

CIVE 6374 – Optical Imaging Metrology

Lab #1 – Similarity, Affine and Projective Transformations

Lab Description

The purpose of this lab is to introduce the use of a least squares adjustment to determine transformation parameters to transform measured image coordinates on a comparator to measurements in the fiducial coordinate system.

In the included spreadsheet (Lab1_Fiducial_Measurements.xlsx) are image measurements of the fiducial marks (given in pixels), and their corresponding image locations in the fiducial coordinate system (given in mm). The fiducial coordinate values were extracted from the camera calibration certificate. The measurements are given for a pair of stereo images (dec_1_027 and dec_1_028).

Assignment

Using a programming language of your choice (e.g. Python, MATLAB, or C/C++) write a program to perform the tasks given below. The code should be well documented with comments and descriptive variable names so that it is easy to understand. The output from the program should be neatly organized to display the required calculations and plotted results.

Tasks

1. Using a similarity transformation and a least squares adjustment, determine the optimal set of parameters for transformation from image measurements to the fiducial coordinate system for both of the images separately. Give the linear parameters (i.e. a, b, c and d) and the non-linear parameters (i.e. translation, rotation and scale) that were determined for both images. Compute residuals for each of the image measurements and their overall root mean square error value (RMSE) in both the x and y direction for each image. Plot the transformation residuals for each image using a quiver plot.
2. Repeat Task 1 using an affine transformation.
3. Repeat Task 1 using a projective transformation.

Questions

- For each of the Tasks above, are there any noticeable patterns in the residuals for any of the transformations and for any of the images?
- Do the two images have comparable transformation parameters in each of the above tasks? If no, why would there be differences in the derived transformation values?
- Given the results from Tasks 1, 2 and 3, which transformation should be used for observations from this camera/comparator system? Justify your answer and explain your reasoning.

Notes:

- Points will be deducted for sloppy programming style and/or results format, and failure to properly document your code.

Due Date: February 22, 2023 at 10:00 am (hand in at start of class)