Filtragem Espacial (parte 2)

ES235 - Aula 05
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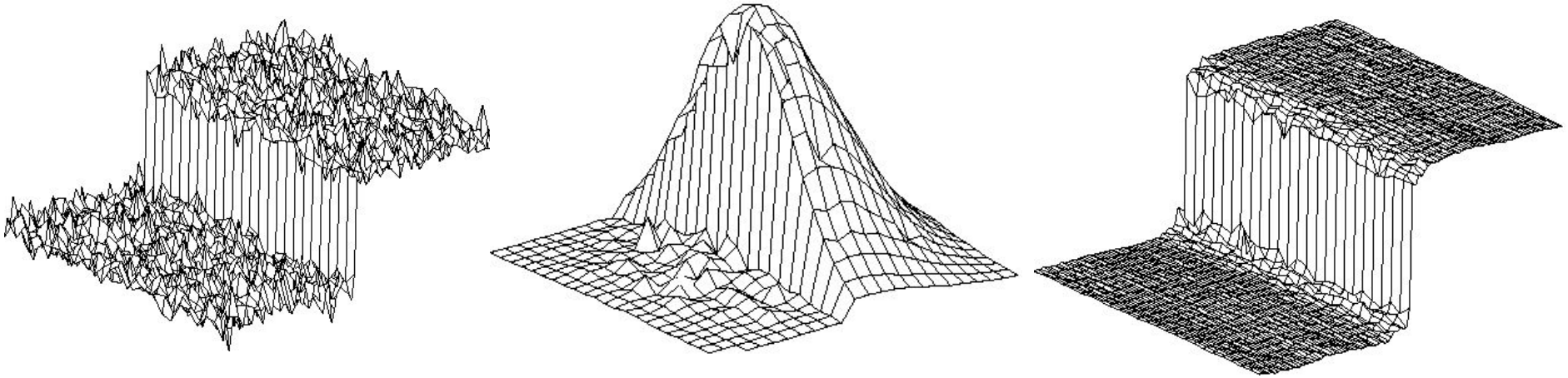
Bilateral Filter

- Ideia: suavizar a imagem mantendo informação de bordas
- Pixels próximos != pixels semelhantes
- O pixel é substituído por uma média dos pixels semelhantes



Bilateral Filter

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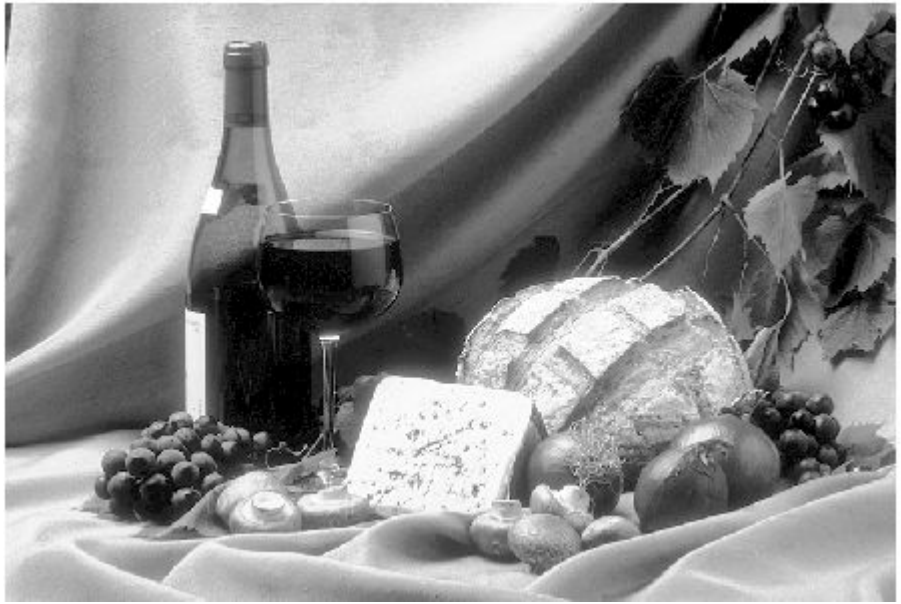
Bilateral Filter

- 


Bilateral Filter

Bilateral Filter

Box Filter

- Suaviza a imagem usando o seguinte kernel:

$$K = \alpha \begin{bmatrix} 1 & 1 & 1 & \cdots & 1 & 1 \\ 1 & 1 & 1 & \cdots & 1 & 1 \\ & & \cdots\cdots\cdots & & & \\ 1 & 1 & 1 & \cdots & 1 & 1 \end{bmatrix}$$

$$\alpha = \begin{cases} \frac{1}{\texttt{ksize.width*ksize.height}} & \text{when } \texttt{normalize=true} \\ 1 & \text{otherwise} \end{cases}$$

Imagens Integrais

- Mais comum:

$$\mathrm{sum}(X,Y) = \sum_{x<X,y<Y} \mathrm{image}(x,y)$$

- Outras opções:

$$\mathrm{sqsum}(X,Y) = \sum_{x<X,y<Y} \mathrm{image}(x,y)^2 \quad \mathrm{tilted}(X,Y) = \sum_{y<Y,\mathrm{abs}(x-X+1)\leq Y-y-1} \mathrm{image}(x,y)$$

