Practical Course: Vision Based Navigation

Premeeting

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Motivations

No GPS

Path planning (when we have a map)

Pose estimation

3D reconstruction
Direct Sparse Odometry
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ORB-SLAM

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Content of this course

• You will 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
Course organisation

• Initial phase (first 5 weeks): Lectures & Exercises
  – Wednesdays 2-4 pm lecture
  – Wednesdays 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)
Course organisation

• 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
- 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 the Computer Vision II: Multiple View Geometry
  - Similar lectures can also be accepted
Course registration

• Apply for this course through the matching system: https://matching.in.tum.de/

• Additionally, you 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++!** (e.g. 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-ss24@vision.in.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://cvg.cit.tum.de/teaching/ss2024/visnav_ss2024

• The course starts on Wednesday, 17.04.2023
Questions?