Practical Course: Vision Based Navigation

Premeeting

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Motivations

- No GPS
- Path planning
- Pose estimation
- 3D reconstruction
Direct Sparse Odometry
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\textsuperscript{1}Computer Vision Group
Technical University Munich

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ORB-SLAM

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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 fully online
  − 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 (remainder): 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 min per group)
  − 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 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-ss22@vision.in.tum.de

• The deadline for the matching system and prerequisite email is 15.02.2022.

• 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/ss2022/visnav_ss2022

• The course starts on Monday, 02.05.2022
Demo
Questions?