Photogrammetry & Robotics Lab, Bonn

3D Coordinate Systems
(Bsc Geodesy & Geoinformation)

0. Introduction

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The slides have been created by Wolfgang Förstner.

Topics
- Spatial Motions and Similarities
- Representation and Estimation
- Uncertainty Analysis

Example
- Mobile Mapping System with Several Sensors
- Represent and Estimate
  - Mutual Relations of Sensors
  - Motions of Vehicles
- Describe Uncertainty of Relations

Applications (1/3)
- Surveying
  - Integration of measurements from different viewpoints
  - Evaluation
  - Observation
  - Observing

Applications (1/3)
- Surveying
  - Integration of measurements from different viewpoints
  - Evaluation of deformations
  - Observation from moving platforms
  - Observation of moving objects
Applications (1/3) → Mobile mapping

- Surveying
  - Integration of measurements
  - Evaluation of deformations
  - Observation from moving platform (Mobile mapping)
  - Observation of moving objects


Applications (1/3) → traffic monitoring

- Surveying
  - Integration of measurements
  - Evaluation of deformations
  - Observation from moving platforms
  - Observation of moving objects

https://www.youtube.com/watch?v=sswTalNzKlo

Applications (2/3)

- Photogrammetry/Computer Vision
  - Modelling systems of cameras or LiDAR
  - Object tracking from one of more cameras
    → Track human poses

- Theoretical Geodesy
  - Integration of measurements of satellites
  - sometimes only rotations
  - Coordinate transformations between ground and space borne sensors (e.g. GPS)

Applications (2/3)

- Photogrammetry/Computer Vision
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- Theoretical Geodesy
  - Integration of measurements of satellites
  - sometimes only rotations
  - Coordinate transformations between ground and space borne sensors (→ Lunar Reconnaissance Orbiter)
Focus of lectures
- Rotations
- Motions
- Similarities

Generalizations to
  perspective mappings or
  mappings on the sphere
  → Specialized lectures
      (photogrammetry, satellite geodesy)

Questions to be answered
- How to represent spatial motions and similarities?
- How many parameters are necessary?
- How to concatenate motions and similarities?
- How to derive transformations from observations?
- How to handle outliers?
- How to represent uncertain motions?
- How to determine the uncertainty of motions?

Tool boxes to be used
- **Projective geometry:**
  easy and compact representation of
  concatenation and inversion
- **Probability theory and statistics:**
  easy and compact representation of uncertainty
- **Calculus:**
  easy propagation of uncertainty and
  estimating parameters of nonlinear relations

Timing Estimate for this Course
- 3 ECTS points = 90 h workload
- Lectures = 15 h (1 h per week, 15 weeks) on an average
- Exercises = 45 h (3 h per week, 15 weeks)
- Exam preparation = 30 h
Exercises

- Mandatory homework assignments
- Nominal 45 points per exercise
  1 point per minute, if perfectly prepared
- Requirement: 50% of points
- 2 written examinations: Midterm and Endterm
- Time for exercise: 1 week (see deadlines)
- Time for evaluation: 1 week
- Interactive discussion

Table of contents and references

- The numbers appearing in the slides refer to the German lectures. The letter "V" in the following table of contents refers to "Vorlesungen" not to videos.
- The slides for each video and the complete set of slides contain the references for all videos
- A large part of the videos cover material from the book Förstner/Wrobel (2016). The relevant pages are given in the slides for each video

Next lecture

1. Motions and Similarities in the Plane

Table of contents/Inhalt

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References of video series