Due on 20 March 2024

Computer vision - Assignment 5

This assignment is about spatial and frequency filters. Images can be found in this folder.

1. Download the image "moon.jpg". Apply the following spatial filters to the image and compare the results by plotting the images side-by-side:
   (a) Box filter with kernel size 9×9
   (b) Gaussian filter
   (c) Laplacian filter - apply the filter and display the Laplacian. Then use appropriate image addition to enhance the edges. Display the result.
   (d) Sobel filter

   What are your observations about the effects of each of these filters on the given image?

2. Generate a filled white rectangle at the center of a 100×100 pixel image, with rest of the pixels being black and display its Fourier transform. Write a code that is flexible enough to generate any size of rectangle so that you can observe the different effects.
   (a) Display the magnitude spectrum, the phase spectrum and the power spectrum of the above image so that the avarage of the pixel values is visible at the center. You may find the following link useful: `https://opencv24-python-tutorials.readthedocs.io/en/latest/py_tutorials/py_imgproc/py_transforms/py_fourier_transform/py_fourier_transform.html`
   (b) How does increasing/decreasing the size of the white rectangle affect the above spectral images? Provide an explanation for these changes (or lack of changes).

3. SOlve problem 4.21 from the Gonzalez-Woods book 4th edition (page 310).

4. Comparison of low pass filters: use the image "ricegrains.jpg".
   (a) Spatial domain filtering - Apply a box filter, a Gaussian filter and a median filter to smooth the image. Change the kernel size from 3x3 to 5x5 and 7x7 and observe the result. Use a fixed $\sigma = 1.5$.
   (b) Frequency domain filtering - Design a lowpass frequency filter (try both Butterworth and Gaussian) to smooth the image (choose appropriate radius).

5. Comparison of high pass filters: use the image "RBCs.jpg".
   (a) Spatial domain filtering: Apply unsharp masking, Sobel edge detector, and Laplace edge detection in the spatial domain to highlight the edges in the image.
   (b) Frequency domain filtering: Design a highpass frequency (use both Butterworth and Gaussian) filter in the frequency domain to highlight the edges in the image.

6. Convolution in the spatial and the frequency domain: There are two ways to implement spatial filters - one is to apply convolution, the other is through multiplication in the frequency domain. Use "cameraman.jpg" as the testing image.
   (a) Apply a 11×11 average filter in the spatial domain.
   (b) Perform this enhancement in the frequency domain. Follow these steps:
      - pad both the original image and the kernel
      - transform both the padded original original image and the kernel
      - perform multiplication
      - perform inverse transform
      - cut and display the useful content of the transformed image
   (c) Compare the time required for parts (a) and (b).