Mathematical Principles in Vision and Graphics

Ass.Prof. Friedrich Fraundorfer

SS 2019

About me

- Ass. Prof. Dr. Friedrich Fraundorfer
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- Send email to schedule an appointment

Additional lecturer

- Ass. Prof. Dr. Markus Steinberger
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- Institute of Computer Graphics and Vision
- Inffeldgasse 16/II

Course grading

- 3 class room assignments (50% of grade)
  - Math problems
  - Small programming assignments
- Final written exam (50% of grade)

- Written exam at last lecture slot (26 June 2019)
- Submitting the first assignment counts as attempt. A grade will be issued in this case.

- *“§ 22 para. 4: In order to assist students in completing their degrees in a timely manner, all courses with continual assessment must allow students to submit, supplement or repeat in any case at least one partial course requirement to be determined by the course director, by no later than four weeks after the course has ended.”*
- This one course requirement is the examination.

Assignments

- Individual work, no group work
- Electronic submission using the TeachCenter (Hand-writing and scanning is ok)

- Schedule:
  - Class room assignment 1:
  - Handout: 10.4.2019
  - Deadline: 29.4.2019

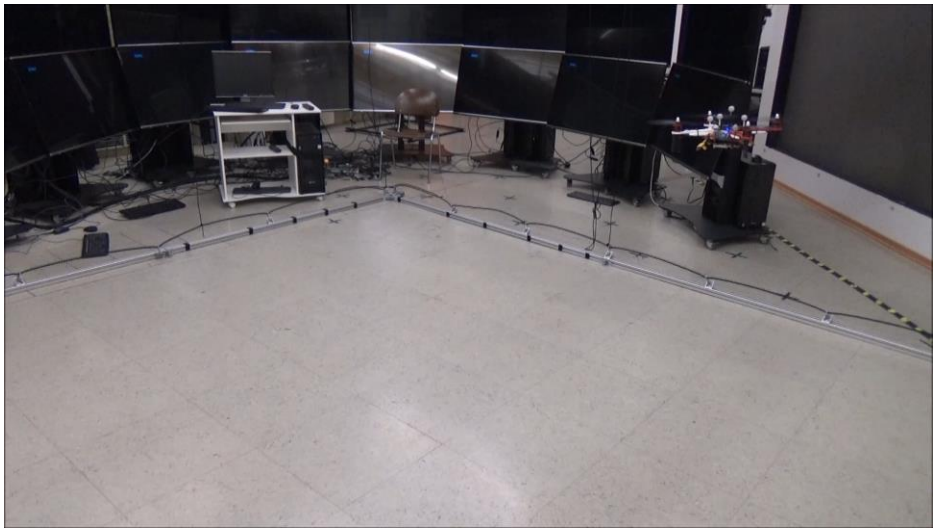
  - Class room assignment 2:
  - Handout: 8.5.2019
  - Deadline: 28.5.2019

  - Class room assignment 3:
  - Handout: tba
  - Deadline: tba

Lecture material

- Slides are the main material
- Links to relevant publications and book sections will be given
- Lecture will be recorded and recordings are visible for you in the Teach Center

