Middle East Technical University Department of Computer Engineering

CENG 466

Fundamentals of Image Processing

Fall '2019-2020

Take Home Exam 1

Due date: November 6 2019, Thursday , 17:00

1 Objectives

The purpose of this assignment is to familiarize you with the fundamental spatial domain image enhancement techniques. For each question you are required to develop your own algorithm based on the techniques you learned in 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.
- In your solutions you are **NOT** allowed to use any function from Image Processing Toolbox of MATLAB other than imread or imwrite.

2.1 Question 1 (33 Points) - Image Interpolation

You are given three images, namely, A1, A2 and A3 and their downsized counterparts. In this part you are required to identify the level of downsizing in the given images (**A1_shrinked.jpg, A2_shrinked.jpg** and **A3_shrinked.jpg** shown in Figure 1). You are also required to develop an algorithm to resize them. Note that full recovery is not possible in some cases due to the information loss.

(a) A1 (b) A2 (c) A3

Figure 1: Shrinked images of part 1

Follow the steps below;

- Explain the concept of interpolation in general.
- Explain 'bilinear' and 'bicubic' interpolation in detail. Explanations should be your own work, otherwise you may lose points. Provide proper references, AVOID PLAGIARISM!
- Write a matlab function *bilinear_interpolation.m* that takes an input image and a final size. It should resize the given image based on second argument using bilinear interpolation. (You can use imresize function. However if you do so, yo must explain how it works and its parameters in detail)
- Write a matlab function *bicubic_interpolation.m* that takes an input image and a final size. It should resize the given image based on second argument using bicubic interpolation. (You can use imresize function. However if you do so, yo must explain how it works and its parameters in detail)
- Write a MATLAB script named as **the1_partA.m** that takes given resized images (**A1_shrinked.jpg**, **A2_shrinked.jpg** and **A3_shrinked.jpg**) and resize them based on their originals (**A1.jpg, A2.jpg** and **A3.jpg**) using both bilinear and bicubic interpolation. Save resulting images with the names *AX_result_bilinear.jpg* and *AX_result_bicubic.jpg*
- Comparison between bilinear and bicubic interpolation may not be obvious to the human eye. In **the1_partA.m**, compute the Euclidean distances between
  - *AX_result_bilinear.jpg* and *AX.jpg* *AX_result_bicubic.jpg* and *AX.jpg*

  Report these distances.
- Comment on your findings. Based on your findings compare bilinear and bicubic interpolation.

2.2 Question 2 (33 Points) - Histogram Processing

In this part you are given four images B1.jpg, B2.jpg, B3.jpg and B4.jpg shown in Figure 2. Your job is to apply histogram matching on four different combinations.

1. Apply histogram matching on B1.jpg, when reference image is B2.jpg
2. Apply histogram matching on B2.jpg, when reference image is B1.jpg
3. Apply histogram matching on B3.jpg, when reference image is B4.jpg
4. Apply histogram matching on B4.jpg, when reference image is B3.jpg

Write a script named **the1_partB.m**. Your script should create and save two different images for each input. Create **BX_histmatch.jpg** which shows the matched histogram of the input image BX.jpg, and **BX_histmatch_output.jpg** which shows the input image after histogram equalization. Explain and discuss your findings.

(a) B1

(b) B2

(c) B3

(d) B4

Figure 2: Images of part 2

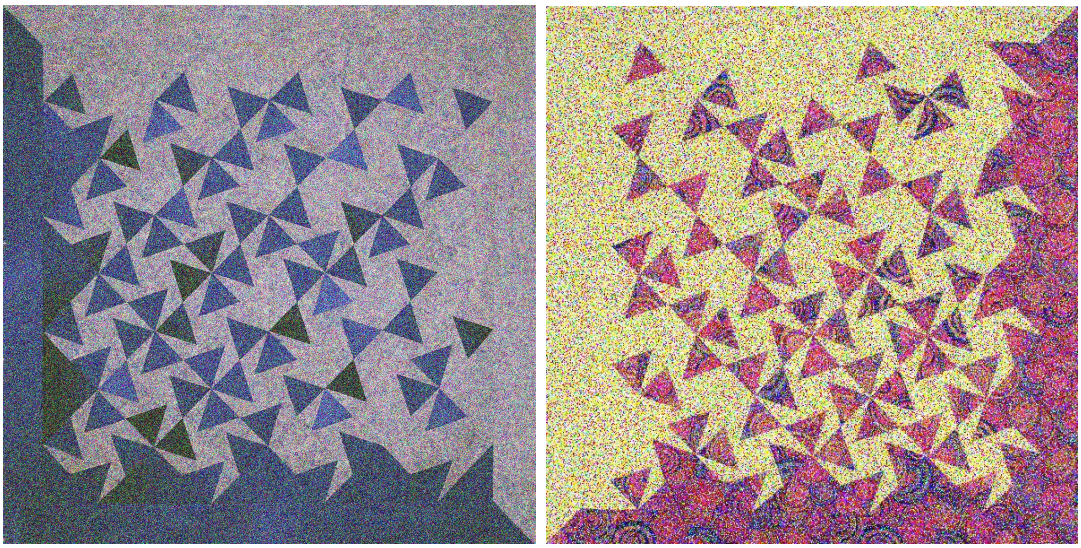
2.3 Question 3 (34 Points) - Noise Elimination

In this part you are given three images C1.jpg, C2.jpg and C3.jpg shown in Figure 3. Your job is to denoise these images and find edge maps. Follow the steps below.

- Write a convolution function that takes two inputs, an image and a spatial domain filter. Function should convolve the image with the filter, and return the convolved image. For this purpose you will write a MATLAB script named **the1_convolution.m**
- Analyze the type of the noise in the images and design a series of filters to denoise them. Note that you should examine each channel of the images. For this purpose write a MATLAB script named as **the1_partC.m** that uses the convolution function in the previous step for applying filters (You can not use imfilter, and fspecial filters). Your script should save the resulting denoised images, name them as **CX_result.jpg**.
- Develop an edge detection algorithm to detect the edge maps in a script named **the1_partC_edges.m**. (You can also use edge filters to enhance given images in the previous step.) Your script should save resulting edge maps, name them as **CX_edges.jpg**.
- Report all the filters you have used and their purposes. Discuss the differences among edge filters according to your findings.
- Explain and discuss your findings.

3 Regulations

1. **Group:** You are required to do your assignment in a group of two students. If there is an unclear part in your code, we may ask any of the group member to describe that code segment. Also group



(a) C1 (b) C2

Figure 3: Noisy images of part 3

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. Your submission will be tested with MATLAB R2018a on department lab machines. You are expected make sure your code runs successfully with MATLAB R2018a.

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]