Imagens Integrais

- Utilizado para otimizar box filtering de tamanho grande
- Para um kernel 10x10, realiza 4 acessos à memória por pixel ao invés de 100

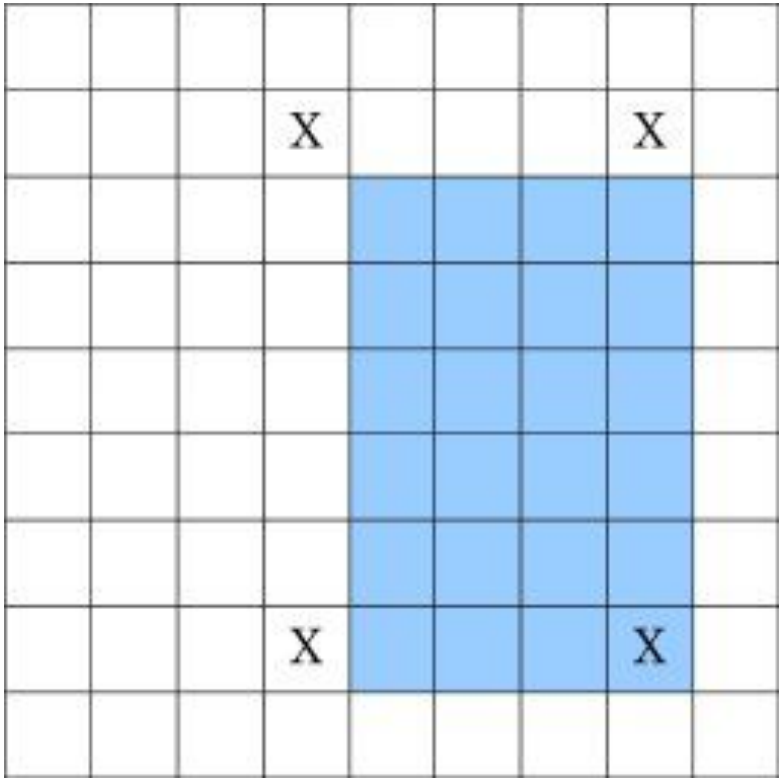
1	2	2	4	1
3	4	1	5	2
2	3	3	2	4
4	1	5	4	6
6	3	2	1	3

input image

0	0	0	0	0	0
0	1	3	5	9	10
0	4	10	13	22	25
0	6	15	21	32	39
0	10	20	31	46	59
0	16	29	42	58	74

