

Computer Vision: Lecture 1

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Outline

- General course information
- What is computer vision?
- Research and applications
- Modelling cameras

General Course Information

- Lectures: $13 \times 2h$.
- Assignments: 5 (**mandatory!**)
- Q & A-sessions: $5 \times 2h$

Q & A-sessions are optional! They are intended to be an opportunity to ask questions about the assignments.

Course requirements

- Passing the course: Completed assignments (submitted on time).
- Higher grades (4 or 5): Same as above, written home-exam and oral exam. NOTE: Good solutions to optional exercises in the assignments will give bonus credits for the written home-exam.

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Assignments and Q&A-sessions

- 5 assignments, contain both regular exercises and computer exercises.
- Main body of work in the course.
- Ask questions and get help during Q&A-sessions.
- Some of the exercises are hard. If you get stuck send a mail to carl.olsson@math.lth.se.

Some Instructions/Advise

- Feel free to work in groups (as many as you want).
- The reports should be written individually. (You should understand and be able to explain the solution you hand in.)
- Ask as many questions as you like.

Assignments and Q&A-sessions

Work distribution

- Assignment 1: warm up, quickly solved.
- Assignment 2: lots of work (make sure that you don't start too late)
- Assignment 3: lots of work (make sure that you don't start too late)
- Assignment 4: moderate
- Assignment 5: moderate

Plan your work accordingly. Check the suggested schedule for guidance.

Literature

- Lecture notes. (Posted on the web. Continuously updated.)
- Some additional scientific papers.

Additional Reading

- Hartley, Zisserman, Multiple View Geometry, 2004.
- Szeliski, Computer Vision Algorithms and Applications, 2010.
Available online; <http://szeliski.org/Book/>

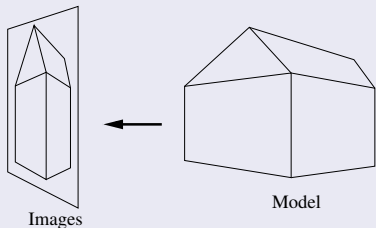
Sign-up and Registration

There is no registration during at the lectures anymore!
Registration is done at "Studentportalen".

If you have not signed up for the course or have registration issues contact the administrators: expedition@math.lth.se

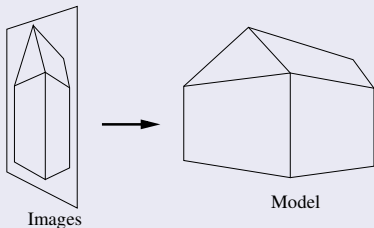
What is Computer Vision?

Computer Graphics



Generate images from a 3D model.

Computer Vision



The inverse problem: Generate 3D model from images.

Main Goal of the Course: Multiview Reconstruction

Given Images



4 images out of a sequence with 435 images.

Compute 3D Model



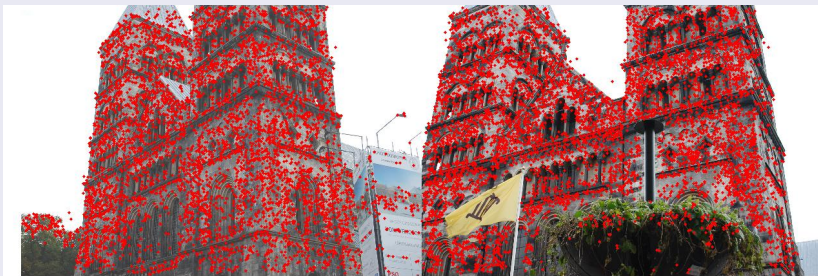
Reconstruction Pipeline

Point Detection and Matching



Reconstruction Pipeline

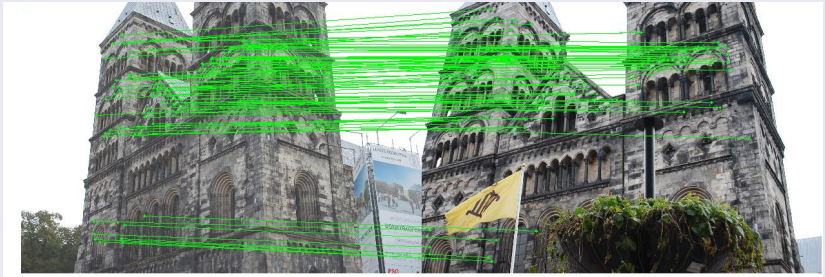
Point Detection and Matching



Detect interesting (descriptive) points in all images.

