Vision and Perception
Exam A

20 June 2023

Name, Surname, Student ID [please compile here]:

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The exam has to be carried out in 1 hour and 40 minutes.
In order to pass the exam you need to get 18 and a minimum of 8 points in each of the two parts. The exam consists in 6 exercises. **Write the answers for the two respective parts on two separate sheets.**

1 Part 1

- **Exercise 1** Given an image Im and a filter f_1, shows the intermediate passages and the the resulting image g after applying the convolution operator between Im and f_1. Use the following coordinates (3,3), (1,2),(2,4) with "reflect across edge" padding. Which kind of filter is f_1? [4 points]

$$Im = \begin{bmatrix} 2 & 2 & 1 & 0 \\ 0 & 6 & 2 & 1 \\ 4 & 0 & 1 & 2 \\ 7 & 1 & 0 & 2 \end{bmatrix} \qquad f_1 = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

- **Exercise 2.a** List the main steps of SIFT detector and descriptor.
  Exercise 2.b State if SIFT is robust with respect to scale, rotation, perspective transformations and illumination variations. Justify your answer. [6 points]

- **Exercise 3** Describe one of the optical flow algorithm. What is the aperture problem? What is the direction in the image along which optical flow cannot be reliably estimated? [6 points].

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2 Part 2

- **Exercise 4** Describe the steps needed to map a 3D X point in world coordinates into a 2D x point in camera coordinates in a camera model by showing the intermediate representations/steps. Ignore the possible lens distortion effects. [6 points]
- **Exercise 5** In a two-view geometry, given an image point x in the first view, how this constraints the position of the corresponding point x' in the second view? Explain briefly. Which formula is linking x to x'? [6 points]
- **Exercise 6** Could a Deep Learning model be built without the use of activation functions (eg. ReLU)? Explain briefly why they are or aren't required for a successful deep model, and what will be the model behaviour without them. [4 points]