Robot Vision and Navigation

Coursework 2 - Description

Overview

Weighting: 50% of module total

For this coursework **you will work in groups. You may keep the groups you had for CW1 or re-arrange the groups.**

Assessment Format: the assessment will consist of:

- **Part I (50%)**: Install ORB-SLAM2, run **monocular** ORB-SLAM2 on TUM and KITTI sequences under 4 different settings (see detailed description below), use EVO to compare the estimated and GT trajectories in each case, plot error graphs to visualise the performance in each case, write a report to describe your experiments, show the results and write up an analysis of the reasons for the changes in performance under the different settings using evidence to support your findings.
  Assessment of Part I (50% of the overall CW mark) will be based on the PDF report. The most important part is your analysis of the results. Our recommendation is that you use LaTeX to write the report using a 2-column style. Think of this as an exercise to write the Results section of a research paper. You are expected to provide a brief description of each dataset (where recorded, length, ...) results from EVO and discuss how performance varies. **You must use evidence** - including specific screenshots and timestamps - **to support your discussion**.
- **Part II (50%)**: Acquire your own **monocular** sequences (1 indoor, 1 outdoor), run sequence on COLMAP, use COLMAP to calibrate the camera, to create a 3D model and extract the camera trajectory, run ORB-SLAM2 (mono) on the sequence using the calibration parameters, visualise the 3D reconstructions and camera trajectories obtained both with COLMAP and with ORB-SLAM2, use EVO to compare the trajectories obtained with each method, and write a report that describes your data collection, shows the results and an analysis of the steps or settings you chose to improve the performance.
- **Assessment of Part II (50% of the overall mark)** will be split into 2 parts:
  - Part IA (25%): Split into 2 parts
    - A PDF report with two main sections: (a) Data Acquisition (b) Results. We also recommend you use LaTeX to write the report using a 2-column style. The first section (a) should describe your data acquisition for the 2 sequences (indoor, outdoor) explaining your strategy to capture the data to obtain good reconstruction results. What worked? Which settings did you use? Why? You should also describe the process to calibrate the cameras. Part (b) should show the results you obtain when comparing the camera poses (trajectories) obtained with COLMAP with those

obtained with ORB-SLAM2. These should include the plots you obtain using the EVO tool.
        - A video: We would also like you to submit a video where you include the acquired videos, a screen-capture of ORB-SLAM2 reconstructing the scenes and a visualisation of the quality of the 3D pointclouds and the camera trajectories. Think of the videos that are currently submitted to accompany research papers.
    - Part IIB (25%): Each group will give an ORAL presentation of Part II. After the presentation the markers will ask you questions/clarifications. **All members of the group must participate in the presentation – we expect each of you to present part of the presentation**. You will need to prepare some Powerpoint/Keynote/GoogleSlides/PDF slides but you should use the materials you have submitted in Part IIA (i.e. graphs and visualisations). You are not allowed to re-run the code to get some new results for the presentation. All the results should be based on your submission (Part IA).

Assignment Submission Deadline: The deadline to submit Part I and Part IIA is 4pm on 28 April 2025
Oral presentations: All members of the team must participate. These will take place on the 1st week of June.

Install ORB-SLAM2 on your machine

For this coursework you will need to download and install ORB-SLAM2 on your machines and you will be running it in **Monocular mode**. You should have done this already in the LAB. You should also install COLMAP. Follow the instructions you received in the lab sessions. The github repository is here:
https://github.com/UCL/COMP0249_24-25_ORB_SLAM2

More Coursework Details

Part I

Run and evaluate monocular ORB-SLAM2 using the EVO tool on example sequences (TUM and KITTI) under four different conditions and write a report (50%)

We want you to run the **MONOCULAR** ORB-SLAM system under four different conditions. You must produce the evaluation plots with EVO and write your interpretation of the effects caused on the quality of the camera tracking in each case:

1. Run the system with off-the-shelf options, evaluate and obtain the ATE plot for both sequences.
2. Reduce the number of ORB features used by the system and test the impact on the estimation of the camera trajectory. Choose 3 levels of number of features (you will end up with 3 graphs per sequence). Your job is to go into the code and find the place where you can change the parameter/s that govern the number of features that are detected by the system.
3. Turn off the outlier rejection stage and evaluate again. Your job is to go into the code and find the place where you can switch off the function that rejects outliers and run the system without it. The performance of the system should suffer substantially.
4. Turn off the loop closure and evaluate again. Your job is to go into the code and find the place where you can switch off the loop closure and run the system without it. The performance of the system should suffer substantially.

Please refer to the start of this document for a description of the structure and content of your report.

You will need to run ORB-SLAM2 on at least two sequences:

1. KITTI 07: This one is *compulsory*. You MUST run Monocular ORB-SLAM2 on this sequence and complete the tasks specified above.
2. For the second sequence, use a long sequence from the TUM dataset.

Part II

Acquire your own sequences and evaluate monocular ORB-SLAM2

- Acquire 1 indoor and 1 outdoor sequence. Length – at least 500 frames *after* ORB-SLAM manages initialization.
- Run on COLMAP, and on ORB-SLAM2 (monocular) and compare both using the EVO tool.
- Please capture your sequence as a video (instead of a bunch of images taken from different viewpoints).
- Please refer to the start of this document for a description of what you should submit.

Running EVO tool

Please refer to this document we prepared for the last lab.
https://docs.google.com/document/d/1Ro6-XfCYKexmYYKcYkSmgWb4TMa0SLdyqz7s9wo4SRk/edit?usp=sharing