Reconstruction Pipeline

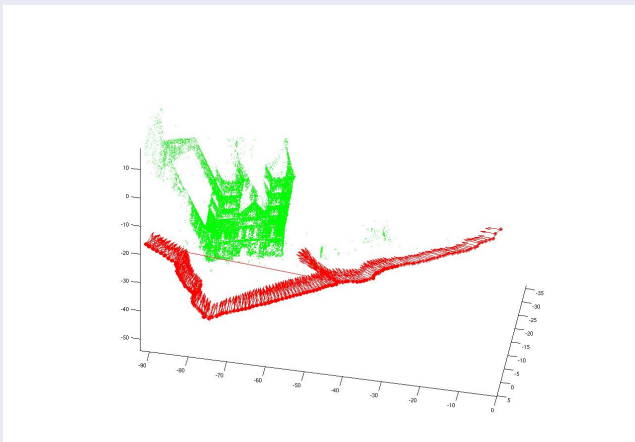
Point Detection and Matching



Match points between images.

Reconstruction Pipeline

Geometric Computations (main part of this course!)

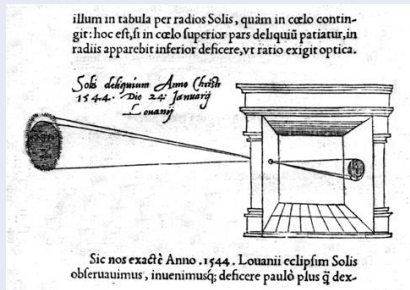


Compute 3D-positions of the matched points, position and orientation of the cameras.

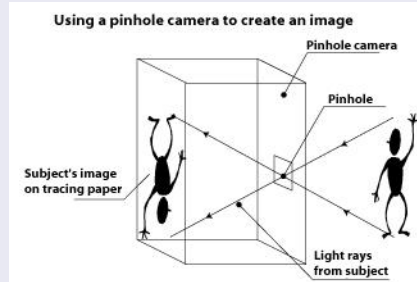


Camera Model

The Pinhole Camera

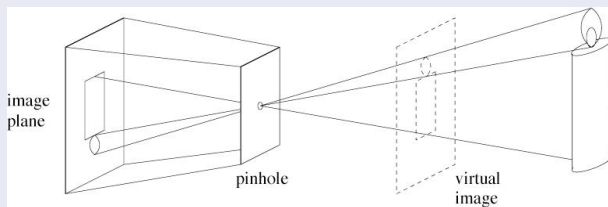


Reinerus Gemma-Frisus
camera obscura from 1544.



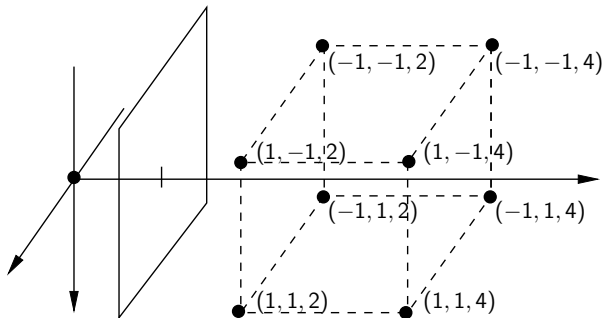
Camera Model

The Pinhole Camera



Exercise 1

Compute the image of the cube with corners in $(\pm 1, \pm 1, 2)$ and $(\pm 1, \pm 1, 4)$.



Exercise 2

What is the position of the camera (the coordinates of the camera center) in the global coordinate system? What is the viewing direction in the global coordinate system?

Exercise 3

Compute the projection of $X = (0, 0, 1)$ in the cameras

$$P_1 = \begin{pmatrix} \frac{1}{\sqrt{2}} & 0 & -\frac{1}{\sqrt{2}} & 0 \\ 0 & 1 & 0 & 0 \\ \frac{1}{\sqrt{2}} & 0 & \frac{1}{\sqrt{2}} & 1 \end{pmatrix} \text{ and } P_2 = \begin{pmatrix} 1 & 0 & -1 & 0 \\ 0 & \sqrt{2} & 0 & 0 \\ 1 & 0 & 1 & \sqrt{2} \end{pmatrix}.$$

Exercise 4

Suppose that P is a 3×4 matrix that can be factorized into $P = K [R \ t]$ where K is upper triangular with positive diagonal elements and R is a rotation. How can we find the camera center and viewing direction from P without computing the factorization?