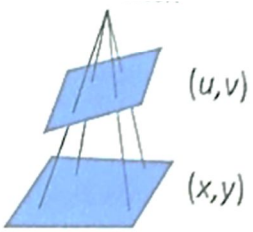
1. Compare alternatives how a camera can be calibrated

1: (6 p.)

Camera calibration is an essential part of photogrammetric measurements. Discuss about alternatives how to make a camera calibration

1. 2D projective transformation is the most useful tool to, e.g., rectify an image to the normal case of stereo imaging or to create panoramic images. Solve the contents of matrix *A* and vector *l* for one observation pair. (Tip. Reorder the elements of equations according to unknown parameters and convert them into a matrix-vector representation)

$$u = \frac{n_{11}x + n_{12}y + n_{13}}{n_{31}x + n_{32}y + 1}$$
$$v = \frac{n_{21}x + n_{22}y + n_{23}}{n_{31}x + n_{32}y + 1}$$



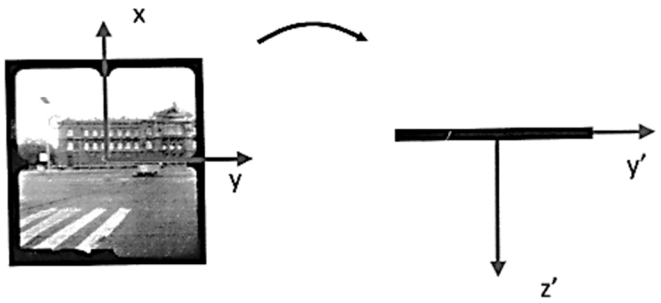
$Ax=l$

$$\begin{bmatrix} - & - & - & - & - & - & - & - \\ - & - & - & - & - & - & - & - \end{bmatrix} \begin{bmatrix} n_{11} \\ n_{12} \\ n_{13} \\ n_{21} \\ n_{22} \\ n_{23} \\ n_{31} \\ n_{32} \end{bmatrix} = \begin{bmatrix} - \\ - \end{bmatrix}$$

2.

a. Write the 3D rotation matrix that correctly makes the transformation illustrated below. Both camera coordinate systems are right-handed

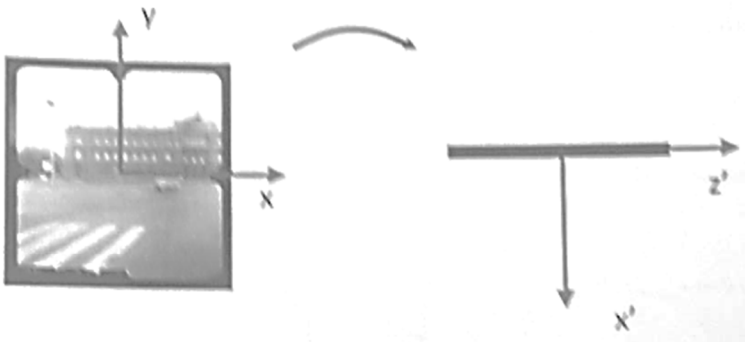
(3 p)



b. In which observation parameters the correction parameters of terrestrial laser scanners are typically attached?

a. Write the 3D rotation matrix that correctly makes the transformation illustrated below. camera coordinate systems are right-handed

(3 p)



b. What kinds of lens distortions are typically corrected with the Brown's lens distortion model?

b. In industrial environments, there might be special conditions that make it difficult to apply a multi-camera system. Mention at least three of such conditions that might disturb measurements.

2: (6 p.)
Atmospheric correction is often a prerequisite for the use of optical remote sensing data in many applications. Three different situations (a, b, c) have been outlined below. Please name and describe an atmospheric correction method you would use in each of the cases. Select a different method for each case based on what you learned during the course.

a. You have multispectral satellite images covering the entire planet. You are creating a global map of forest cover once per month from the data. (max 2 points)
b. You have a set of two multispectral satellite images from a remote area that cannot be accessed easily. You will use the image to predict changes in a biophysical variable during the study period. The remote area includes a large, clear lake. (max 2 points)
c. You are planning to collect airborne optical remote sensing data around a field station owned by the university. During the flight campaign you have access to a field spectrometer and help from research assistants. (max 2 points)

a. Tell about flash-lidar 3D-depth cameras.
b. Describe the principle of triangulation-based laser scanners.

a. Tell about the properties of 3D rotation matrices.

3. What kind of registration methods can be applied to register several laser scans into the same coordinate system?
3. Tell about the classification of terrestrial laser scanning point clouds.

3. You have collected several 3D point clouds with a terrestrial laser scanner. How would you process data?

4: (6 p.)
Describe at least three methods for finding neighboring points in case of point cloud classification.

4. Tell about atmospheric corrections of satellite images.

5: (6 p.)
Laser scanning error sources can be divided to four basic categories, what are they and please give some examples of each category.

4. Explain the main principle in the following methods that can be used to interpret optical satellite data. Give an example of a variable the method could be used to map and explain why the method is appropriate for it.

A. Linear spectral mixture analysis
B. Derivative spectroscopy of vegetation
C. Tasseled cap transformation

4. Atmospheric correction is often a prerequisite for the use of remote sensing data in many applications. Three different situations (a, b, c) have been outlined below. Please name and describe an atmospheric correction method you would use in each of the cases. Select a different method for each case based on what you learned during the course.

a. You have satellite images covering the entire planet. You are creating a global map of canopy cover once per month from the data.

b. You have a set of two satellite images from a remote area that cannot be accessed easily. You will use the image to predict changes in a biophysical variable during the study period. The remote area includes a clear lake.

c. You are planning to collect airborne remote sensing data around a field station owned by the university. During the flight campaign you have access to a field spectrometer and help from research assistants.

5. A spectroradiometer has been used to measure the reflectance spectra of five targets outdoors

a. Please name the targets (A, B, C, D, E in the figure below) and explain how you identified them.

b. Which of the targets is the brightest in the shortwave infrared (SWIR) domain?