

CENG 466

Fundamentals of Image Processing

Fall 2024-2025

Take Home Exam 4

Due date: December 30, 2024, Monday, 17:00

1 Specifications

You are given a questions related to morphology and image segmentation. Implement your solutions using Python. 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 10 pages** long and should be prepared in IEEE Conference Proceedings Template (**L^AT_EX** is 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 *the4_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 *the3_solution.py* and your report. 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. **Newsgroup:** You must follow the odtuclass for discussions and possible updates on a daily basis.

2.1 Segmentation

In this part you will apply segmentation over several images given in Figure 1. Each image requires specific segmentation goals:

- **Figures (a) and (b):** Extract the primary pattern on the rug.
- **Figures (c) and (d):** Extract the fabric areas with visible wrinkles.
- **Figures (e) and (f):** Extract the zip in the given images.

Your task is to explore and compare three segmentation methods:

- **Gray-scale Morphology:** Apply grayscale morphological operations such as erosion, dilation, opening, and closing to isolate the required features.
- **KMeans Clustering using RGB Features:** Segment the image using KMeans with RGB pixel intensities as features.
- **KMeans Clustering using Local Binary Pattern (LBP) Features:** Extract LBP features for each pixel and use them as input to KMeans.

Instructions:

- Experiment with several parameters for each method to find the optimal settings for the segmentation task. Discuss your parameter selection process in detail.
- Use preprocessing and postprocessing techniques as necessary to enhance segmentation quality. Clearly describe these techniques in your report.
- Compare and analyze the results of the three methods for each image. Your analysis should include:
 - The effects of parameter choices on segmentation quality.
 - The strengths and weaknesses of each method for the given images.
 - Which algorithm performed best for each image? Why?
 - How did the complexity of the image (e.g., texture, color patterns) influence the results?
 - The impact of preprocessing and postprocessing on the results.



Figure 1: Sample images for segmentation

3 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 assistants. 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 notes 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 trash, 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>]