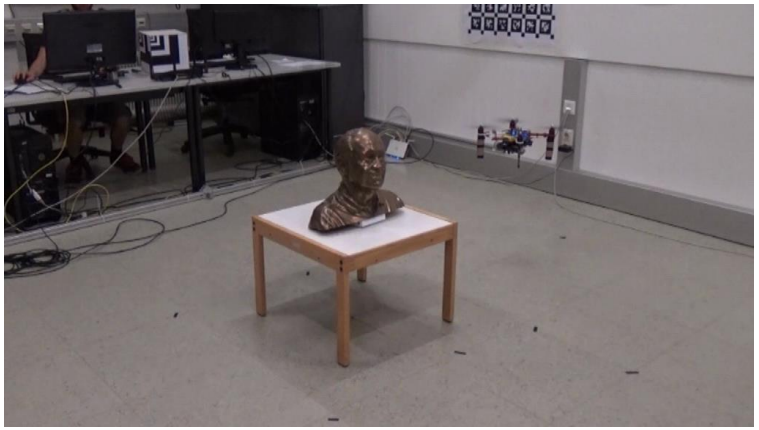
Research areas



Project examples

- Vision based landing and following

- Flying 3D scanner

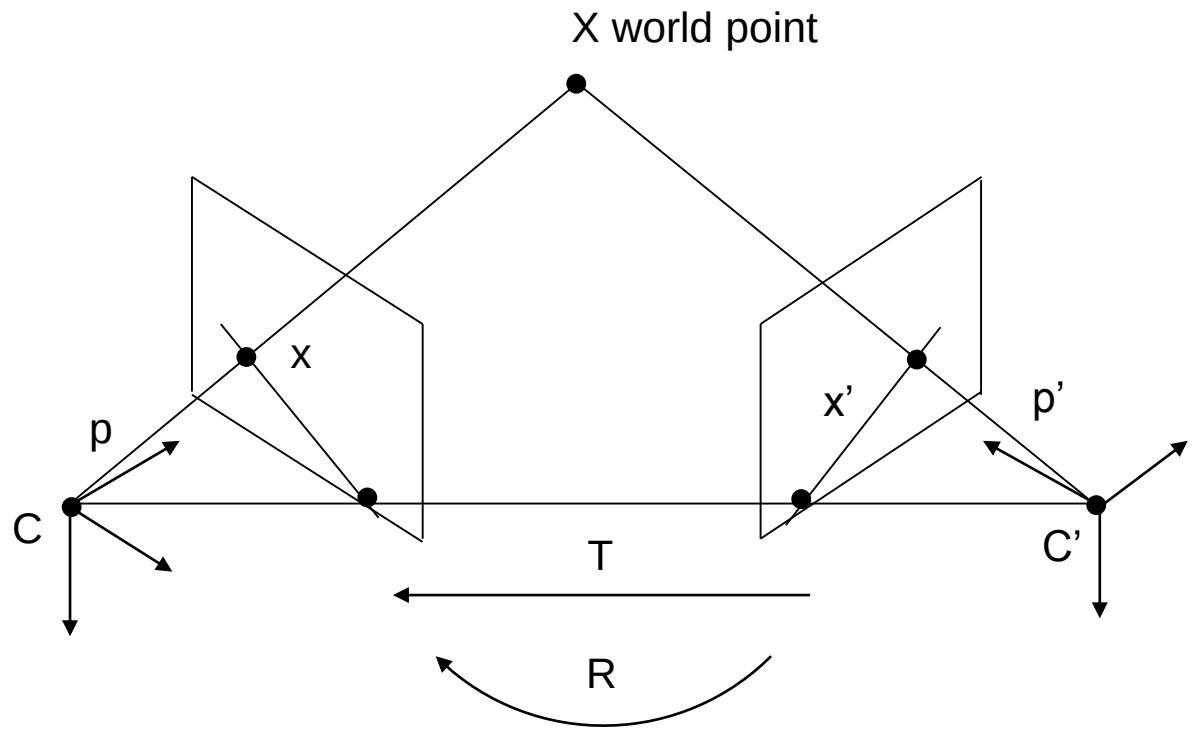


Topics

- Projective geometry
- Geometry of multi-view camera system
- Parameterization of rigid transformations
- Robust estimation (Ransac, Robust cost functions)
- Polynomial systems in computer vision
- Root-solving
- Mesh Matrix Basics (Steinberger)
- Subdivision and its Applications (Steinberger)
- Splines (Steinberger)
- Topology (Steinberger)

