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Pattern Recognition & Computer Vision

1) Give an example of a separable filter and explain the primary advantages of using them.

A Sobel Filter, which is used for edge detection, is a type of separable filter. A separable filter's primary advantage is efficiency. Separable filters reduce the number of computations because instead of doing 2D convolutions, it breaks down into two 1D convolutions.

2) What does it mean if a filter is an edge-preserving filter? Give an example of one.

If a filter is edge preserving, it means that it performs the filtering (whether it be blurring or smoothing or something else), while maintaining the edges. A bilateral filter is a filter that smooths while keeping the edges sharp.

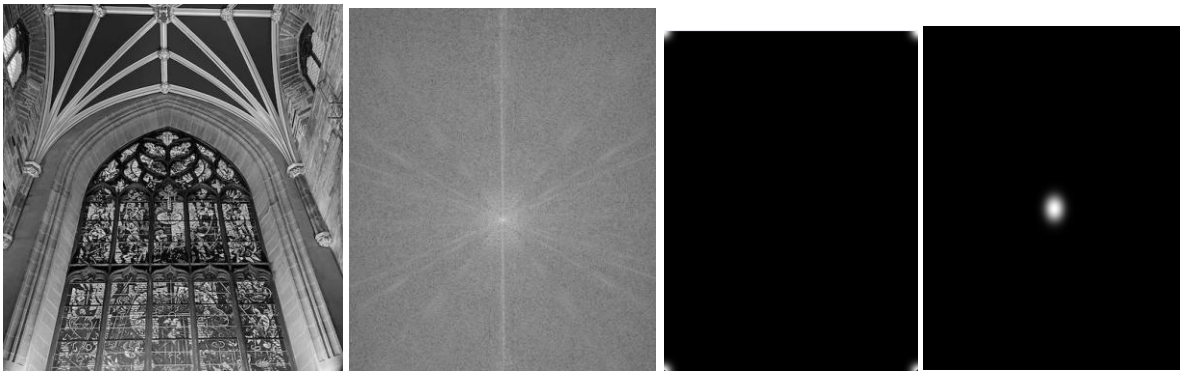
https://people.csail.mit.edu/sparis/publi/2009/fntcgv/Paris_09_Bilateral_filtering.pdf

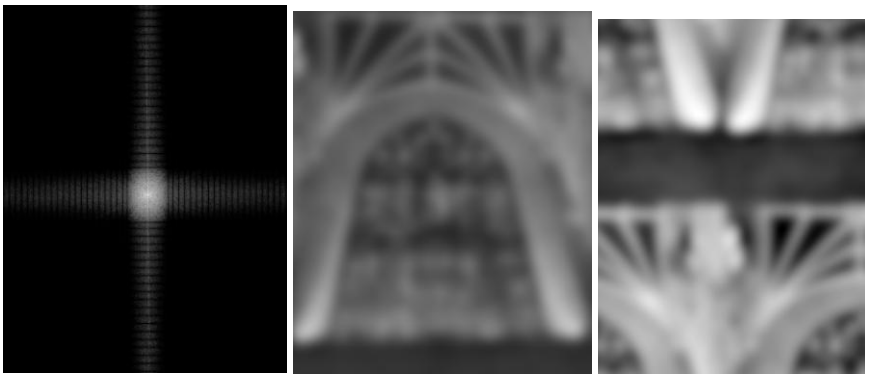
3) A Gaussian filter is a low-pass filter. Explain what that means by visualizing the Fourier Transform of the image after multiplying it by a Gaussian in the Fourier domain (look at the demo from class). What is being "passed" through a low-pass filter?

A low pass filter lets the low frequencies through and blocks the high frequencies. In the case of a Gaussian filter, the low frequencies are the gradual changes in the image.