integral image

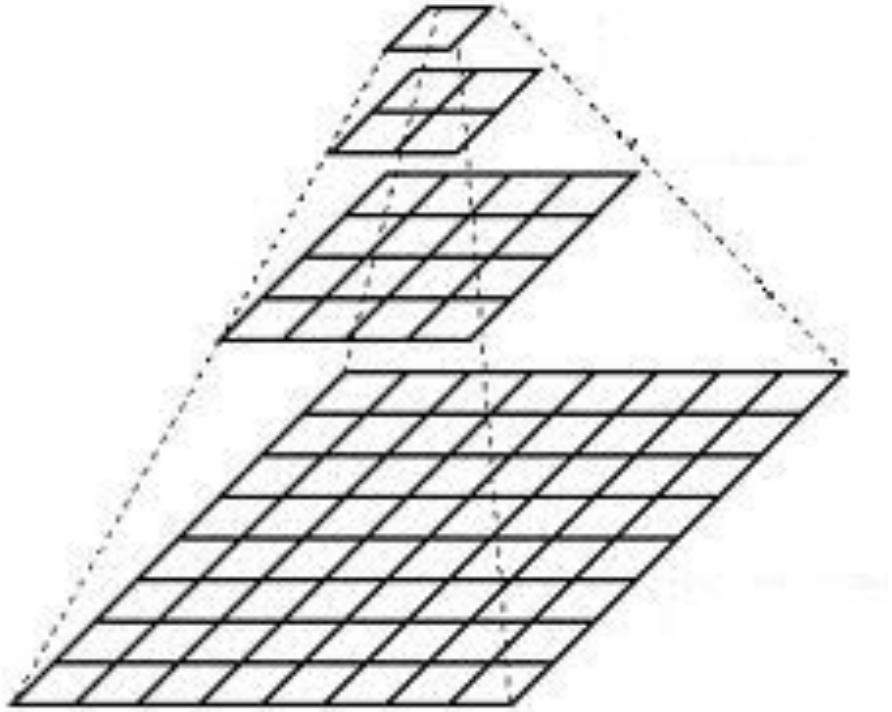
Imagens Integrais



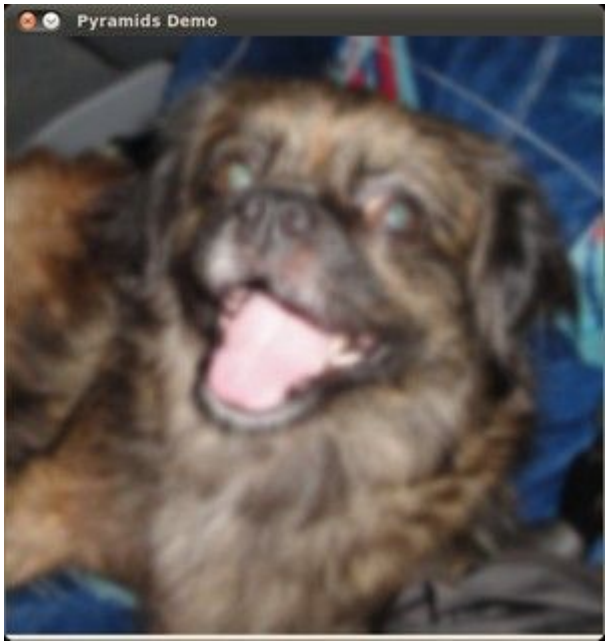
Pirâmides de Imagens

- Resolução varia de acordo com nível da pirâmide
- Exemplo de kernel gaussiano utilizado:

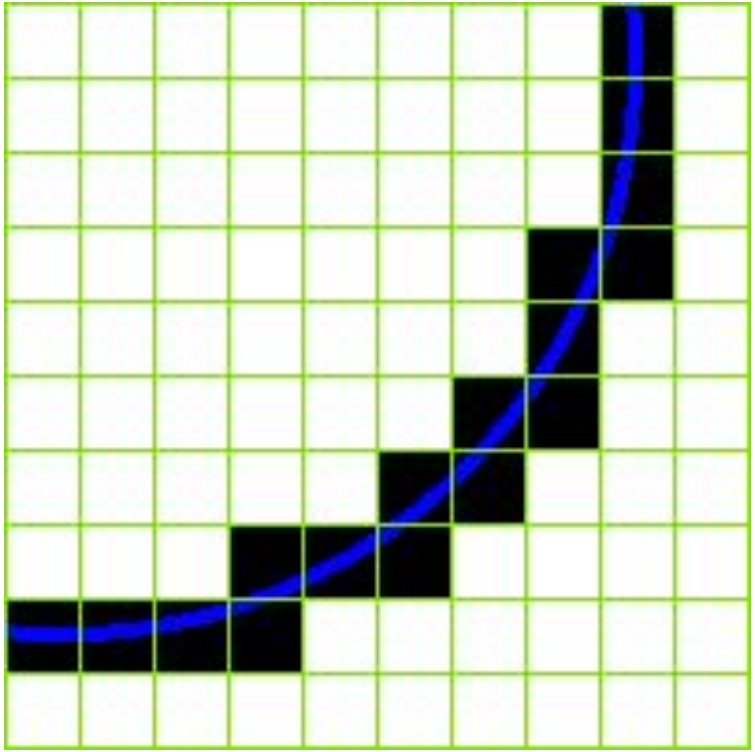
$$\frac{1}{16}\begin{bmatrix} 1 & 4 & 6 & 4 & 1 \\ 4 & 16 & 24 & 16 & 4 \\ 6 & 24 & 36 & 24 & 6 \\ 4 & 16 & 24 & 16 & 4 \\ 1 & 4 & 6 & 4 & 1 \end{bmatrix}$$

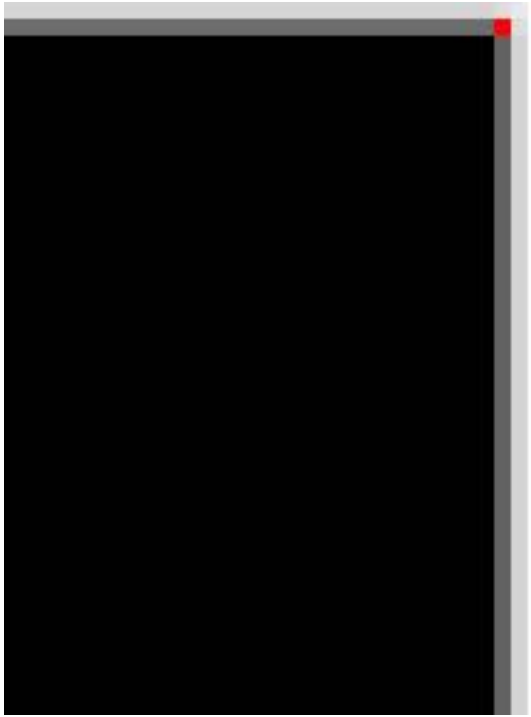


Pirâmides de Imagens



Precisão a Nível de Sub Pixel





REFERÊNCIAS

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

http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/MANDUCHI1/Bilateral_Filtering.html

https://docs.opencv.org/3.0-beta/modules/imgproc/doc/filtering.html

https://docs.opencv.org/2.4.13.7/doc/tutorials/imgproc/pyramids/pyramids.html

https://en.wikipedia.org/wiki/Sub-pixel_resolution