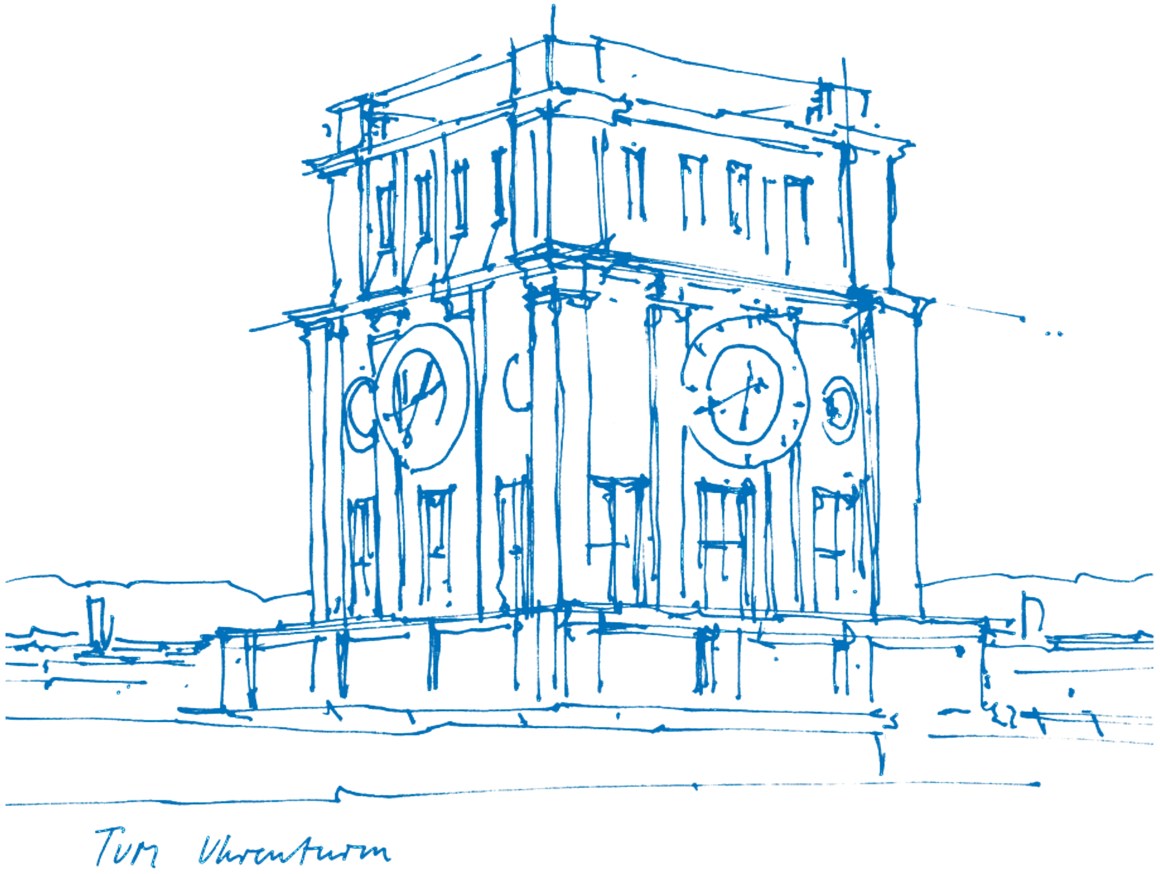
Practical Course: Vision Based Navigation

