ASSIGNMENT- ADDITIONAL

Stereo Image Analysis: Computation of Transformation Matrices and Exploration of Camera Geometry

Introduction

In this report, we explore the process of stereo image analysis by calculating several matrices that represent the transformation and relationship between two stereo images. The matrices computed are essential for tasks in computer vision such as 3D reconstruction, motion analysis, and camera calibration.

Methodology

1. Calibration Matrix **K** Calculation:

- The Calibration Matrix K was calculated based on provided image dimensions. This matrix transforms 3D camera coordinates into 2D homogeneous image coordinates.

- The formula used for the matrix incorporates the focal length and optical center, derived from the image dimensions.

2. Homography Matrix **H** Estimation:

- The Homography Matrix H was estimated using corresponding points between the two images. These points are assumed to be correct and correspond to the same physical points in the scene as viewed from different camera positions.

- The method employed was the RANSAC algorithm, which is robust to outliers.

3. Rotation Matrix **R** Derivation:

- The Rotation Matrix R was derived from the Homography Matrix H and the Calibration Matrix K. The formula R = K^ {-1} H K was used, assuming negligible translation between views.

4. Fundamental Matrix F Estimation:

- The Fundamental Matrix F relates corresponding points on each image under the epipolar constraint. It was calculated using the 8-point algorithm, suitable for scenarios with a sufficient number of point correspondences.

Results

1. Calibration Matrix **K**:

[[-288 0 288.]

[0 512 512]

[0 0 1]]

- This matrix reflects the focal length and principal point derived from the image dimensions.

2. Homography Matrix **H**:

[[5.68823963e-01 -2.34085697e-02 4.30377696e+02]

[-7.80436481e-02 8.68323356e-01 1.02731081e+01]

[-4.16968458e-04 2.16316378e-05 1.00000000e+00]]

- Indicates transformations including rotation, scaling, and translation between the two image planes.

3. Rotation Matrix **R**:

[[0.68891088 0.05269063 -1.13058724]

[-0.07618736 0.85724796 -0.04650001]

[0.12008692 0.0110754 0.89098848]]

4. Fundamental Matrix **F**:

[[7.69454017e-08 8.93267973e-07 -2.22758090e-04]

[1.44359063e-06   1.95747296e-05   -4.90749202e-03]

[-3.16699844e-04   -3.99810611e-03   1.00000000e+00]]

Discussion

Rotation Matrix Validation: The non-orthogonality of the Rotation Matrix **R** suggests the need for additional validation or correction, possibly employing normalization techniques like SVD to ensure it accurately represents a rotation.

Matrix Accuracy: The accuracy of **H** and **F** depends significantly on the correctness and precision of the corresponding points used. Misalignments or errors in point matching can lead to inaccuracies in estimated transformations.

Conclusion

This analysis demonstrates the fundamental processes involved in stereo image analysis using common algorithms and matrix computations. The results provide a basis for further analysis, such as 3D scene reconstruction or camera pose estimation, with considerations for improving accuracy and handling practical challenges in real-world applications. Future work may involve refining point selection and handling outliers more robustly in computation to enhance the precision of the derived matrices.