



Adaptive Multiple Camera Calibration

Project Management and Software Development
for Medical Applications

General Info

Project Title Adaptive Multiple Camera Calibration

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Project Abstract

Goal of this work is the implementation of a robust approach to *multiple camera calibration*. This type of calibration has gained significant attention in past years due to its application to 3D model recovery.

Background and Motivation

Multiple Camera calibration is similar to single camera calibration, the main difference being that the affine transformation between all possible pairs of cameras in each frame is considered rigid. This type of calibration is especially challenging in setups where the cameras do not have a good overlap in their fields of view and as such the calibration pattern cannot be seen by all of them.

Robust Camera Calibration:

The standard chessboard calibration pattern is ill suited for calibrating multiple cameras, as its detection requires that the entire pattern be visible by the camera.

Random Dot Markers: have been developed to relax the constraints for the design and us-

ability of fiducial markers [4]. The recognition and tracking of the markers are based on key-point matching using local geometrical relationship of keypoints with LLAH (Locally Likely Arrangement Hashing) [2, 4].

Students Tasks Description

The students work is organized into the following work packages:

Random Features Finder:

In this package the student is tasked to extend an existing implementation of Random Circle Markers¹ to also perform a RANSAC marker correspondences. That is to match the pattern circles with the ones detected in the image, while minimizing the re-projection error.

This will enable detection and tracking of partially occluded calibration targets.

Multiple Camera Calibration:

This package will see the student implement Multiple camera calibration class. The student can assume that the images are grouped into frames, and that the cameras are in each frame rigid to each other. Furthermore he can assume that the calibration pattern is visible by all cameras, and he should discard frames where the pattern was not detected in all images.

Tracking Loss:

In this Package, the student will extend the work from the previous package in order to handle frames where one or more cameras loose track

¹Just like Random Dot Markers [4] but with circles

of the pattern (at least one camera should still have a good view).

Post-Processing and Presentation

In the final package, the student should extend her/his implementation to assess the acquisition quality of the images in a frame, and discard poor quality images which might have a negative impact on the calibration.

The post-processing and presentation package should teach the student the importance of presenting the results of her/his work in such a form that it can be picked up by a future student/researcher and continued.

Technical Prerequisites

Programming Skills: Java or C++

Attended Courses: Computer Vision 1

- filtering of images in frame
- calibration of cameras

duration: 4 weeks

• Robust Tracking:

- handle images from cameras with different image sizes
- handle one or more images per frame with no detected features

duration: 2 weeks

• Documentation and Report:

- document code
- finalize writing report on the project

duration: 2 weeks weeks

Administrative Info

Working Time 10 hours per week for between 14 and 16 weeks.

Project Location AR Lab at the CAMP chair in Garching

Required Equipment

- Multiple cameras
- Desktop or portable computer with a minimum of 2 GB of RAM

Timeline and Milestones

• Familiarize with the state-of-the art:

- pinhole camera model
- camera calibration
- multiple camera calibration [1]

duration: 2-4 weeks

- **Random Feature Finder:** extend existing implementation by RANSAC matching
duration: 4 weeks

• Multiple Camera Calibration:

References

- [1] A. Geiger. Automatic multiple camera calibration using a planar calibration pattern. Master's thesis, Ecole Polytechnique Fdrale de Lausanne, 2006.
- [2] T. Nakai, K. Kise, and M. Iwamura. Use of affine invariants in locally likely arrangement hashing for camera-based document image retrieval. *Document Analysis Systems VII*, pages 541–552, 2006.
- [3] T. Svoboda, D. Martinec, and T. Pajdla. A convenient multi-camera self-calibration for virtual environments. *PRESENCE: Teleoperators and Virtual Environments*, 14(4):407–422, August 2005.
- [4] H. Uchiyama and E. Marchand. Deformable random dot markers. In *Mixed and Augmented Reality (ISMAR), 2011 10th IEEE International Symposium on*, pages 237–238, 2011.
- [5] H. Uchiyama and H. Saito. Random dot markers. In *Virtual Reality Conference (VR), 2011 IEEE*, pages 35–38, 2011.