Premeeting

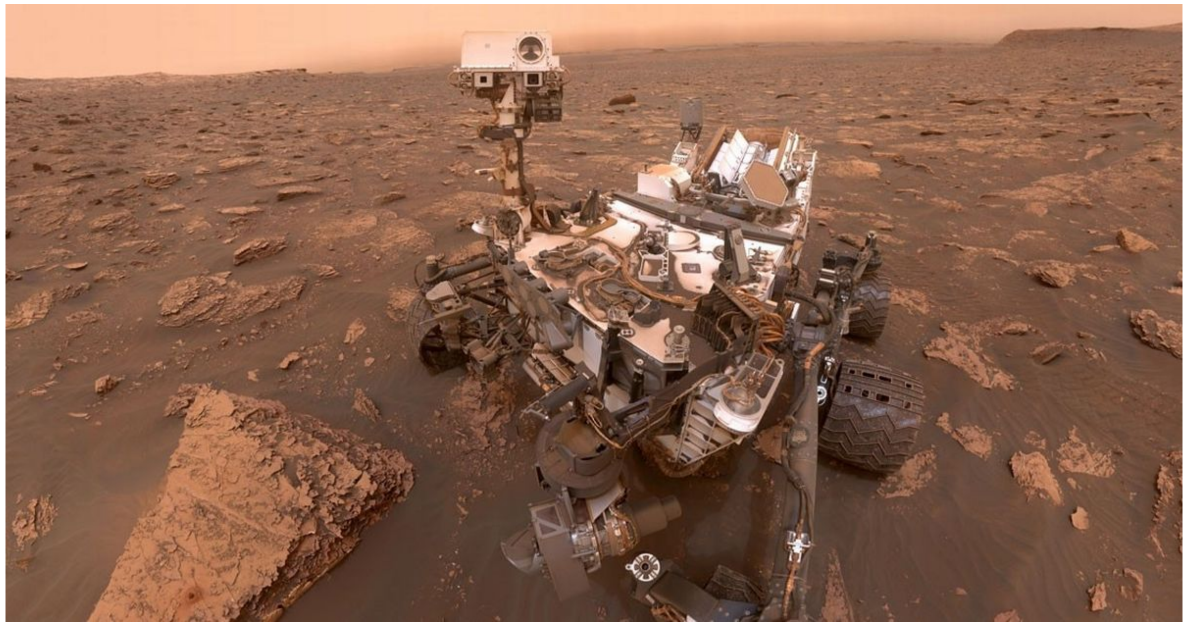
Jason Chui, Simon Klenk, Sergei Solonets
Prof. Dr. Daniel Cremers



