HW1

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1. Method
   I. Spatial domain

      In Spatial domain, I apply two Laplacian filters on the spec to the image, which are:

      0 -1 0

      -1 5 -1

      0 -1 0, and

      -1 -1 -1

      -1 9 -1

      -1 -1 -1.

      The only thing to notice is that when using x = img[i][j], we need x = int(x) to avoid overflow.

   II. Frequency domain

      In Frequency domain, I do the following operations:

      First, I normalize the input image to 0 to 1.

      Second, I apply Fourier transform to the normalized image with np.fft.fft2, and then shift the brightest part to the center with np.fft.fftshift, name it fshift.

      Third, I get the Laplacian filter with the following formula:

      H[i][j] = -4*pi^2*((i-p/2)^2+(j-q/2)^2), where p and q are the length and the width of the image, then get the Laplacian image = H * fshift.

      Then, I apply inverse shift and inverse Fourier transform to the image, keep only the real part of I, and convert it to -1 to 1.

      Finally, I get the image by deducting the above result, and multiply back 255 to get the final image.

2. Results

   The original image:

I. Spatial Domain

We can observe that the images are sharpened compared to the original image, and the noises become more noticeable, and the one with 9 in the middle of the Laplacian filter (the right one) is more sensitive to noises than that one with 5 in the center (the left one).

II. Frequency Domain

We can observe that, the overall result is not that sharp compared to the results that apply Laplacian filter in spatial domain.

3. Feedback

   In this homework, I learned how to apply Laplacian filter to the image in spatial domain, and notice that it is sensitive to the noises. Also, I learned how to apply Laplacian filter to the spectrum in frequency domain, and observe what the result images would look like, and what is different compared to the ones that do Laplacian filter in the spatial domain. This is important because it was abstract before, but after this homework, I have a better comprehension about the concepts. Overall, I learned a lot in this homework!