

Exam in Computer-Assisted Image Analysis I

1TD396

Wednesday January 5, 2022, at 08:00 – 13:00

During the course you have handed in five group computer exercises corresponding to 2 hp of pass or fail.

At today's written exam corresponding to 3 hp, neither tools nor collaborations are allowed. This individual exam is on your knowledge after having followed and studied the course and will result in your grade 3 – 4 – 5 for the course of 5 hp.

The exam is divided into two phases where Phase 1 is mandatory and Phase 2 is optional.

Phase 1 (mandatory)

You are given 4 questions of 5 points (= 20 points) on very basic course content.

Please, be accurate in your answer in no more than one A4 page per question.

Grade 3 requires that you reach a minimum of 18 points on Phase 1.

If you pass Phase 1, then I will correct Phase 2.

Phase 2 (optional)

You are given a task from an image analysis application, where you should propose a step-by-step system that solves the task.

Grade 4 requires that

- You propose an image analysis pipeline using relevant methods from the course.
- You provide a convincing motivation for your proposed solution.
- You demonstrate a good understanding of the methods involved.

Grade 5 requires that

- You propose an image analysis pipeline using relevant methods from the course.
- You provide a very convincing motivation for your proposed solution, and discuss the advantages and disadvantages of your solution compared to other possible approaches.
- You demonstrate a very good understanding of the methods involved.
- You discuss different ways in which the performance of the proposed system could be measured, and compare possible advantages/disadvantages of different performance metrics.

Good luck!

/ Ingela Nyström

Phase 1 (mandatory)

Question 1 – General

During the course, we have repeatedly pointed to where in the traditional image analysis pipeline the concepts from the lecture belong. Please, describe the pipeline and its main steps.

Maximum one A4 page.

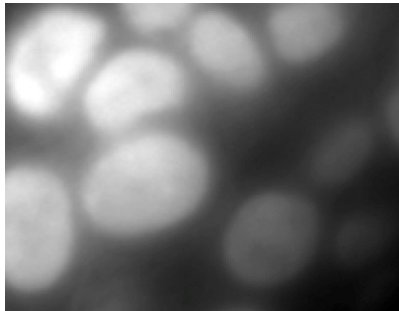
Question 2 – Filtering in the frequency domain

An ideal low-pass filter completely eliminates all frequencies above a given cut-off frequency while leaving those below unchanged. Explain how to perform ideal low-pass filtering in the frequency domain.

Why does an ideal low-pass filter produce ringing artifacts?

Maximum one A4 page.

Question 3 – Segmentation in cell image analysis



Intensity thresholding applied to the cell image above is likely to fail to segment the objects from the background. Why is that?

One common approach that could be used to segment the cells is to use edge information. Give an example of how.

Maximum one A4 page.

Question 4 – Feature extraction and object descriptors



Consider the five berries above. Suggest a collection of features and descriptors which would distinguish them from each other and classify them into raspberry, blackberry, strawberry, cherry, and blueberry, respectively.

Maximum one A4 page.

Phase 2 (optional)

Your task is to implement an optical character recognition (OCR) system, that takes a digital image of a scanned document and outputs a text file with the text contained in the scanned document.

You can assume that the scanned document contains only text and no figures, that the text is dark on a bright background, and that the text is written in a known font with fixed size. Furthermore, you can assume that the document has been scanned using a high-quality document scanner, so that the illumination across the scanned document is even, and that the document is placed so that the orientation of the text lines is well aligned with the horizontal axis of the image.

Your system should return a text file containing the text of the scanned document. The line-breaks in the original document should be preserved; each text-line in the original scanned document should be represented by a separate line in the resulting text document. The computation time of the text recognition system is not crucial, but your solution should be possible to implement in a reasonably efficient manner.

- Describe in detail how the image analysis pipeline of such a text recognition system might be designed, using methods covered in the course. What different steps would you propose to include and what methods could be used at each step?
- Discuss how the performance of such a system could be evaluated? What performance metrics might be relevant?
- Discuss possible limitations of your proposed solution. What assumptions about the scanned images, besides those stated above, does your method rely on? When might those assumptions be violated and how would your method perform in that case?

There is no limitation on the number of pages for Phase 2.

For grading criteria, see the cover page.