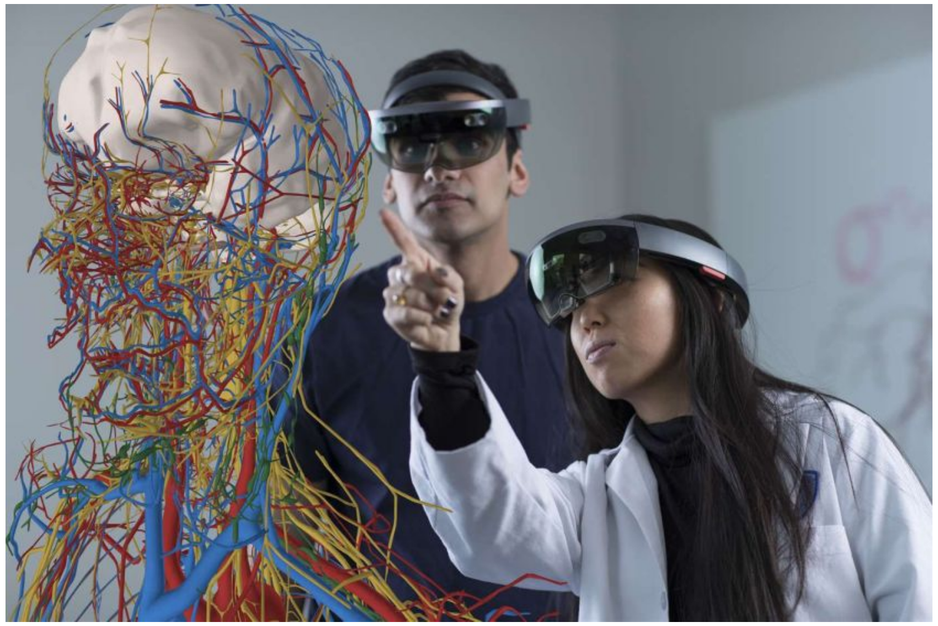
Version: 14.07.2022

Motivations

No GPS



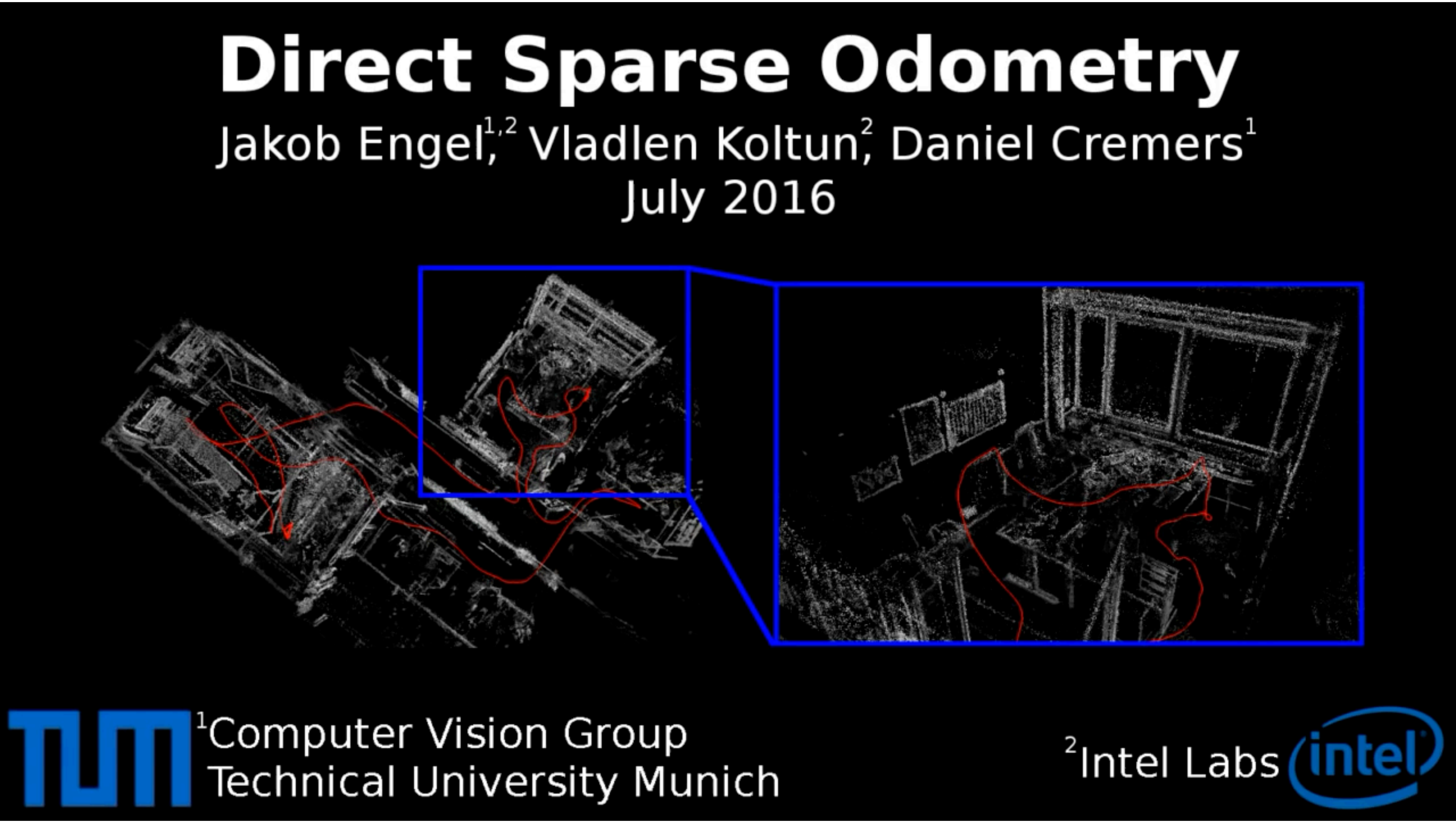
Pose estimation



3D reconstruction

Path planning(when we have a map)

DSO


Direct Sparse Odometry
Jakob Engel[1,2], Vladlen Koltun[2], Daniel Cremers[1]
July 2016
[1]Computer Vision Group
Technical University Munich
[2]Intel Labs
intel

ORB-SLAM

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Raúl Mur-Artal, J. M. M. Montiel and Juan D. Tardós

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Universidad Zaragoza

Content of this course

- You can gain practical experience with
  - Visual odometry and localisation / state estimation
  - Vision-based Simultaneous Localization and Mapping (SLAM)
  - Structure from Motion (SfM)
- Implementation of algorithms
- Benefits / drawbacks of specific methods when applied to concrete, relevant problems
- Get familiar with relevant software libraries (Eigen, Ceres, OpenGV, …)
- Learn how to work in teams / on projects
- Improve your presentation skills

