Middle East Technical University Department of Computer Engineering

CENG 466

Fundamentals of Image Processing

Fall '2020-2021

Take Home Exam 1

Due date: November 30 2019, 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.
- You can use either MATLAB or Python in your solutions. In either case you should implement the algorithms yourself, such as convolution. Please provide information on this matter in your report.
- Your scripts should read the given images from the current directory(for example ./THE1-Images/Part1/A1.jpg), and write the output images in the current directory as well.

2.1 Question 1 (30 Points) - Histogram Processing

In this part you are given two images B1.jpg and B2.jpg shown in Figure 1. Your job is to apply histogram matching on two 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

(a) A1 (b) A2

Figure 1: Images of part 1

Write a script named **the1_part1**. 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.

2.2 Question 2 (50 Points) - Edge Detection

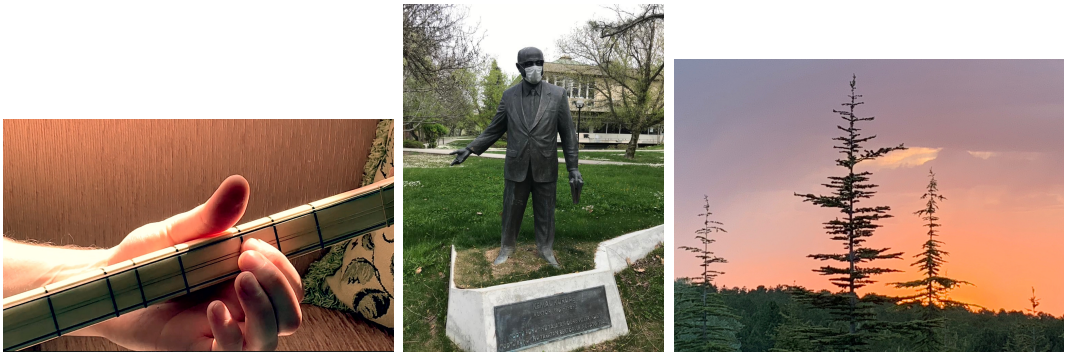
This part aims to familiarize you with the basics of filtering and the affects of parameters. You are given three images B1.jpg, B2.jpg and B3.jpg shown in Figure 2. Your job is to find edges of these images using Canny edge detector. While doing so you will change the parameters and observe the affects of them and see the necessities of the steps in Canny edge detection.

You should write a script named **the1_part2** which should handle the read/write operations and call the necessary functions of your own.

The list of experiments of this task is as follows. You must provide results for all the items in this list and comment on your findings in your report. However you can enlarge this list and provide results in your report.

- You should write a convolution function and use it in the next steps of your algorithm.
- Algorithm of Canny edge detection is covered in class in available at the lecture notes. You should implement the detection algorithm yourself.
- There are different parameters of the algorithm. Try different parameter sets to observe the results. You can use the following guideline.
  - The sigma and the kernel size of blurring can be altered.
  - Blurring can be removed from the algorithm. What would happen when you apply edge detection on the original images?
  - Thresholds can be altered.

  Keep in mind that small changes on the parameters may not be observable to human eye. Also, there are no globally optimal parameter set. Some complex scenes may require further analysis. Please write your outputs and provide detailed information on your report by cross referencing to your output images.
- Implement Sobel image filtering. Use *only* Sobel filters to find edges in the images. Compare your results with the Canny edge detection algorithm.
- Report all the filters you have used and their purposes. Explain and discuss the differences among edge filters according to your findings.

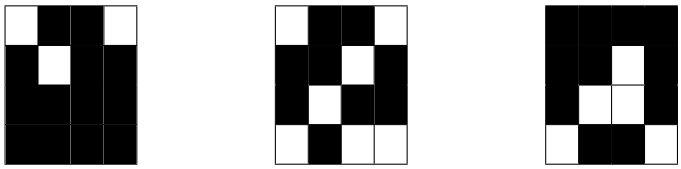


(a) B1 (b) B2 (c) B3

Figure 2: Images of part 2

2.3 Question 3 (20 points) - Old Exam Question

Consider the following RGB image patch (where black cells correspond to 0, and white cells correspond to 1):



R G B

a) Interpolate this image to an image size 8x8 by using nearest neighbor method and plot the interpolated image.

b) How many connected components are there for $V = \{(0, 0, 0)\}$,

i) in 8-neighborhood,

ii) in 4-neighborhood,

iii) in mixed neighborhood.

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 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 Odtuclass. 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]