Homework 4 MATLAB

Signal & System (003)

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HW4: Image manipulation

- In this assignment, you will manipulate images, mostly in frequency domain.
  (DO NOT USE BUILT_IN FUNCTIONS IN IMPLEMENTING FILTERS)
- Complete 'HW4_1.m' to implement
  1. System that shifts an input image by 100 pixels in column direction. This operation should be done in frequency domain [30 points]
  2. Ideal low-pass, high-pass filter in frequency domain and apply them to input image [30 points]
     (1) Explain what does low-pass, high-pass component of images mean. **(in report)**
     (2) Adjust cut-off frequencies of low-pass filter and briefly explain what happens to your images **(include both output images and explanation in your report)**
- Complete 'HW4_2.m' to implement system that denoises corrupted image with gaussian filter [40 points]

HW4: Image manipulation

☐ Your goal is to complete the code of ‘HW4_1.m’ following 5 steps below

1. Load an image (=img)
2. Get the frequency domain representation of the image, i.e. the Fourier transform of the image
3. Implement (1)~(2) and apply them to your input image.
    (1) Shifting system
    (2) Ideal Low pass filter, Ideal High pass filter
4. Get the inverse Fourier transform of the output frequency 3.
5. Compare img and img_output_op1, img_output_op2_LPF, img_output_op2_HPF

HW4: Image manipulation

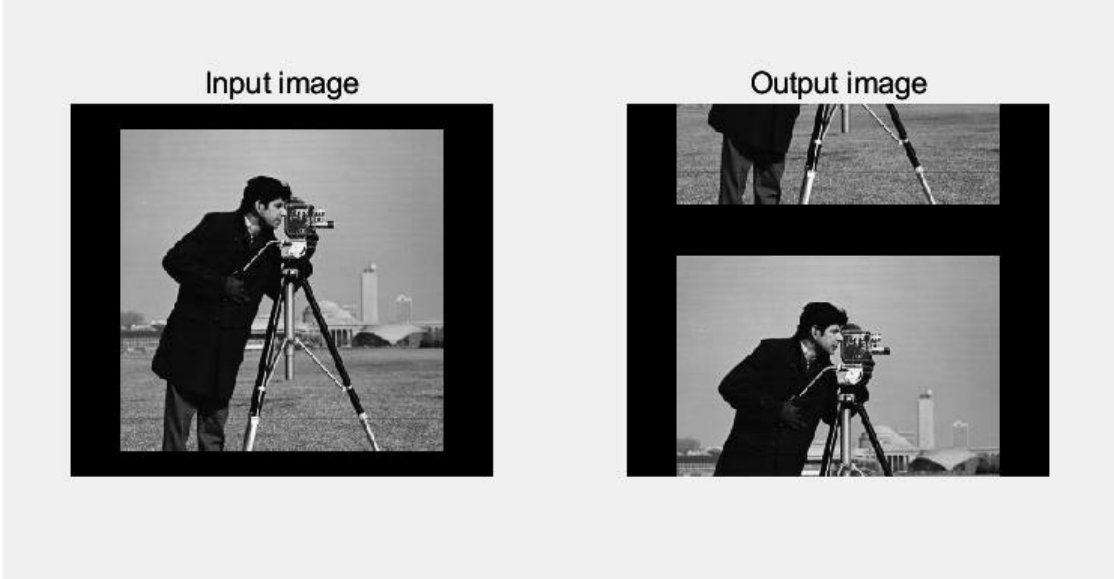
☐ Your goal is to complete the code of ‘HW4_2.m’ following 5 steps below

1. Load an image (=img)
2. Add salt & pepper noise to your image
3. Get the frequency domain representation of the corrupted image, i.e. the Fourier transform of the image
4. Implement gaussian low pass filter in spatial domain. Then, get frequency domain represesentation of filter and apply it to 3 using convolution theorem
5. Get the inverse Fourier transform of the output frequency 4.
6. Compare img and img_output_op3.

HW4: Image manipulation in frequency domain

Operation 1. Shift an input image by 100 pixels in column direction.

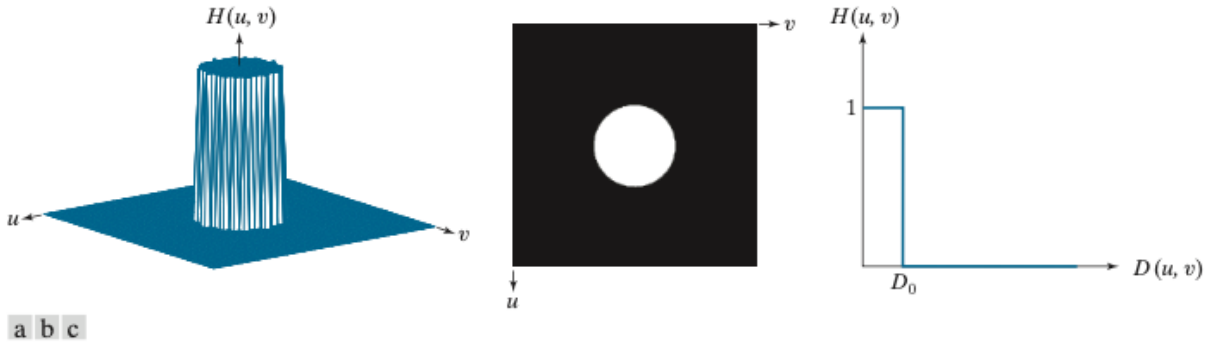
- This operation should be done in frequency domain.
- The shifting system can be represented as a complex exponential function in the frequency domain. Use the convolution property of the fourier transform.
- Your output image should be like this image below.



HW4: Image manipulation in frequency domain

Operation 2. Implement ideal low-pass, high-pass filter in frequency domain and apply them to input image.

- Explain what low-pass, high-pass component of images mean. (in your report)
- Adjust cut-off frequencies of low-pass filter (low-pass filter only) and briefly explain what happens to images. (in your report)
- The image below explains how ideal lowpass-filter will be like in frequency domain.



a b c

FIGURE 4.39 (a) Perspective plot of an ideal lowpass-filter transfer function. (b) Function displayed as an image. (c) Radial cross section.

[1]. digital image processing 4th edition rafael c. gonzalez

HW4: Image manipulation in frequency domain

Operation 3. Complete 'HW4_2.m' to implement system that denoises image with gaussian filter [40 points]

(1) Implement gaussian filter in spatial domain. You can refer to equation below

(2) Then get representation of the filter in frequency domain, apply it to the corrupted image

Corrupted image

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

2D gaussian filter

HW4: Image manipulation in frequency domain

☐ Compress **'HW4_1.m', 'HW4_2.m' and your report** as zip file and upload it in eTL. → Zip file name : **Student ID_NAME_HW4** (ex: 2023-12345_gildonghong_HW4)

☐ Additionally, Submit **'free-form Word Report pdf'** which explains about your writing Matlab codes (approximately 1~2 pages) in either Korean or English. The Report should include outcome images.

☐ Please read all comments in given m files before posting a question in eTL.

☐ Feel free to email me if you have any questions about the matlab assignment : snu.icl.ta@gmail.com (TA Jiha Jang, 장지하 조교)