Course organisation

- Course takes place during the lecture period

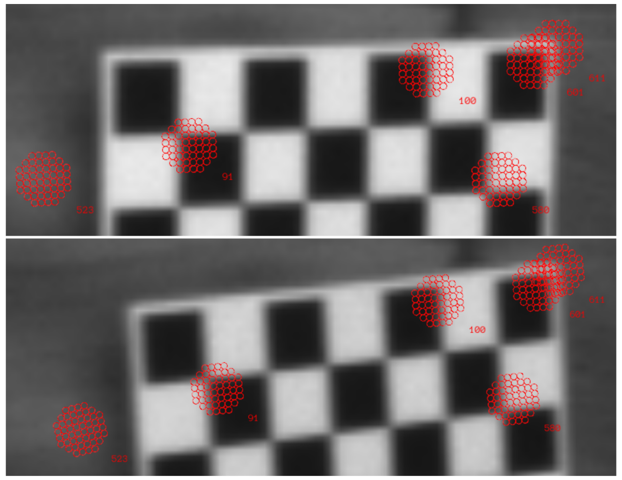
- The course will be held in person
  - Work on your own Linux desktop / laptop

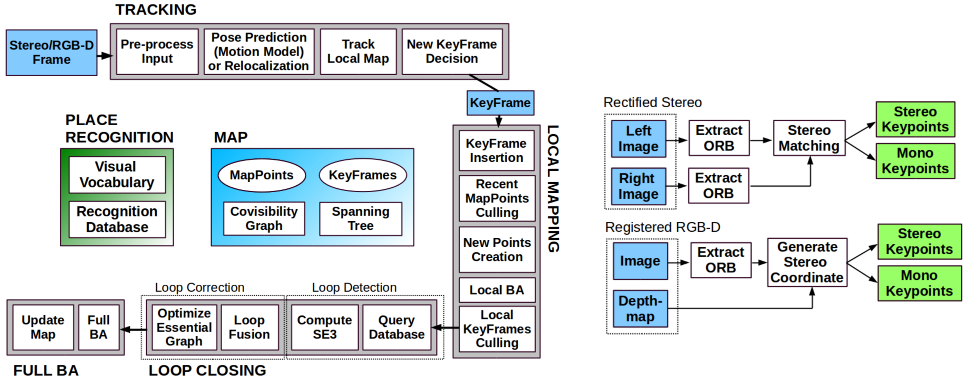
- Initial phase (first 5 weeks): Lectures & Exercises
  - Mondays 2-4 pm lecture
  - Mondays 4-6 pm exercise session
  - Programming assignments will be handed out every week and checked / graded by the tutors
  - Assignments are worked on individually by every student; each participant should be able to explain their solution
  - Attendance to lecture and exercise sessions voluntary (but **highly** encouraged)

- Second phase (6 weeks): project
  - Work in small groups (1-2 people) on a project
  - Mandatory weekly meeting with tutors to discuss progress and next steps (Mondays 2-6 pm)
  - Implement a specific algorithm / extension / paper, which one tbd
  - Present project outcome in talk and Q&A session (15 mins per group + 5 mins Q&A)
  - Written report on project outcome (10-12 pages, single column, single-spaced lines, 11pt)

