Middle East Technical University Department of Computer Engineering

CENG 466

Fundamentals of Image Processing

Fall '2018-2019

Take Home Exam 2

Due date: December 6 2018, Thursday, 17:00

1 Objectives

The purpose of this assignment is to familiarize you with the fundamental frequency domain image enhancement techniques. You are given several tasks. You are expected to carry out these tasks using algorithms you have covered during the lectures.

2 Specifications

You are given three questions, which you should solve with your own algorithms. In addition to the solutions, you are required to prepare a report that explains your methodology and includes the analysis of the results and your comments on them. The report should be **3-5 pages** long and should be prepared in IEEE Conferance Proceedings Template (LaTeXis recommended) provided in the following link.

`https://www.ieee.org/conferences_events/conferences/publishing/templates.html`

- Grading will be based on the quality of the outputs, script contents and the report
- The report should clearly explain the methodology and rationale behind the algorithm design. It should also explain the difficulties encountered in the design, implementation and experimentation stages, and your solutions on them. Last but not least, the report should contain your comments on the results. Even if the results does not match your expectations you should discuss the encountered situation.

2.1 Question 1 (30 Points) - Wavelet Transformations

We were trying to apply wavelet transformation to 2 different images. Our purpose was to extract approximation and detail coefficients of these images for 3 levels. We used the following formula in MATLAB for this transformation;

dwt2(I,'haar')

However, when we tried to apply inverse wavelet transform and reconstruct the images with idwt2(), we noticed that the detail coefficients of these two images have been mixed up. Therefore the reconstructed images are not correct as shown in Figure 1.

Your job is to restore these two images into their original form. For this purpose you should apply the following on both images in a script named **the2_part1.m**;

- Apply Wavelet transformation on both images for 3 levels. (You can use dwt2()).
- How many components have you obtained per image? What are their sizes? How many of these are needed to reconstruct the images? What information can we find at these components? Are there any differences among levels?
- Find the mixed components and solve this problem.
- Reconstruct the original images (You can use idwt2())
- Save reconstructed images with filenames **AX_output.png**.

(a) A1.png (b) A2.png

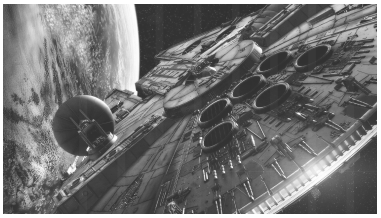
Figure 1: Mixed images of Part 1

2.2 Question 2 (35 Points) - Noise elimination

In this part, you are required to identify the type of noise in the images B1.png, B2.png and B3.png shown in Figure 2 by investigating their spatial and frequency domain representations. Your job is to remove the noise present in the images while preserving informative structures like edges and boundaries as much as possible. Note that full recovery is not possible in some cases due to the information loss. Implement your solution as a MATLAB script named **the2_part2.m**. After running the script, images named **BX_output.png** should be created as the reconstruction. You can use fft2(), ifft2() and fftshift() functions.

(a) B1

(b) B2



(c) B3

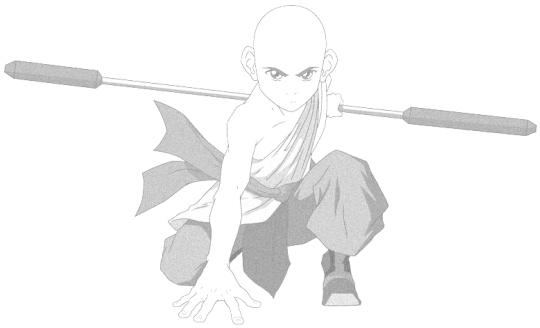
Figure 2: Noisy images of part 2

2.3 Question 3 (35 Points) - Edge Detection

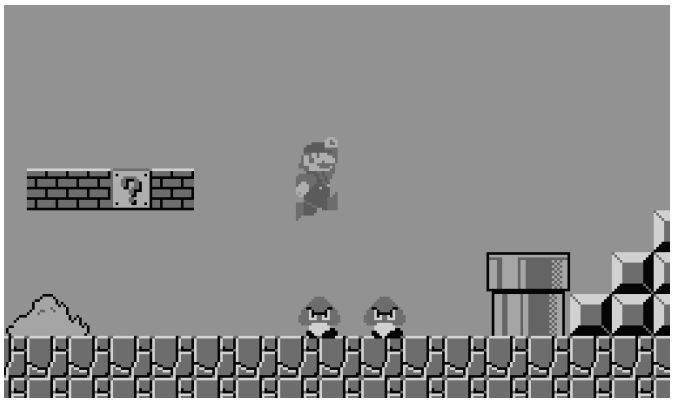
Remember that in THE1 you find edges on images using spatial domain technique. Now, your task is to find edges in Fourier domain. In this part you are given two images C1.png and C2.png shown in Figure 3. Your job is to find edge maps of these images in Fourier domain and answer the following questions.

- What does spatial domain convolution correspond in Fourier domain?
- Notice that the images are the same with THE1. Do you observe any differences between spatial domain and Fourier domain techniques? Why?
- Explain types and characteristics of the filters you have used in detail.

You should implement your algorithm in a script called **the2_part3.m** and save the results into files named **CX_output.png**



(a) C1



(b) C2

Figure 3: Images of part 3

3 Regulations

1. **Group:** You are required to do your assignment in a group of two. If there is an unclear part in your code, we may ask any of the group member to describe that code segment. Also group members may get **different** grades. We reserve the right to evaluate some or all of the groups to determine the contribution of each group member to the assignment.

2. **Programming Language:** You must code your program in MATLAB. You are expected make sure your code runs successfully on department lab machines.

3. **Late Submission:** Late Submission is **not** allowed!

4. **Newsgroup:** You must follow the newsgroup (news.ceng.metu.edu.tr) for discussions and possible updates on a daily basis.

4 Submission

Submission will be done via COW. Create a tar.gz file named THEX.tar.gz that contains all your source code files and the report as a PDF file. Do not send the input and output images. Only one member should submit the homework. Hence, do not forget to **write your names and student id's at the beginning of the scripts.**

5 Cheating

We have zero tolerance policy for cheating. People involved in cheating will be punished according to the university regulations.

Cheating Policy: Students/Groups may discuss the concepts among themselves or with the instructor or the asistants. However, when it comes to doing the actual work, it must be done by the student/group alone. As soon as you start to write your solution or type it, you should work alone. In other words, if you are copying text directly from someone else - whether copying files or typing from someone else's nots or typing while they dictate - then you are cheating (committing plagiarism, to be more exact). This is true regardless of whether the source is a classmate, a former student, a website, a program listing found in the thrash, or whatever. Furthermore, plagiarism even on a small part of the program is cheating. Also, starting out with code that you did not write, and modifying it to look like your own is cheating. Aiding someone else's cheating also constitutes cheating. Leaving your program in plain sight or leaving your computer without logging out, thereby leaving your programs open to copying, may constitute cheating depending upon the circumstances. Consequently, you should always take care to prevent others from copying your programs, as it certainly leaves you open to accusations of cheating. We have automated tools to determine cheating. Both parties involved in cheating will be subject to disciplinary action. [Adapted from http://www.seas.upenn.edu/cis330/main.html]