Homework 05: Monocular SLAM

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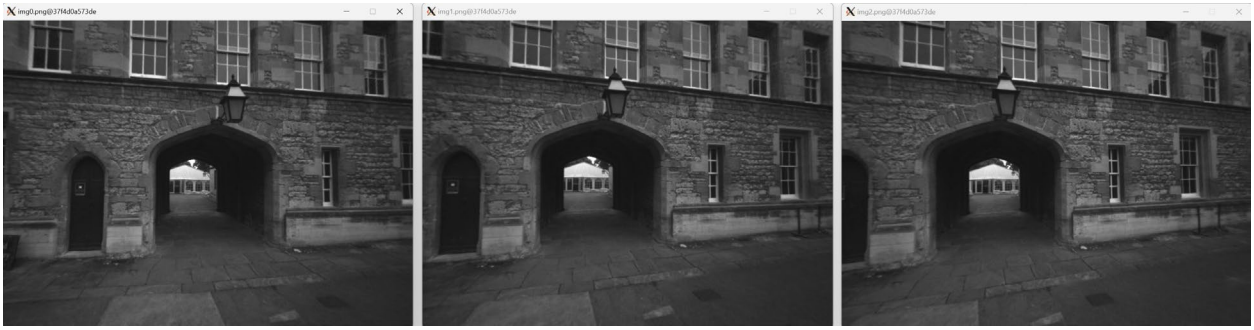
Handout: Mon, 2024-04-15
Due: Thu, 2024-04-30

This homework is designed for you to create your own (basic) monocular SLAM package, and run a state-of-the-art SLAM system.

Exercise 1 (basic monocular SLAM): Download the code template provided in the assignment folder, and build it in a VS Code devcontainer. OpenCV library is integrated for your convenience. Use images provided in the "data" folder to estimate the camera trajectory, and create a 3D map of features using all images. The camera's intrinsic parameters are provided in the code.



Step 1: Extract SIFT features/descriptors

Step 2: Find the relative pose between images/cameras using RANSAC and extracted SIFT features.

Step 3: 3D-reconstruct the image feature points (known as landmarks) using triangulation.

Step 4: To find the common scale factor for 3D reconstructed landmarks, find common landmarks across the images, and adjust their scale such that they overlap.

Step 4: Display the 3D landmarks and camera trajectory and take a snapshot.

Hint: Use ChatGPT to get help with the syntax!

Exercise 2 (ORB-SAM): Create a 3D map of one of Mines buildings using a (monocular) camera.

Step 1: Take a camera (e.g., your cellphone camera) and calibrate it to find its interstice parameters. Note that you should not change the camera setting after calibration (e.g., zoom level), or otherwise the calibration matrix will change!
Hints: Review the lecture on camera calibration for instructions.

- Checkerboard: https://markhedleyjones.com/projects/calibration-checkerboard-collection
- Camera calibration in OpenCV C++: https://docs.opencv.org/4.x/d4/d94/tutorial_camera_calibration.html
- Camera calibration in OpenCV Python: https://docs.opencv.org/4.x/dc/dbb/tutorial_py_calibration.html

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Step 2: Record a video of one of the campus buildings by walking around it and pointing the camera toward the building. Make sure you loop around the building twice (so that you have loop closures).
Example:

Step 3: Convert the video you recorded into a sequence of images using any of the available tools (e.g., https://mconverter.eu/convert/mp4/png/)

Step 4: Download and build ORB-SLAM3 library and examples (https://github.com/UZ-SLAMLab/ORB_SLAM3) by following their instructions. Run ORB-SLAM on your image sequence and see the camera trajectory and 3D map.

Step 5: Take a snapshot of your results.