

Problem Statement and Goals

Image Feature Correspondences for Camera Calibration

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Table 1: Revision History

| Date | Developer(s) | Change |
|------------|--------------|-----------------|
| 17.01.2025 | Kiran Singh | Initial Release |

1 Problem Statement

[You should check your problem statement with the problem statement checklist. —SS]

[You can change the section headings, as long as you include the required information. —SS]

1.1 Problem

1.2 Inputs and Outputs

1.2.1 Inputs

1. The quantity of active cameras.
2. The intrinsic calibration parameters for each camera.
3. The stream of imagery for each camera, taken at any given pose.

1.2.2 Outputs

1. A flag of whether correspondences have been identified.
2. A list that outlines the graph nodes produced for any given camera with another camera.

3. An outline of all identified correspondences.
4. An flag to indicate whether transforms need to be calculated as part of downstream operations.

1.3 Stakeholders

Stakeholders will primarily be composed of roboticists that need to perform some form of extrinsic camera calibration. Though the majority of stakeholders are expected to be academic roboticists, industrial roboticists may wish to use this software as a commercial-off-the-shelf option to perform camera calibration for mobile robots, robotic manipulators, and aerial platforms.

1.4 Environment

The intent of this software is to be versatile in its deployment. Therefore, it should be compatible with standard operations such as Windows 10 or higher, MacOS, and Linux OS.

The software algorithm is expected to be developed in non-real time prior to upload to an embedded system. Therefore, as the algorithm itself will not be computed in real-time, development of the algorithm itself should not be constrained by additional memory limitations that are common for embedded systems.

2 Goals

This project will produce scientific computing software that facilitates robust extrinsic camera calibration for robotic systems without overlapping fields of view between its cameras. The primary goals are outlined below.

1. Accept non-synchronous imagery from multiple imagery streams.
2. Compare images from each imagery stream to identify correspondences between each image.
3. Formulate a graph between each image with identified correspondences.
4. Identify what camera transforms need to be calculated as part of downstream operations using the defined graph network.

3 Stretch Goals

Outline a quality metric, such as confidence, that may be used to estimate what correspondences and points between images may be outliers. This metric can be compared with the performance of outlier detection and removal as part of downstream operations.

4 Challenge Level and Extras

This project is designed as a graduate research project with a corresponding degree of difficulty. The method of how correspondences are defined has been left to be ambiguous at this stage and may constitute that this software be defined as a family of products.

A user manual will be provided as an 'extra' submission for this project.

Appendix — Reflection

[Not required for CAS 741 —SS]

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing "what you think the evaluator wants to hear."

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable?
2. What pain points did you experience during this deliverable, and how did you resolve them?
3. How did you and your team adjust the scope of your goals to ensure they are suitable for a Capstone project (not overly ambitious but also of appropriate complexity for a senior design project)?