



Final Examination
Introduction to Computer Vision

Summer term 2016

Name:

Student ID number:

Auxiliary resources: none

July 28, 2016

1. Pinhole Camera

4P

As is common practise, in the course we made use of the so-called Pinhole Camera Model.

- a) Describe the Pinhole Camera Model. Draw a sketch and introduce variables. 2P
- b) What is the major difference between a real camera and the pinhole camera model? Despite of this difference the pinhole camera model is sufficient for many tasks. Give reasons why! 2P

2. Raspberry Pi Cameras for 3D Object Reconstruction

14P

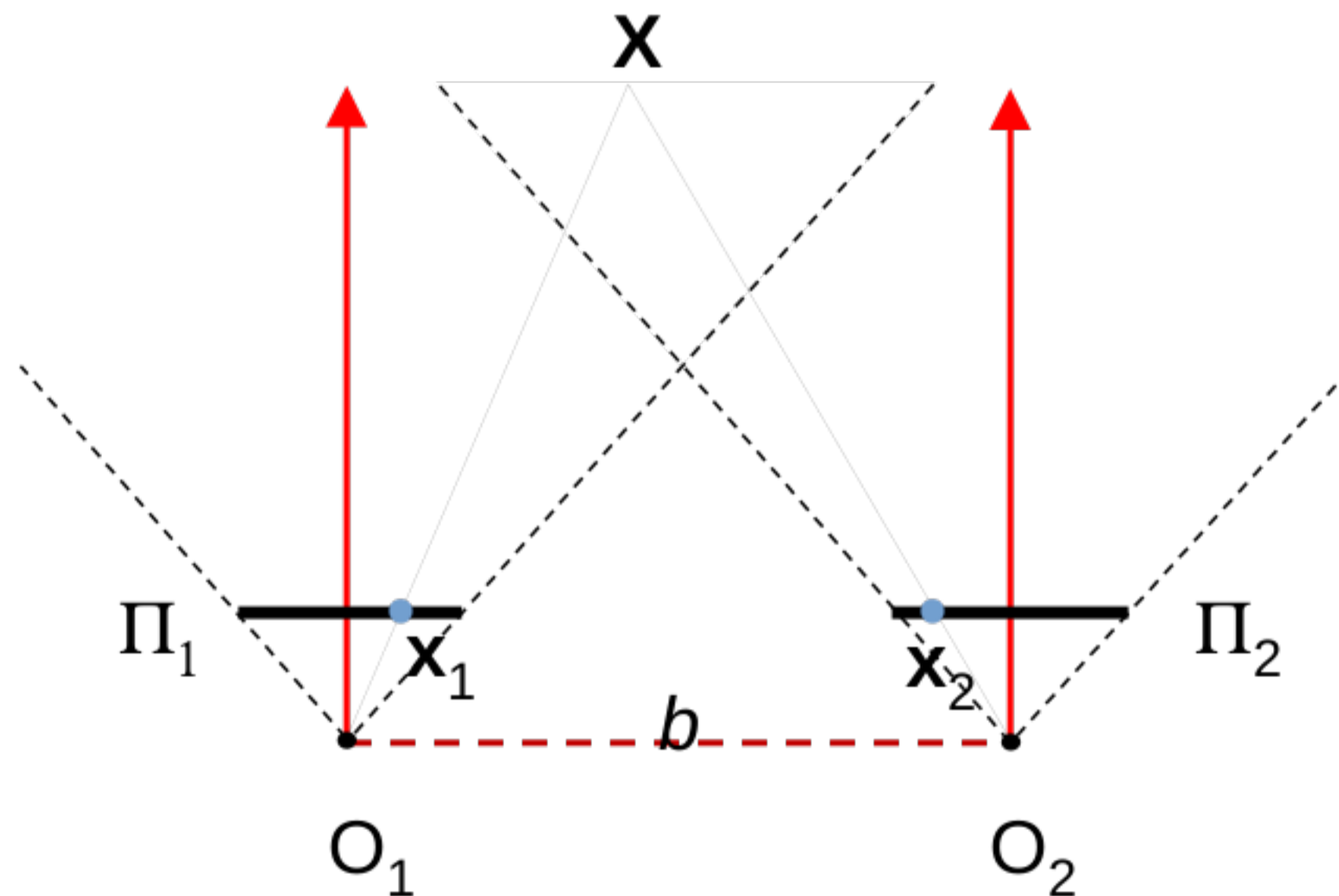
In an exercise Raspberry Pi 3 single board computers equipped with Raspberry Pi cameras have been used to acquire images of a moving object simultaneously in order to compute a 3D reconstruction of the object.

- a) What do you have to do in order to get a C++ program to run on a newly bought Raspberry PI which uses OpenCV library methods for processing video frames? 4P
- b) Which problems occur when 3D reconstructions of moving objects are wanted? In your answer consider both a single/individual camera as well as the compound system consisting of several cameras. 2P
- c) In order to obtain high-quality 3D reconstructions, cameras need to be calibrated. The camera calibration expresses the interior geometry, called interior orientation, of the camera. The most important calibration parameters are contained in the calibration matrix 5P

$$\begin{bmatrix} \Phi_x & \gamma & \delta_x \\ 0 & \Phi_y & \delta_y \\ 0 & 0 & 1 \end{bmatrix} .$$

Name and shortly explain the parameters of the calibration matrix.

- d) 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. The image points \mathbf{x}_1 and \mathbf{x}_2 are used to compute the object space point \mathbf{X} .



3P

Derive a formula to compute the distance of the object space point from the baseline b ? If necessary introduce further parameters.

3. Vocabulary Search Trees

15P

Vocabulary Search Trees are, for instance, used to recognize locations that have been seen before.

- a) Vocabulary Search Trees make use of “visual words”. What is a visual word? Give a general description and an example with reference to a specific image processing method. 3P
- b) Vocabulary Search Trees make use of k-means clustering. Describe the k-means clustering algorithm. 3P
- c) The ability of the Vocabulary Search Tree method to identify objects or locations is – to some degree – based on a weighting making use of a “term frequency – inverse document frequency” (TF-IDF) scheme. Describe the TF-IDF scheme. Explain both components and their influence on the weighting of a visual word found in an image. 3P
- d) A tourist agency asks you to develop a system that allow tourists to use a smartphone image of a sight to get information about it. 6P

Describe such a system making use of the Vocabulary Search Tree method.

In addition to the description also list the practical things (steps of work) you have to do in order to set up the system. Hint: Think in practical work in town as well as the visual location recognition software system.

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.