Final Examination

Applied Computer Vision

Summer Term 2018

Technische Universität Berlin — Computer Vision & Remote Sensing

Name: . . . . . **Student ID:** . . . . . .

Altogether ***33 points*** can be obtained. You have ***90 minutes*** to complete this exam.

- Please fill in your name and student ID on all sheets.
- No auxiliary resources allowed**.**
- Use a blue or black ballpoint pen - no pencil. Do not use any kind of correcting fluid or tape.
- Use only the provided sheets.
- A short and accurate style as well as a clear handwriting should be intended.
- Pay attention to a clear and comprehensible preparation of sketches.

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1. The Pinhole Camera Model

11P

$$\Lambda = \begin{bmatrix} \phi_x & \gamma & \delta_x \\ 0 & \phi_y & \delta_y \\ 0 & 0 & 1 \end{bmatrix}$$

a) What is the name of the above given matrix Λ? 1P

- Calibration matrix

b) Name and describe the parameters ϕ, γ and δ. 6P

-ϕ Scale factor: Photoreceptor spacing

-γ Skew parameter: No clear physical interpretation, helps to consider e.g. non right angles in CCD arrays

-δ Offset parameter: Difference between intersection of optical axis and image plane and center of image plane

c) The pinhole camera model alone does not describe real-world cameras sufficiently for some tasks. Why and which additional effect needs to be modeled for a more accurate approximation? 2P

Real-world cameras have lenses and we need to model radial distortion.

d) Besides the intrinsic camera parameters the extrinsic parameters are necessary for the complete pinhole camera model. What are those parameters and what do they describe? 2P

Relation between optical center and real world coordinate system (rotation and translation).

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2. Automatic Image Analysis

15P

a) Describe the general principle (the two main steps) we need to follow when we try to recognize patterns in images? 3P

- Transform data into feature space.
- Correlate locations in feature space and objective (class).

b) Images are often analyzed either using a regular grid of image coordinates or by choosing interesting points based on the image statistics. Which property of the image could be used to describe “interestingness” of an image region? Name a method that uses this property to compute interest points. 3P

Possible answers:

- Edges, Structure, Derivative
- Plessey/Harris, SIFT Detector

c) Given a set of vectors labeled with classes. Name and describe a method to associate an unlabeled data point with one of those classes. 3P

Possible answer:

k-nn: The class, the majority of its k nearest neighbors votes for is assigned to the unlabeled vector/data point.

d) Assuming no or only sparsely labeled data, we can only cluster the data in an unsupervised manner. This can be done e.g. using the k-Means algorithm. Describe the steps of the algorithm. 4P

0 - Choose number of cluster centers and select k seed points
1 - Assign all data points with the nearest of the k centroids (Voronoi).
2 - Update the cluster centroids with the cluster means.
3 - Repeat 1 and 2 until cluster update doesn’t change (convergence).