Middle East Technical University Department of Computer Engineering

CENG 466

Fundamentals of Image Processing

Fall '2022-2023

Take Home Exam 2

Due date: December 2 2022, 23:55

1 Specifications

You are given two noisy images, which you should denoise. In addition to the solutions, you are required to prepare a report.

- Grading will be based on the quality of the outputs, script contents and the report
- The report should
  - be **maximum 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`
  - clearly explain the methodology and rationale behind the algorithm design.
  - explain the difficulties encountered in the design, implementation and experimentation stages, and your solutions on them.
  - contain analysis of the results, and your comments on the results. Even if the results does not match your expectations you should discuss the encountered situation.
  - contain information on requirements of your code (libraries etc.)
- **Implementation:** Write your solutions to *the2_solution.py*, you should structure the file similar to the one you are given in THE1.
- **Submission** Submission will be done via Odtuclass. Submit a single .zip file containing
  - the2_solution.py
  - Report (single pdf file)

  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.**

2 Regulations

1. **Contribution to the Book:** The selected algorithms will be inserted to the book, "Fundamentals of Image Processing" by H. Mogultay, I. Onal and F.T. Yarman Vural with the consent of the owner students.

2. **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.

3. **Programming Language:** You must code your program in Python. Your submission will be tested on department lab machines. You are expected make sure your code runs successfully on department lab machines.

4. **Late Submission:** Late Submission is penalized by -20 points/day.

5. **Newsgroup:** You must follow the odtuclass for discussions and possible updates on a daily basis.

Image1

Image2

Image3

Image4

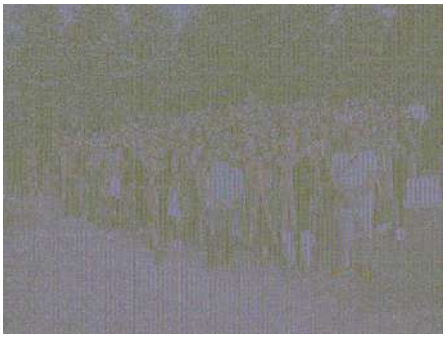

Image5

Image6

Image7

3 Image Transforms and Enhancement

In this part you will be enhancing images in space and transform domains. In order to complete this task follow the given steps:

Step 1: Define read and write functions as in THE1. Read the input image from ./THE2_images. (You can use any python libraries such as cv2 or PIL). Note that the images will be provided in color. Therefore apply the methods in R,G and B bands separately and display your results in normalized RGB values. Create the output directory (./Outputs/) if it does not exist. (You can use os for this purpose).

Step 2: Find the Fourier, Hadamard and Cosine transform of Image 1 and Image 2 compare your results in terms of energy compaction. Save your results to Outputs folder as *F1.png, H1.png, C1.png, F2.png, H2.png, C2.png.*

Step 3: Apply the following Low Pass Filtering on Image3 and compare your results in terms of the degree of blur:

- Apply Ideal Low pass Filter with 3 different cutoff frequencies r_1, r_2, r_3 of your choosing. Save your results to Outputs folder as *ILP_r1.png, ILP_r2.png, ILP_r3.png*
- Apply, Gaussian Low Pass Filter which approximates the same cutoff frequencies as in part a. and save your results to Outputs folder as *GLP_r1.png, GLP_r2.png, GLP_r3.png*
- Apply, second order Butterworh Low Pass Filter which approximates the same cutoff frequencies as in part a. Save your results to Outputs folder as *BLP_r1.png, BLP_r2.png, BLP_r3.png*

Step 4: Apply High Pass Filtering to Image 3 and compare your results in terms of the quality of the edges:

- Apply, Ideal High pass Filter with cutoff frequencies r_1, r_2, r_3 of your choosing. Save your results to Outputs folder as *IHP_r1.png, IHP_r2.png, IHP_r3.png*
- Apply, Gaussian High Pass Filter which approximates the same cutoff frequencies as in part a. and save your results to Outputs folder as *GHP_r1.png, GHP_r2.png, GHP_r3.png*
- Apply, second order Butterworh High Pass Filter which approximates the same cutoff frequencies as in part a. Save your results to Outputs folder as *BHP_r1.png, BHP_r2.png, BHP_r3.png*

Step 5: Apply Band Filtering to remove and model the noise on Image 4 and 5:

- Apply, Band Reject Filter to the noisy Image 4 and noisy Image 5. Specify the filter band which removes the noise. Save your results to Outputs folder as *BR1.png, BR2.png*
- Apply, Band Pass Filter with the same bandwidht frequencies as in part a. and save your results to Outputs folder as *BP1.png, BP2.png*

Step 6: Enhance the following images by Space Domain Filtering and contrast stretching techniques.

- Improve the contrast of Image 6 by designing a series of spatial filters and contrast stretching methods. Save your results in Outputs folder as *Space6.png*
- Improve the contrast of Image 7 by designing a series of spatial filter and contrast stretching methods. Save your results in Outputs folder as *Space7.png.*

Step 7: **REPORT:** Explain each of the previous steps in detail and discuss your findings.

4 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]