Homework 10: Homography and 3D Reconstruction

Kaveh Fathian, Email: fathian@ariarobotics.com

Handout: 2025-11-05

Due: 2025-11-12, 11:59pm, on Canvas

General Instructions:

- You should solve the homework and submit your report **individually**. Identical submissions will receive a grade of zero.
- Getting help from others or checking your answers with other students (not the TAs) is okay and encouraged.
- Ask any questions on **Ed Discussion** (instead of emailing).
- **Before** the homework due date, TAs are strictly prohibited from **pre-grading** your homework. Do not expect the TAs to help you verify if your answers are correct or give you the problem solution.
- **After** the homework due date, if you do not know how to solve a problem, reach out to the TAs. They will walk you through the solution and help you understand it. Note that homework solutions will **not** be posted because some problems will be used in next year's class.
- **Exams** may contain questions related to homework, so make sure you learn how to solve the homework problems correctly.
- The deliverables are outlined for each problem, and you should carefully **follow the instructions**. Failing to follow instructions will result in **points being subtracted**.
- You will submit a **single PDF** file to Canvas as your homework report. The PDF must contain your **answers** and any requested **outputs** (e.g., printouts, snapshots of code, or GUIs). If requested, follow the instructions specified by the problem to provide your **code** (e.g., in a compressed .zip or .tar file) in addition to the PDF file.
- **Grading:** Each homework in this class will contribute **5pts** to your final grade (there will be 12 homework assignments, each 5pts, leading to 60pts for all assignments). A detailed grading **rubric** will be posted on **Canvas** after the homework due date. Any bonus points will be added to your overall course bonus points, which will be added to your final grade.
- **Late submission:** Late or missed submission will not be accepted and will receive a grade a zero. Any excused absence must be documented and disclosed to the instructor (extensions will be granted on a case-by-case basis). Three or more missed homework lead to an INC grade.

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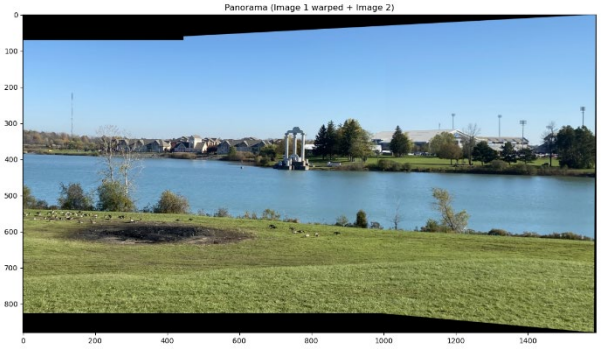
IMPORTANT: You must solve the following problems using the **images you take personally** (e.g., using your phone's camera). Do **not** use images you find online or from other sources. If two submissions have **identical images**, they will both receive a grade of **zero**.

EXERCISE 1 (4pts) – Write an algorithm that creates a panoramic image from overlapping images you took personally**.** You must take/use a ***minimum of 3 images*****.** To create the algorithm, extract and match image feature points, and use them to recover the homography transformation between the images using RANSAC. Using the recovered homography, transform/overlap the images into a single, large image frame.

Feel free to use the code provided in "**11_homography.ipynb**" available at https://github.com/ariarobotics/cv/tree/main/code or any other resources/libraries, however, you are ***NOT*** allowed to use any function that directly stiches images into a panorama.



Deliverables:

- Printout of your entire code
- Display of input images (must be ≥ 3)
- Print out of *homography matrix transforms* between images (e.g., between images 1-2 and 2-3)
- Display of resulting panorama output

EXERCISE 2 (1pts) – Given a ***minimum of 5 images*** you took personally, create a 3D model using Meshroom structure from motion software (download free from https://alicevision.org/#meshroom). Your output 3D model can be a point cloud, or a 3D mesh (if you have a CUDA-enabled Nvidia GPU).

Hints for getting a good 3D model:

- Focus on a small object/scene rather than a large area
- Make sure the object and its surrounding environment have lots of features
- Take overlapping images from different viewpoints
- Make sure the camera is moved/translated between the viewpoints (and not just rotated)
- The more images you take, the better the 3D model (however, the longer it takes to compute it)

Deliverables:

- Snapshot of Meshroom's screen, which should include:
  - Your input images (must be ≥ 5)
  - The outputted 3D model