Maastricht University

Department of Advanced Computing Sciences

Computer Vision 2022/2023

Exam Questions

– Do not turn this page before the official start of the exam! –

First name, Surname: _____

Student ID: _____

Program: Master in Artificial Intelligence & Master in Data Science for Decision Making

Course code: KEN4255

Examiner: Dr. Mirela Popa

Date/time: Monday, 5th of June 2023, 13:00-15:00h

Format: Closed book exam

Allowed aides: Pens, simple (non-programmable) calculator from the DKE-list of allowed calculators.

Instructions to students:

- The exam consists of 4 questions on 10 pages.
- Fill in your name and student ID number on each page, including the cover page.
- Answer every question at the reserved space below the questions. If you run out of space, continue on the back side, and if needed, use the extra blank page.
- Ensure that you properly motivate your answers.
- Do not use red pens, and write in a readable way. Answers that cannot be read easily cannot be graded and may therefore lower your grade.
- You are not allowed to have a communication device within your reach, nor to wear or use a watch.
- You have to return all pages of the exam. You are not allowed to take any sheets, even blank, home.
- If you think a question is ambiguous, or even erroneous, and you cannot ask during the exam to clarify this, explain this in detail in the space reserved for the answer to the question.
- If you have not registered for the exam, your answers will not be graded, and thus handled as invalid.
- **Success!**

The following table will be filled by the examiner:

Question:	1	2	3	4	Total
Maximum points:	12.5	12.5	12.5	12.5	50
Achieved points:					

Question 1. (12.5 points) Image processing

a) Describe (with words, no math needed) two techniques for edge detection and discuss their advantages and disadvantages.
b) Which image pre-processing technique is recommended before applying edge detection and how can it be adapted to various images (e.g. which parameters are important)?
c) Which morphological operations could be applied for detecting edges, in the case of binary images?
d) How was the displayed image corrupted and which image processing technique could be applied to improve its quality?

Question 2. (12.5 points) Feature Detection, Fitting and Alignment

a) Explain the advantages and limitations of the Harris corner detector without going into mathematical details.
b) Briefly explain one major improvement proposed by the SIFT detector in comparison to the Harris corner detector.
c) Describe one potential situation in which the Hough transform would be better suited for object detection in comparison to RANSAC?
d) How can the robustness of the Lucas-Kanade motion estimation algorithm be increased to cater for varying motion magnitudes within the same frame sequence?

Question 3. (12.5 points) Object Recognition and Detection

a. Your task is to detect a suspicious car on the highway. You can initially make a set of assumptions, please state them (e.g. think about what, where, for which time interval, input, output, etc.). Which computer vision solution would you propose for a fast and efficient detection (briefly describe the architecture)? Describe at least one major challenge you could encounter and the proposed solution.

b. How would you modify the proposed solution at point (a) to enable the detection of suspicious driving behaviour?

c. Briefly describe the concept of eigenfaces and their contribution to face recognition.

d. Describe one unsupervised deep learning technique suitable for obtaining an efficient feature representation in case of noisy data. How is the input data altered in this case?

Question 4. (12.5 points) Epipolar geometry

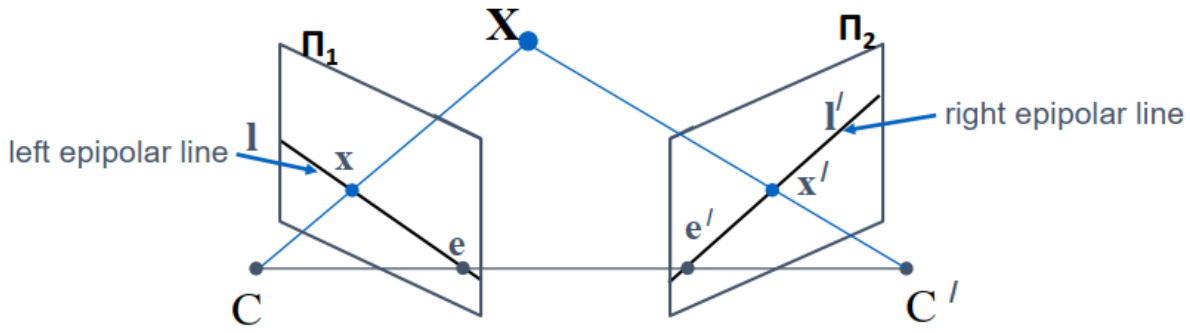

Figure 1. Epipolar Geometry

a) Given the example displayed in Figure 1, where $\mathbf{P_1}$ and $\mathbf{P_2}$ are the two camera matrices, could you please describe the process of obtaining the 3D point **X**? (The explanation should be based only on epipolar geometry concepts). Which initial information is needed?
b) Which factors could influence the proper detection of the 3D point **X**? Provide at least two different situations.
c) In case you obtained the Fundamental matrix F, how could you use it to retrieve information about the left image, when it is parallel to the right one?
d) Describe a potential scenario in which the use of feature detectors could be combined with epipolar geometry concepts for achieving an improved set of correspondences.

Extra answer sheet