Visualizing the Fourier Transform of the image after multiplying it by a Gaussian in the Fourier domain:

Original image->DFT, Gauss Filter->Gauss DFT -> Product FFT, filter real (image after gaussian and removing high frequency noise), filtered real ft (frequency components of the image after Gaussian is applied)

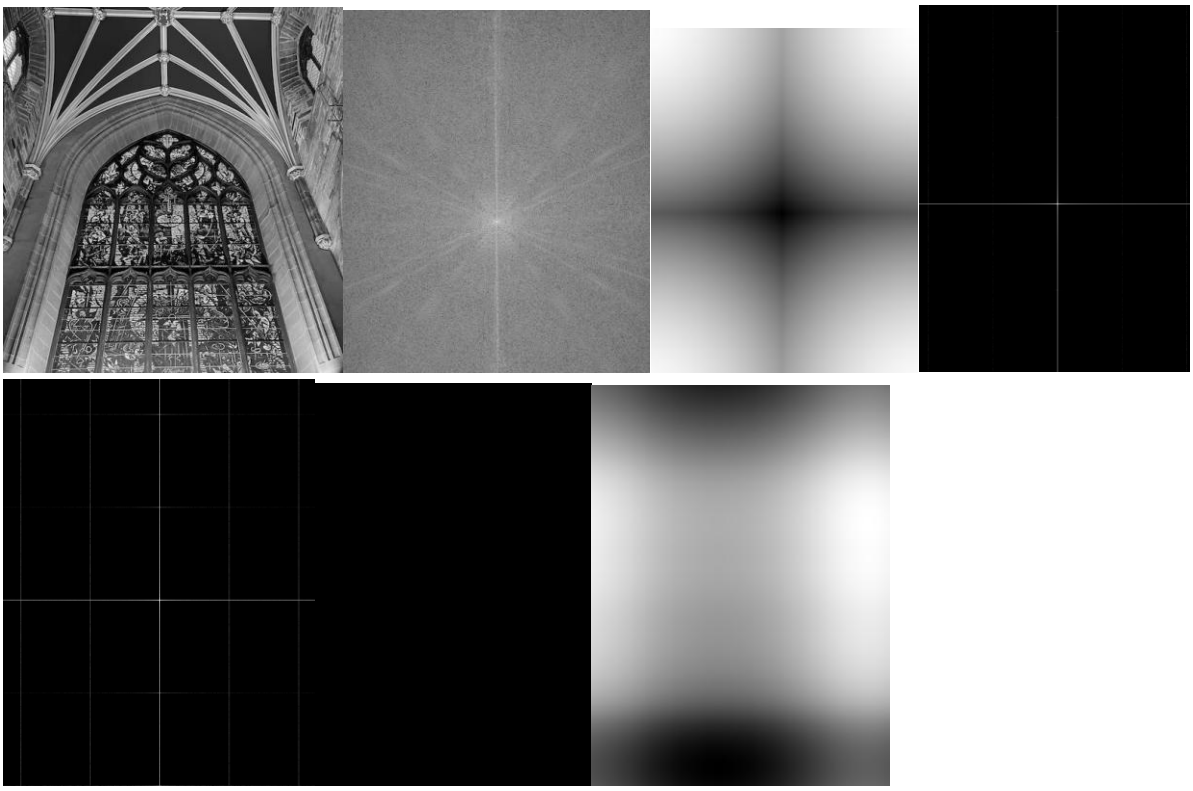




4) A Sobel filter or a Laplacian filter are high-pass filters. Can you visualize what that might be doing to the Fourier Transform of an image in the Fourier domain? What is being "passed" through a high-pass filter?

A high pass filter lets the high frequencies through and blocks the low frequencies. In the case of a Sobel filter or a Laplacian filter, the high frequencies are the sharp changes in the image.

Visualizing high pass filter to the Fourier Transform of an image in the Fourier domain:



5) I am building a convolutional network. Given an image with 3 channels (RGB), I want the first convolution layer to have 16 5x5 filters. How many filter coefficients (parameters) does the layer need to learn? Explain your reasoning.

Each 5 x 5 filter has 75 parameters because (5 x 5 x 3 RGB channels) = 75. Then since there are 16 filters, 16 x 75 = 1200 total parameters that the layer needs to learn.

6) Given a second convolution layer on the same network (first layer has 16 filters), we want the second layer to have 32 3x3 filters. How many filter coefficients (parameters) does the second layer need to learn? Explain your reasoning.

Each 3 x 3 filter has 144 parameters because (3 x 3 x 16 input channels) = 144. Since there are 32 filters, the 2nd layer needs to learn 144 x 32 = 4608 coefficients.