# Computer Vision 2020/2021

## 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 and Dr. Stelios Asteriadis

**Date/time:** Thursday, 3rd of June 2021, 9:30-11:30h

**Format:** Closed book exam

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

**Instructions to students:**

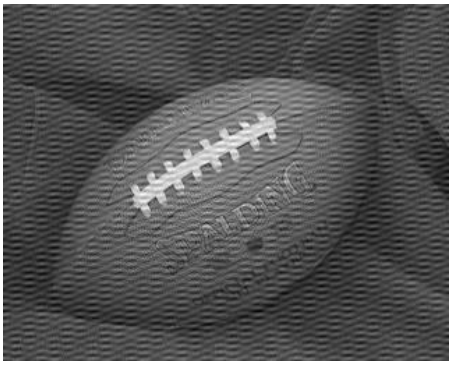
- The exam consists of 4 questions on 10 pages.
- Fill in your name and student ID number on each page, including the cover page.
- Answer every question at the reserved space below the questions. If you run out of space, continue on the back side, and if needed, use the extra blank page.
- Ensure that 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) Discuss and explain (with words, no math needed) when is useful to apply the 2D Fourier Transform (FT) to an image.
b) How can we adjust the FT technique for obtaining a blurring or a sharpening effect?
c) Which are the particularities of the convolution process of an image with a filter in the frequency domain?
d) Which technique could be applied to denoise the image displayed below?



**Question 2. (12.5 points) Harris Corner Detection**

a) Explain the basic idea of Harris corner detection without going into mathematical details. *hint:* make use of the notion of eigenvalues.
b) Is it possible to make use of the tool described in (a) for telling whether a small patch corresponds to an edge?
c) Why would corners be preferable to use as opposed to edges and for what purpose?
d) You are given a pair of stereo images where corners have been detected. The two images depict the same scene, partially. Briefly describe a way to create a panoramic image out of the two images.

*For (b)-(d), limit your answers within 4-8 lines*

**Question 3. (12.5 points) Deep Learning Applications**

a. Consider the task of object detection in an image; briefly describe in this case the advantages of deep learning techniques in comparison to traditional approaches.
*b.* Which DL models are suitable for object localization? Briefly present the main architectural blocks and their purpose.
c. Which architectural decisions can increase the efficiency of the localization task?
d. Your goal is to recognize the Eiffel Tower given a set of images, but you notice that after applying the PCA technique for reducing the dimensionality of features, the classification accuracy drops, why is this happening? Below you can find depicted a few examples from your training dataset.

**Question 4. (12.5 points) Epipolar geometry**

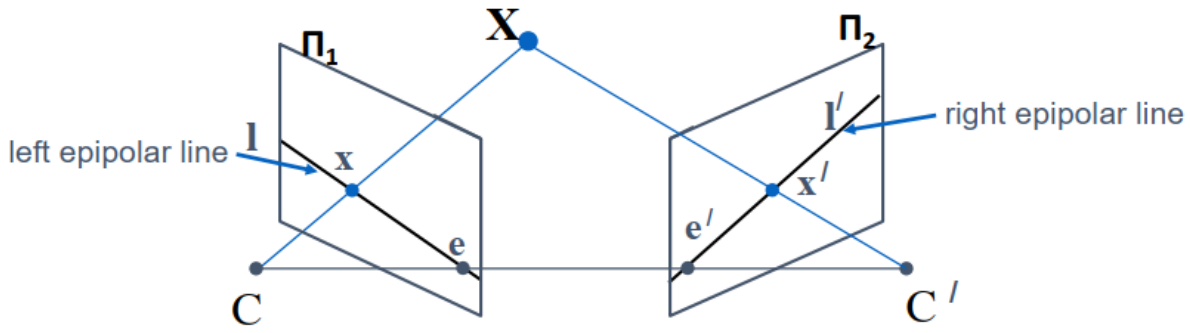



*Figure 1. Epipolar Geometry*

a) Given the example displayed in Figure 1. Let $\mathbf{P_1}$ and $\mathbf{P_2}$ be the two camera matrices and the fundamental matrix **F** corresponding to these camera matrices is of the following form:
**F= [a]$_x$ A**, where **[a]$_x$** is the matrix:

$$[\mathbf{a}]_x = \begin{pmatrix} 0 & -a_z & a_y \\ a_z & 0 & -a_x \\ -a_y & a_x & 0 \end{pmatrix}$$

Assume that $\mathbf{P_1 = [I|O]}$, where **I** is the identity matrix and $\mathbf{P_2 = [A|a]}$, where **A** is a 3x3 (nonsingular) matrix. Prove that the last column of $\mathbf{P_2}$, denoted by **a**, is one of the epipoles.

b) Briefly explain the difference between a perspective and an orthographic projection.

c) What happens with the epipoles, in case the cameras in Figure 1 ($\mathbf{\Pi_1}$ and $\mathbf{\Pi_2}$) are parallel?

d) In which case is the Fundamental matrix useful? Briefly describe its characteristics.

## Extra answer sheet