UKRAINIAN CATHOLIC UNIVERSITY

MASTER THESIS

Corner localization and camera calibration from imaged lattices

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Declaration of Authorship

I, Andrii STADNIK, declare that this thesis titled, “Corner localization and camera calibration from imaged lattices” and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
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- I have acknowledged all main sources of help.
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Signed:

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"Thanks to my solid academic training, today I can write hundreds of words on virtually any topic without possessing a shred of information, which is how I got a good job in journalism."

Dave Barry

UKRAINIAN CATHOLIC UNIVERSITY

Faculty of Applied Sciences

Master of Science

Corner localization and camera calibration from imaged lattices

by Andrii STADNIK

Abstract

The Thesis Abstract is written here (and usually kept to just this page). The page is kept centered vertically so can expand into the blank space above the title too…

Acknowledgements

The acknowledgments and the people to thank go here, don't forget to include your project advisor…
If you was supported with the scholarship, please thank to your donor organization or a person who supported you.

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Chapter 1

Introduction and motivation

1.1 Outline of the problem

Better camera calibration improves the performance of various downstream tasks by providing a more accurate mapping between 3D world coordinates and 2D image plane coordinates. This improved mapping enables precise alignment, positioning, and scaling of objects within the scene. By determining the camera's intrinsic and extrinsic parameters, algorithms can correct for lens distortion, estimate depth information, and accurately overlay virtual content. Consequently, tasks such as 3D reconstruction, augmented reality, and object detection can achieve better results in terms of precision, spatial consistency, and overall visual quality.

Although manufacturers can estimate camera calibration parameters a priori, fully automatic calibration is often preferred, especially when camera metadata is unavailable. Currently, wide-angle lenses, particularly in mobile phones and GoPro-type cameras, dominate consumer photography. These cameras pose additional challenges due to their requirement for highly non-linear models with numerous parameters. The high distortion of the image plane also makes finding key points robustly challenging.

Typically, camera calibration is obtained by capturing an image of a known calibration pattern, which is then used to estimate the camera parameters. Alternatively, some methods do not use a calibration pattern but instead infer geometric constraints directly from the scene. However, this approach is generally less accurate.

As reported by Duisterhof et al. (2022) on Oct. 5, 2022, the current state-of-the-art methods **olsonAprilTagRobustFlexible2011** Schöps et al., 2020 Krogius, Haggenmiller, and Olson, 2019 fail on images with high distortion. Duisterhof et al. (2022) suggested an iterative the approach of image undistortion and target reprojection, achieving the superior robustness to the noise than the state-of-the-art methods because the feature detection is performed on the undistorted image.

Instead of searching for the features on the undistorted image, it is possible to use conjugate translations Schaffalitzky and Zisserman, 1998, to predict the position of the previously undetected feature points and to further, constrain the camera calibration. Pritts et al. (2021) showed that three pairs of points, related by the same translations on the scene plane are sufficient to estimate the camera calibration and the parameters of the conjugate translations.

We want to use the work of Pritts et al. (2021) to bootstrap the camera calibration, and then use the found conjugate translations and camera parameters to iteratively predict and refine the positions of the calibration board features, calibration parameters, and conjugate translations.

1.2 Thesis structure

This paper has the following structure: in **??**, we will describe the related work, including the literature search method and methodology, various subtopics of the camera calibration, mention conjugate translations, and outline the state-of-the-art solutions. We define the research gap in **??** and outline the proposed approach to solution and evaluation in **??**. We will describe the early results in **??**, including the dataset analysis, feature detector, and conjugately translated points simulator. In **??**, we will summarize the results and outline future work.

Update

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