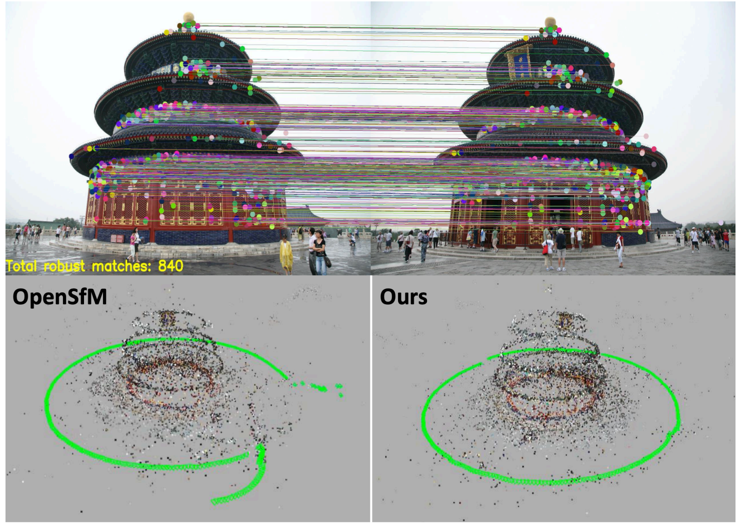
Topics covered

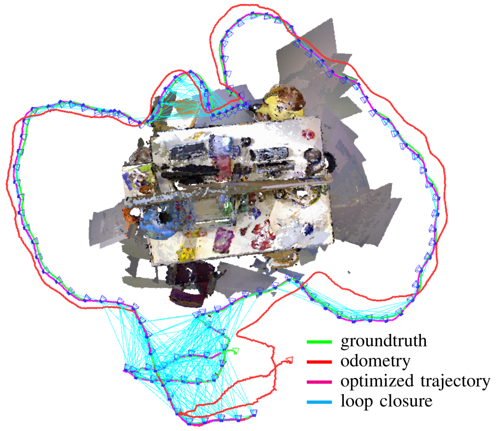
- 3D geometry and camera models
- Non-linear optimisation and camera calibration
- Feature detectors and descriptors, feature matching, RANSAC
- Offline Structure from Motion, Bundle Adjustment, Schur complement
- Visual odometry and SLAM (online BA)
- Possible topics for projects:
  - Large-scale consistency for SLAM
  - Visual place recognition
  - Optical flow for visual odometry
  - Direct methods (odometry, BA)
  - Dense reconstruction
  - Rotation / Translation averaging (global SfM)
  - …

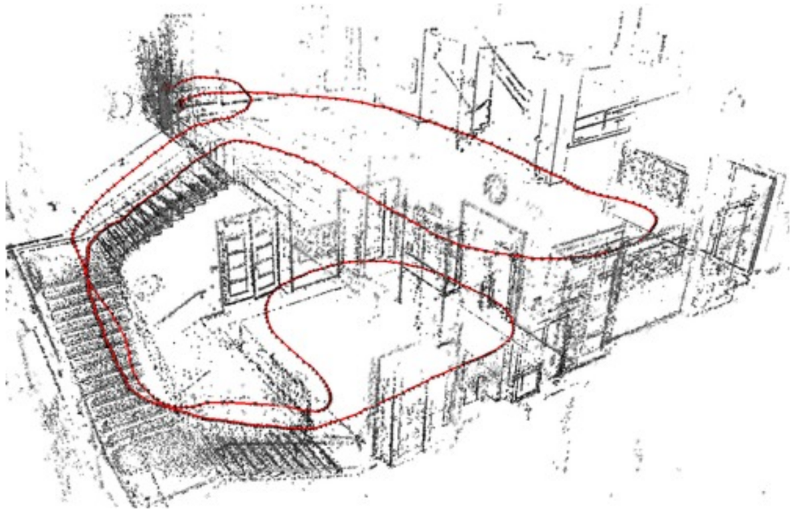




(a) System Threads and Modules. (b) Input pre-processing







Course requirements

- **Good knowledge of the C/C++ language is essential**
- Good knowledge of basic mathematics such as linear algebra, calculus, probability theory, and numerics is required
- Prior practical knowledge in robotics and computer vision topics is a plus
- Participation in at least one of the following lectures of the TUM Computer Vision Group
  - Computer Vision I: Variational Methods
  - Computer Vision II: Multiple View Geometry
  - Similar lectures can also be accepted

Course registration

- You apply for this course through the matching system: https://matching.in.tum.de/

- Additionally, you have to send us an email:
  - Please specify how you meet the course requirements / if you have attended any related computer vision courses before!
  - **Comment on you programming experience in C++!** List concrete examples of projects you have worked on.
  - Send all your grade transcripts, in particular showing any lectures on pre-requisite topics (computer vision / robotics / maths) that you have attended to: visnav-ws22@vision.in.tum.de

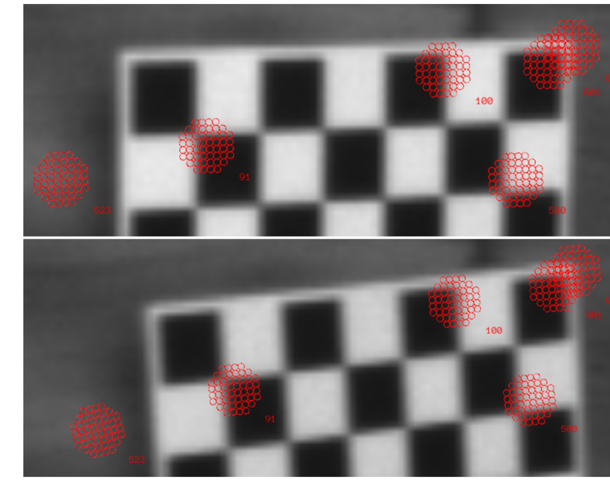
- The deadline for the matching system and prerequisite email is 27.07.2022.