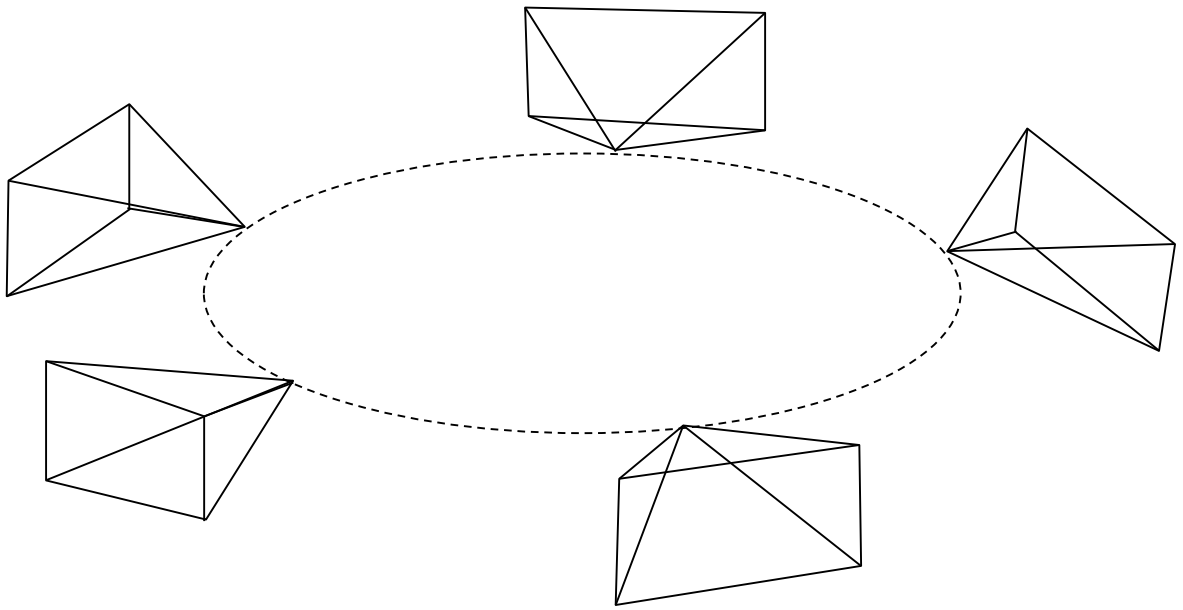
Projective geometry

$$x'^T F x = 0 \quad \textit{... Epipolar constraint}$$



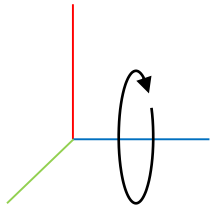
Geometry of multi-view camera system

$$l'^{T} E_G l = 0 \quad \textit{... generalized Epipolar constraint}$$

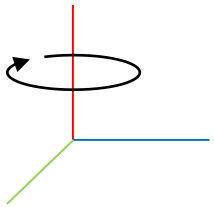


Parameterization of rigid transformations

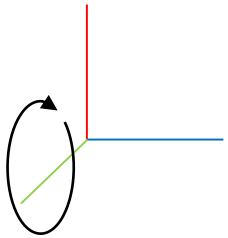
$$R_x(\alpha) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\alpha & -\sin\alpha \\ 0 & \sin\alpha & \cos\alpha \end{bmatrix}$$



$$R_y(\beta) = \begin{bmatrix} \cos\beta & 0 & \sin\beta \\ 0 & 1 & 0 \\ -\sin\beta & 0 & \cos\beta \end{bmatrix}$$

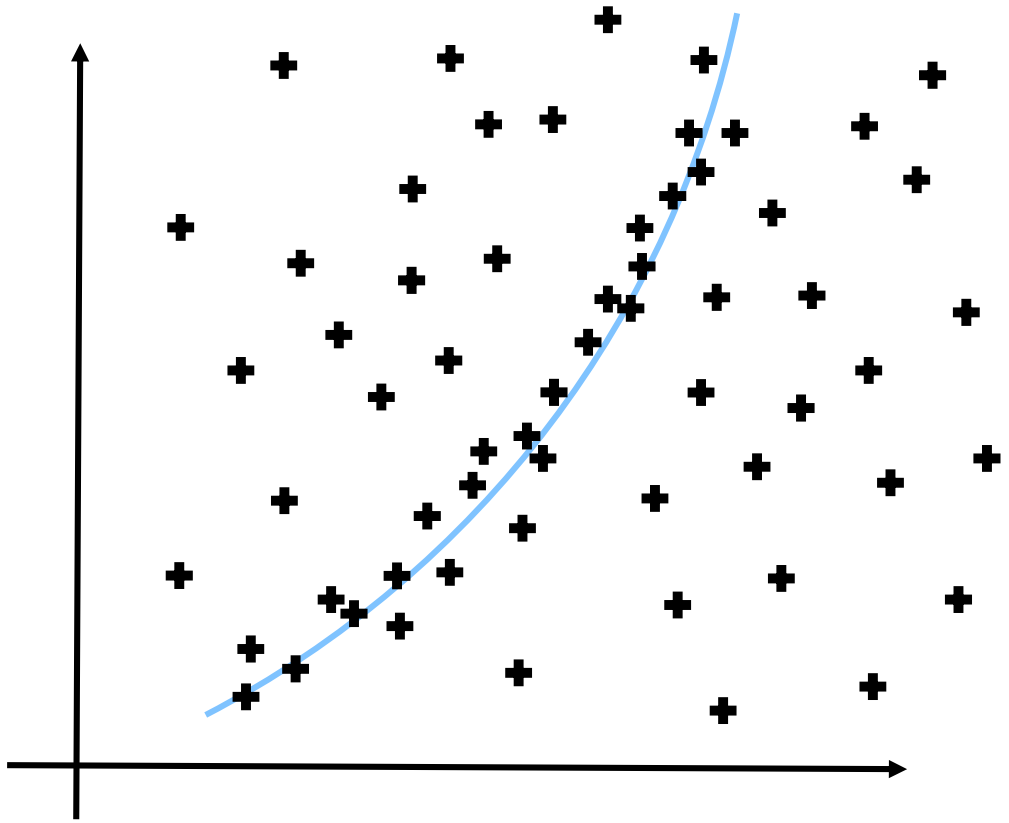


$$R_z(\gamma) = \begin{bmatrix} \cos\gamma & -\sin\gamma & 0 \\ \sin\gamma & \cos\gamma & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



Robust estimation

- Ransac – Random sample consensus



Polynomial systems in computer vision

- P3P, PnP problem:

$$\begin{array}{l} L_1 \\ L_2 \\ L_3 \end{array} \begin{cases} 2x^2 + y^2 - 2z + 3z^2 + 5 &= 0 \\ x^2 + z + z^2 &= 0 \\ x^2y^2 + y^2z^2 - 2 &= 0 \end{cases}$$