State Estimation - Assignment 4

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Abstract

In this assignment, our objective is to implement the RANSAC algorithm on a given data set and determine the best homography matrix

1 Question

The objective of this course is to learn how to distinguish inliers from out- liers in statistical inference. For more information, refer to ‘Ch 5.3 Handling

Outliers’ of your textbook. Given the source and destination 2d points below, compute a homography that maps the source points to the destination. a minimum of 10 inliers needed to be detected by the RANSAC algorithm. The re-projection error of the inliers need to be less than 0.005. To learn about homography, see
https://www.cs.toronto.edu/ lindell/teaching/420/slides/lecture8.pdf
or read ‘Multiple View Geometry in Computer Vision’ textbook. Report your normalized homography transformation. Write your code in Python, do not use OpenCV. Plot a scatter plot, showing inliers (marked by o) and outliers (marked by x), where inliers of source and destination are connected via a line. Include the plot in your report. You should only use the following modules:
import numpy as np , import random , import matplotlib.pyplot as plt

2 Solution

Certainly! The RANSAC (Random Sample Consensus) algorithm is an iterative method used for robust estimation of parameters in the presence of outliers. It is commonly employed in computer vision, image analysis, and other fields where it is necessary to estimate model parameters from a data set containing a significant number of outliers.
The RANSAC algorithm is effective in handling datasets with a substantial number of outliers. By iteratively selecting random samples, fitting models, and evaluating the number of inliers, RANSAC is able to robustly estimate model parameters even when a large portion of the data is contaminated by outliers.
The RANSAC algorithm, as presented in the slides, works as follows:

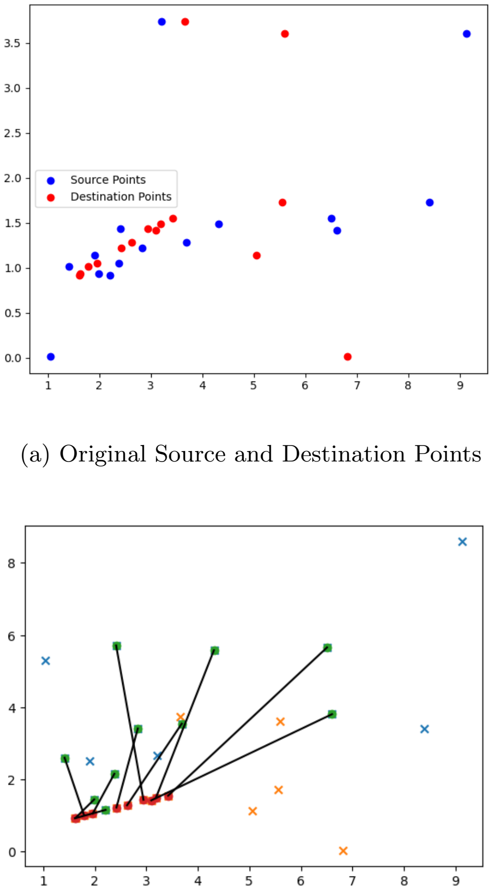
1. Sample (randomly) the number of points required to fit the model
2. Solve for model parameters using samples
3. Score by the fraction of inliers within a preset threshold of the model

repeat 1-3 until the best model is found
In the stage 2 of the RANSAC algorithm, we need to use the Direct linear transformation (DLT) algorithm for solving homographs. DLT solves for a homography matrix, H, given the source and destination points x_i, x'_i. The algorithm for DLT is:

1. For each correspondence, create 2x9 matrix A_i
2. Concatenate into single 2n x 9 matrix A
3. Compute SVD of $A = U\Sigma V^T$

4. Store singular vector of the smallest singular value h
5. Reshape to get H

In Fig. 1-a, we can see the original points and in Fig. 1-b, we can see the inliers connected to their corresponding projections, and the outliers marked by X. The Python code is committed to my github



(a) Original Source and Destination Points

(b) Processed with Homography matrix

Figure 1: Results from RANSAC