**Lecture 4: Region**

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- Spatial Filtering

Spatial filtering is performed for each pixel (i,j) using neighborhoods of (i,j). I(i,j) is input image, O(i,j) is output image and w(s,t) is filtering kernel. And the filtering operation is defined according to what kind of w(s,t) is used. In the spatial filtering, w is manually defined but in cnn w is learned from data. It is the point that those are different. I is in range 0~255 and O has same range. Therefore, w should be normalized weight that the sum of w is almost 1.

- Convolution

When the filtering kernel is symmetric, i.e. h[i] = h[-i] , Filter is same as the Convolution.

- 2D image filtering

Uniform mean filter is the simplest low-pass filter. W is 1/9 in 3x3 window. At first, mirroring or zero padding at an image boundary. And then adjusting filter kernel. The result image would be blurry. Also, uniform mean filtering is separable.

For one point, some points close to the point are more important than the others that far away from the point. Uniform doesn’t care about that. Therefore, Gaussian Filter has meaning. And Gaussian Filtering is separable filter. It can reduce the amount of computing multiplication.

Sobel filter is based on the first order gradient. And Laplacian filter use 2d derivative.

Max, Min and Median filter belong in nonlinear filter.

-Frequency : Low- and High-pass Filters

It means how often do intensity values in neighborhoods. Uniform average filter and Gaussian filter are in loss-pass filter. Sobel filter and Laplacian filter are in High-pass filter. And High-pass filter’s w summation are usually 0.

-Unsharp Masking

It makes an image look sharper by boosting high-frequency components. Output is (I-kL)(1-k), k is scale less than 1 and L is (low-pass filter \* I).