Practical Course: Vision Based Navigation

Premeeting

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Motivations

No GPS

3D reconstruction

Pose estimation

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