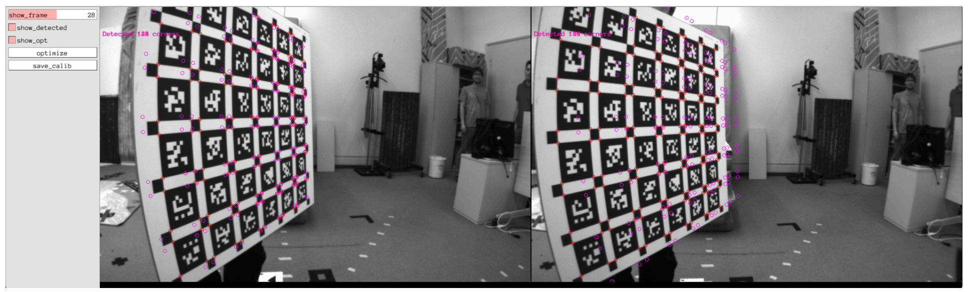
- We can only guarantee places to students assigned through the matching process (and fitting the course requirements)!

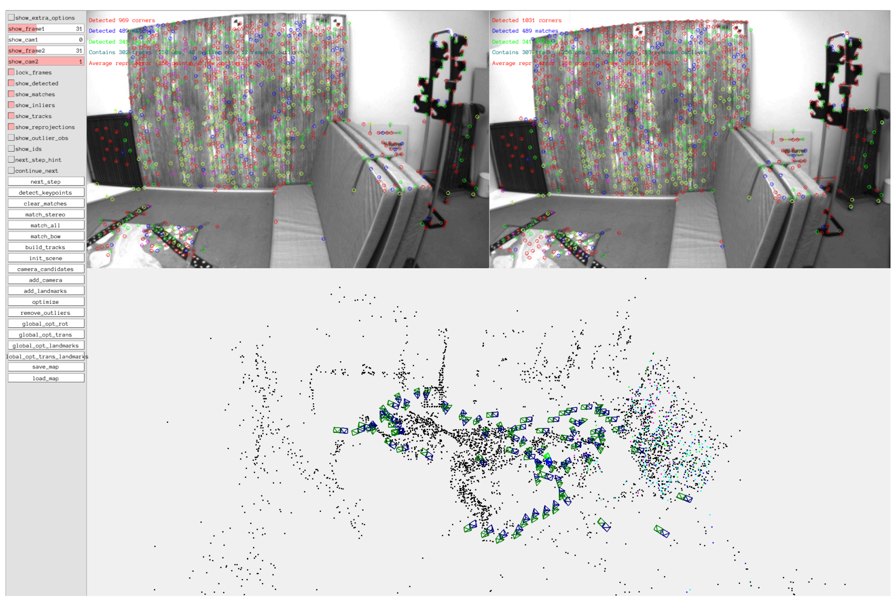
- Watch announcements on the course website: https://vision.in.tum.de/teaching/ws2022/visnav_ws2022

- The course starts on Monday, 24.10.2022

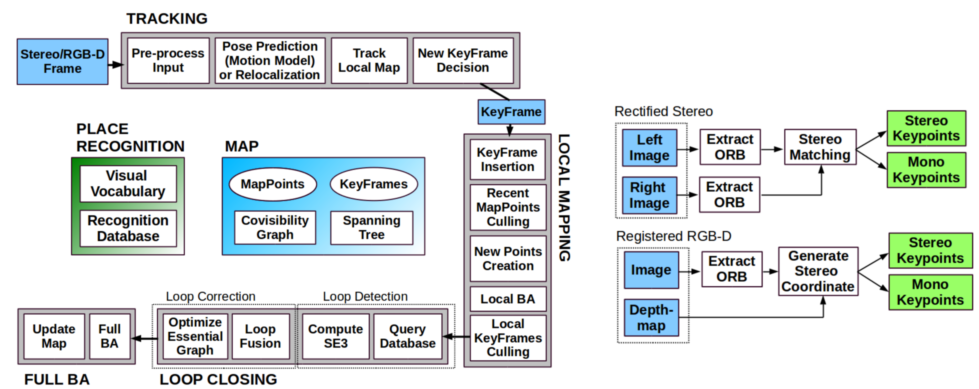
Demo







Questions?



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