

Rafael C. Gonzalez and Richard E. Woods. 2006. Digital Image Processing (3rd Edition). Prentice-Hall, Inc., Upper Saddle River, NJ, USA.

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http://www.eee.bham.ac.uk/spannm/Teaching%20docs/Computer%20Vision%20Course/Image%20Enhancement%20and%20Filtering.ppt