Practical Course: Vision Based Navigation

Premeeting

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Motivations

No GPS

Pose estimation

3D reconstruction

Path planning (when we have a map)
Direct Sparse Odometry

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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)
  - …
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 your 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: pak.chui@.in.tum.de, Simon.Klenk@tum.de

• The deadline for the matching system and prerequisite email is 14.02.2023.

• 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/ss2023/visnav_ss2023

• The course starts on Monday, 24.04.2023
Demo
Questions?