**Computer Vision Notes**

*Created: 2024-09-06*

*Updated: 2024-09-07*

References:

* Introduction to Image Understanding course at the University of Toronto

**Linear Filters** (TODO: Tb ch 3.2)

***Digital Image***: a map or a matrix of integer intensity values , is in a grayscale image, in a color image.

Problem: want to locate object in image.

Solution: slide and compare the image of the object.

Problem: noise in image.

Solution: modify pixel by applying function on a neighborhood of pixels e.g., average neighbors (assumes neighbors similar, noise independent) using moving average with (non-)uniform weights.

***Correlation*** (cv2.filter2D, 2D moving average with (non-)uniform weights): Given input , where

where size of the weight **kernel/mask** is and its entries are **filter coefficients**.

where .

Let where , then

***Normalized Cross-Correlation***: exact match of image crop and filter results in 1.

**Types of Filters**

Sharpening Filter:

Gaussian Filter: smooth/blur, reduce noise, neighbors closest to a center have the most influence.

Generic Gaussian Filter: anisotropic (asymmetric), .

**Effect of Size of Filter and Variance**

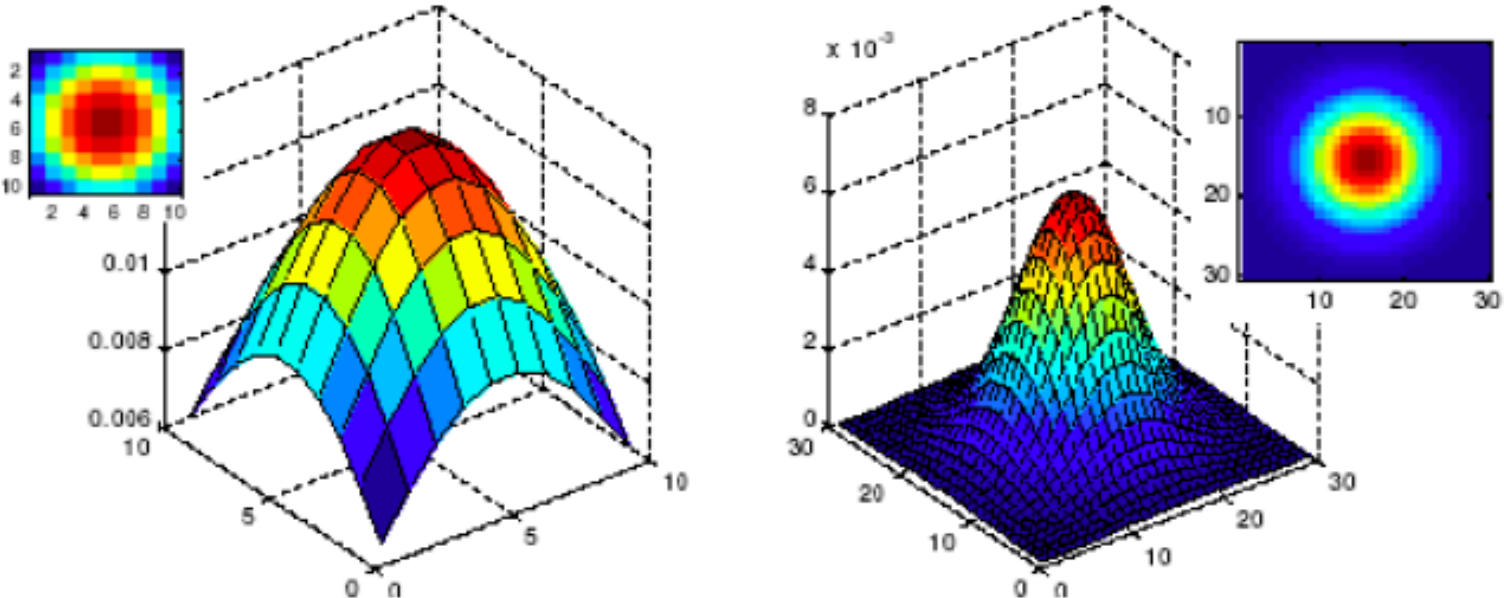


Figure: same different filter/mask/kernel size 10x10 vs 30x30.

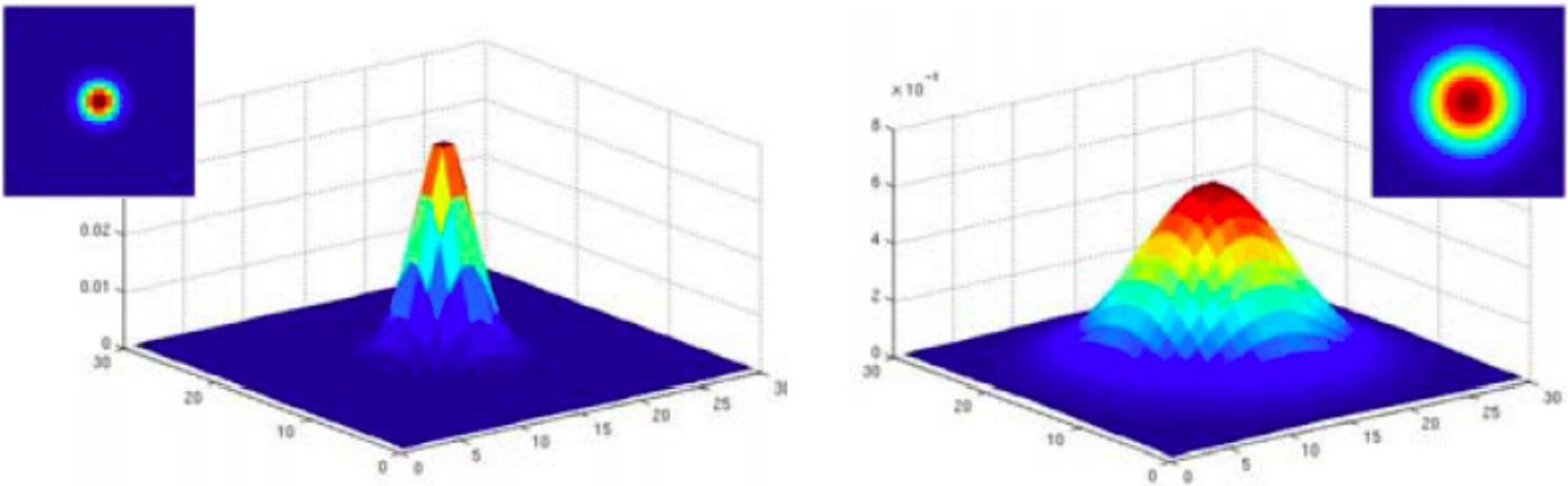


Figure: same size 30x30, (left) (right), larger is more smoothing.

**Properties of Smoothing**

* All values positive
* Sum to 1; prevents rescaling image
* Low-pass filter; removes high frequency (rate of change in pixel intensity values) components which include edges.

***Convolution***: operator that flips filter horizontally and vertically then applies correlation. Given input , where

**Properties of Convolution**

|  |  |
| --- | --- |
| Commutative |  |
| Associative |  |
| Distributive |  |
| Associative with scalar multiplier |  |
| Convolution Theorem ( is Fourier Transform) |  |

**Implications of Convolution Theorem**

Method 1: convolution runs in .

Method 2: FFT and IFFT run in and mult in .

**Separable Filters**

[TODO]