Berlin University of Technology

Computer Vision & Remote Sensing

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Example of a Final Examination

Applied Computer Vision

Summer term 2018

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

Auxiliary resources: none

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1. Concept of an Object Recognition Scenario **14P**

Your research task is to analyse a video sequence of people sitting at a table having breakfast. Among other things you are asked to provide an analysis explaining which items are on the table, how often each item has been touched, or used, and on which path it has been moved.

Please answer the following questions.

a) One of the requirements of the image analysis method to be developed is that it should be able to detect and localize objects in single frames (i.e. single images) of the video reliably.

Which are the challenges your method has to cope with? Please list problems expected and invariance properties the method needs to have. 4P

b) Does the breakfast video analysis context allow to take some problems less seriously than in general, context-free (or “any context”) situations? 2P

c) For instance based on the methods you have studied in lectures and exercises, suggest a step by step processing flow giving you the requested results listed in the description. Please do not forget to mention, if you need a training procedure that has to be completed before the analysis of a breakfast video. 5P

d) Consider the fact that in a video sequence subsequent frames are correlated, i.e. that they are similar to some degree.

How can this be used to make your system more robust? Consider both object recognition and object tracking. 3P

2. Convolutional Neural Networks

12P

Recently, deep learning methods and convolutional neural networks have been shown to be able to solve computer vision tasks very successfully.

a) Why was the technical term “Deep Learning” chosen as name of related methods? 2P

b) What is a convolution operation in image processing? Describe the operation using an example. Mention input and output to the operation. 3P

c) What is a “Convolutional Neural Network” (CNN)? Describe its structure with help of a sketch. 4P

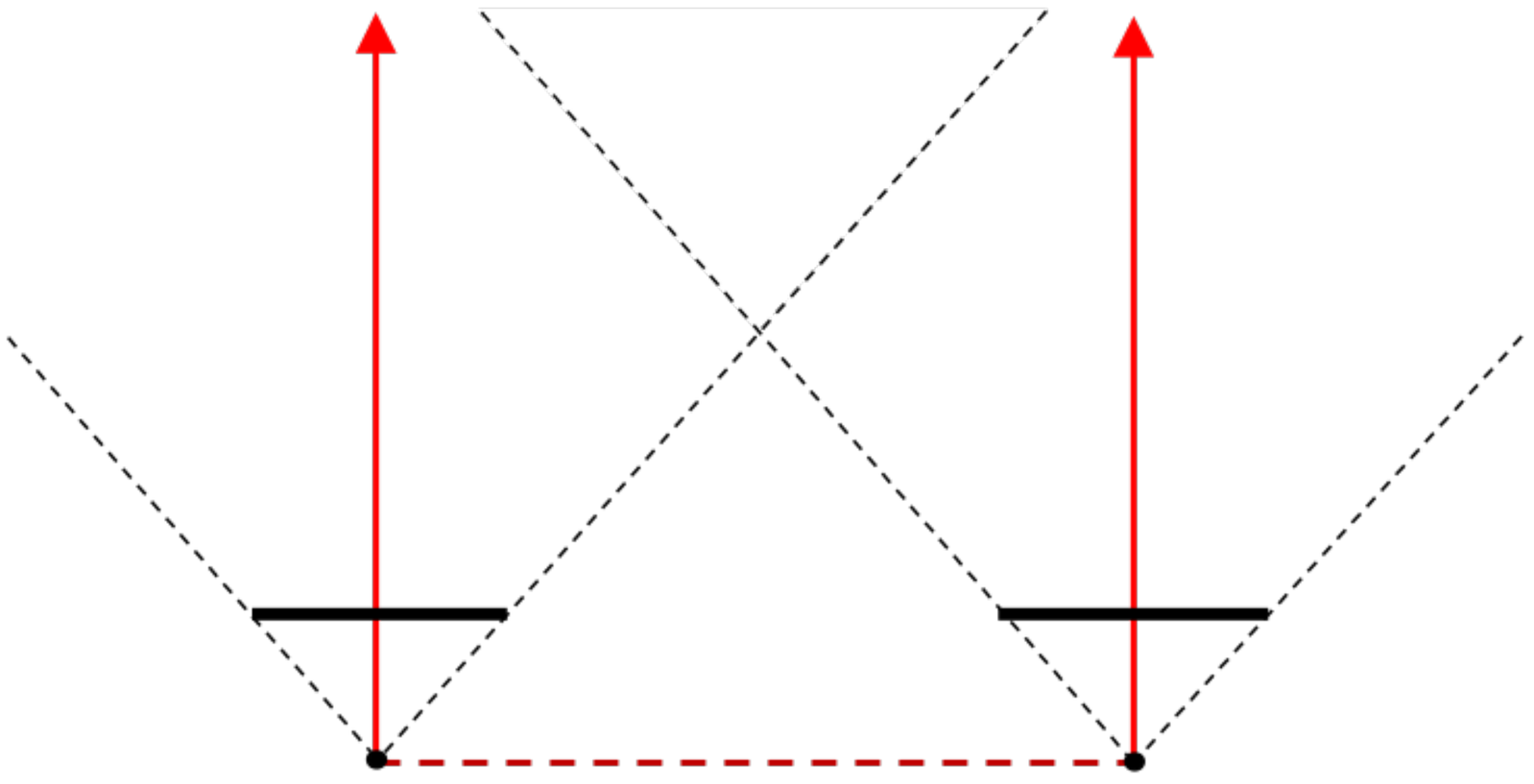
d) Give possible reasons why CNN are suitable to solve computer vision tasks. 3P

3. Image-Based 3D Object Reconstruction

7P

A pair of stereo images can be used to reconstruct 3D object space. The sketch

below shows a stereo normal image pair. For a stereo normal image pair the two image planes Π_1 and Π_2 are located in the same, common, plane, and the camera axes are parallel to each other and perpendicular to the baseline *b* connecting the projection centers O_1 and O_2 of the cameras.



a) Enter Π_1 and Π_2, O_1 and O_2, and *b* in the sketch. 1P

b) Enter an object space point **X** and its image points $\mathbf{x}_1$ and $\mathbf{x}_2$ in the sketch. 1P
Draw the rays projecting the object space point into the images.

c) What is the dimension of the vectors **X**, $\mathbf{x}_1$, and $\mathbf{x}_2$? Answer with respect to both the original spaces and the use of homogeneous coordinates. 2P

d) Derive a formula to compute the distance of the object space point from the baseline b? 3P

Altogether ***33 points*** can be obtained.
A short and accurate style as well as a clear handwriting should be intended.
Pay attention to a clear and comprehensible preparation of sketches.