Digital Image Processing
School of Information Science and Technology
ShanghaiTech University

Assignment 2

Due time: 23:59, April 15th, 2023

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1 Notes

This homework has **100 points** in total.

Please submit your homework to blackboard with a zip file named as **DIP2023_ID_Name_hw2.zip**. The zip file should contain three things: **a folder named 'codes' storing your codes**, **a folder named 'images' storing the original images**, and **your report named as report_ID_Name_hw2.pdf**. The names of your codes should look like **'p1a.m'** (for (a) part of Problem 1), so that we can easily match your answer to the question. Make sure all paths in your codes are relative path and we can get the result directly after running the code. Please answer in English.

Using MATLAB to complete coding assignments is recommended. All core codes are required to be implemented by yourself (without using relevant built-in functions). Make sure your results in the report are the same with the results of your codes. Please explain with notes at least at the key steps of your code.

2 Policy on plagiarism

This is an individual homework. You can discuss the ideas and algorithms, but you can neither read, modify, and submit the codes of other students, nor allow other students to read, modify, and submit your codes. Do not directly copy ready-made or automatically generated codes, or your score will be seriously affected. We will check plagiarism using automated tools and any violations will result in a zero score for this assignment.

3 Problem sets

Problem 1 (37 pts)

(a) Perform DFT to 'Lena.tif' and center the low frequency component (fft and fftshift are not allowed here). Show the frequency spectrum (Hint: log compression helps better display frequency spectrum). (4 pts)

(b) Here, we will use an ideal lowpass filter and a 4th order Butterworth lowpass filter to filter the 'Lena.tif' respectively. Set $D_0 = 30$, show your filter in form of image and the filtered results. (12 pts)

(c) Describe the difference of results in (b), and explain the reason. (4 pts)

(d) Design a highpass filter to extract details of 'Baboon.tif'. (5 pts)
Show the result like this:

Figure 1: Baboon detail

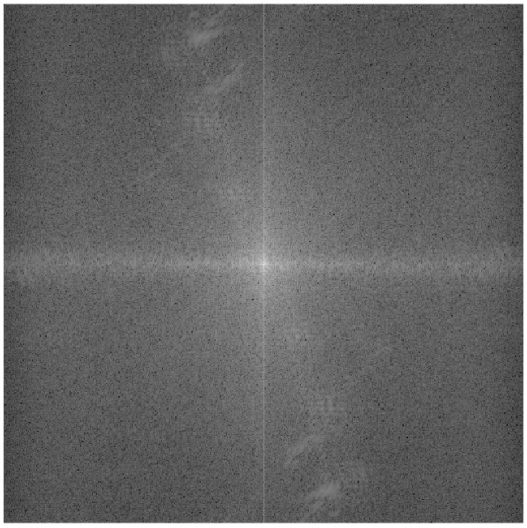


Figure 2: original frequency spectrum

(e) Please design a notch filter to denoise 'Goldhill_noised.tif'. The frequency spectrum of noiseless image is displayed above. Show the frequency spectrum of 'Goldhill_noised.tif' and your denoised result. (12 pts)

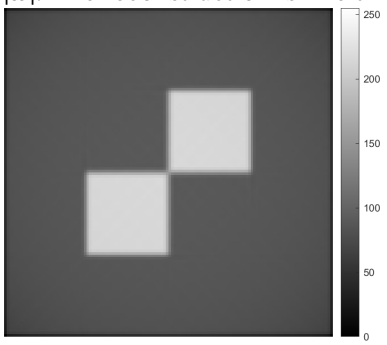
Solution:

Problem 2 (41 pts)

(a) Given a degraded image 'child_degraded.tif' and the degradation function H_1. Restore the image with full inverse filter and inverse filter with proper cut-off, respectively. Show the results, and explain why full inverse filter works bad. (12 pts)

(b) Given a motion blur degradation function H_2, apply H_2 to 'child.tif' and show the blurred image. Try to restore the blurred image using inverse filter with proper cut-off. Explain why this restoration is more difficult than H_1 (restoration result doesn't need to show). (8 pts)

(c) Given a set of projection data, try to reconstruct the image using filtered back-projection with ramp filter, i.e. $|\omega|$. The reconstruction is like this:



Show your filtered data and the reconstructed image (Hint: function 'imrotate', 'interp', and 'interp2' may be helpful in back-projection, but 'iradon' is not allowed). (15 pts)

(d) Apply hann window to ramp filter, then reconstruct the image again, show the image, describe the function of applying hann window in this question (Hint: hann window can be generated by function 'hann'). (6 pts)

Solution:

Problem 3 (22 pts)

(a) Please convert 'PeppersRGB.tif' from RGB to HSI color space, and then convert it back. Show the image in HSI space and the recovered result in RGB space (Hint: you need to normalize all channels to [0, 1] in HSI space. Also, some exceptional values need to be judged individually). (16 pts)
Results are like this (displayed by imshow(img, [])):

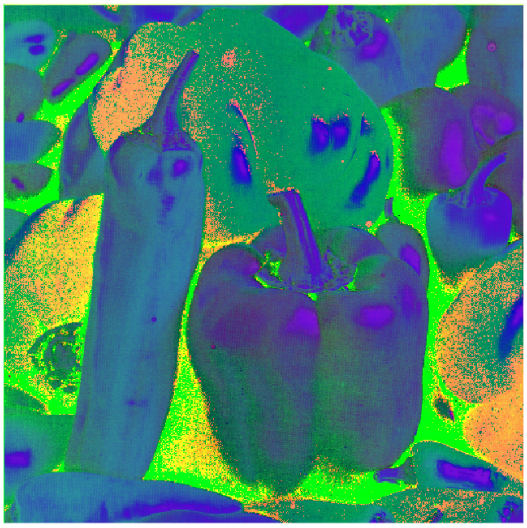


Figure 3: HSI space

Figure 4: RGB space

(b) Choose proper structure element to conduct morphological operation to remove black points inside the object in 'guitar.tif' (6 pts)

Solution: