UNIVERSITY OF BURGUNDY

Supervisor: Devesh ADLAKHA

Autonomous Robotics
Camera Autocalibration

SHAH Bhargav B
Email: shahbhargav1992@gmail.com

UNIVERSITÉ DE BOURGOGNE

1. Introduction

Camera auto-calibration is the process of determining internal camera parameters directly from multiple uncalibrated images of unstructured scenes. In contrast to classic camera calibration, auto-calibration does not require any special calibration objects in the scene. In the special effects industry, camera auto-calibration is often part of the "Match Moving" process where a synthetic camera trajectory and intrinsic projection model are solved to reproject synthetic content into video.

Camera auto calibration important because in 3D reconstruction, the recovery of the calibration parameters of the cameras is significant since it provides metric information about the observed scene, e.g., measures of angles and ratios of distances. Auto-calibration enables the estimation of the camera parameters without using a calibration device (e.g., checkerboard), but by enforcing simple constraints on the camera parameters, such as constant intrinsic parameters in multiple images, known principal point, known pixel shape, etc.

2. Mendonça-Cipolla auto calibration method

This method is based on the use of rigidity constraint. Design a cost function, which considers the intrinsic parameters as arguments and the fundamental matrices as parameters. Fij is defined as the fundamental matrix, Ai and Aj as intrinsic parameters matrices.

The key insight in Mendonca-Cipolla method is that the non-zero Eigen values Of an essential matrix are equal. We would thus like to minimize the difference between the Eigen values of (essential) matrix estimated using our camera matrix and fundamental matrices.

```
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
Calculat Intrinsic parameters using Mendonça-Cipolla method
   1.0e+02 *

   8.000000026770635   8.000000028394336  -0.000000002536316   2.559999984991552   2.559999995733173

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
```

3. The classical and simplified Kruppa's equations

In classical Kruppa method, we assume that the image are taken from same moving camera with same parameters. The cost function for classical Kruppa method is a sum of Frobenius norms of difference matrices, D_i.

The Frobenius norm of a matrix is analogous to (Euclidean) length of a vector (square root of sum of squares). The cost vector to be returned to 'lsqnonlin' Using 'levenberg marquadt' was therefore formulated as a list of above diagonal entries of the difference matricesD_i.

```
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
Calculat Intrinsic parameters using Classical_kruppa method
   1.0e+02 *

   7.999999999998311   7.999999999998284   0.000000000000070   2.560000000000059   2.559999999999836

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
```

```
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
Calculat Intrinsic parameters using Simplified_kruppa method
   1.0e+02 *

   7.999999999998770   7.999999999998458  -0.000000000000181   2.560000000000142   2.560000000000891

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
```