Computer Vision LAB#7

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Introduction

The Epipolar geometry is the intrinsic projective geometry between two views. It is independent of scene structure, and only depends on the cameras' internal parameters in addition, relative pose.
The fundamental matrix F encapsulates this intrinsic geometry. It is a 3×3 matrix of rank 2. If a point in 3-space X is imaged as x in the first view, and x′ in the second, then the image points satisfy the relation $x'TFx = 0$.

LAB Assignment

Estimation of the fundamental matrix

In this lab we will implement the **8 points algorithm**, to estimate the fundamental matrix F. To asses your implementation use this stereo pairs: Mire, Rubik. You will find both images and corresponding points.

We start off from the characteristic equation of the fundamental matrix, which relates corresponding points in the two views

$$\mathbf{x}'^{T} F \mathbf{x} = 0$$

From 8 (or more) corresponding points we may compute the following homogeneous system of the form A**f**=0:

$$\begin{bmatrix} x_1'x_1 & x_1'y_1 & x_1' & y_1'x_1 & y_1'y_1 & y_1' & x_1 & y_1 & 1 \\ x_2'x_2 & x_2'y_2 & x_2' & y_2'x_2 & y_2'y_2 & y_2' & x_2 & y_2 & 1 \\ & . & . & . & . & . & . & . & \\ x_n'x_n & x_n'y_n & x_n' & y_n'x_n & y_n'y_n & y_n' & x_n & y_n & 1 \end{bmatrix} \begin{pmatrix} f_{11} \\ f_{12} \\ . \\ . \\ . \\ f_{33} \end{pmatrix} = \mathbf{0}$$

The 8-points algorithm

1. Normalize the points: you may use the function already adopted within lab. 5
2. Write down the matrix A
3. Compute the SVD decomposition of A and select as solution f the last column of the right singular vectors
4. Reshape column vector f so to obtain a matrix F
5. Force the rank of F to be 2: use again the SVD to decompose the matrix, $F=UWV^T$, set W(3,3)=0, recompute the final F: $F=UWV^T$.
6. De-normalize the resulting F.

Procedure/steps in main program

The goal of this lab was to Estimate the fundamental matrix F for 8 point algorithm between images. Some pairs of images along with their corresponding points were given. The procedure adopted was follows

LAB_7.m

1. Read corresponding points of both images as r1 and r2
2. Read a pair of both images as im1 and im2.
3. Select sample size of points. E.g 8 or 10 points r1_p and r2_p.
4. Pass np, r1_p,r2_p,im1 and im2 to function eight_point and obtain the fundamental Matrix F.
5. Again perform SVD on F and obtain Left and Right Epipoles by taking last column of V and U and Normalizing them.
6. Repeat the above procedure for and pair of Images.

eight_point.m(Implements the 8 point Algorithm)

1. Takes np,r1_p,r2_p,im1,im2 and returns the fundamental matrix.
2. Homogenize the points and normalize them using normalize2dpoints.m function form LAB 5.
3. Compute the matrix A compute the following homogeneous system of the form A**f**=0:

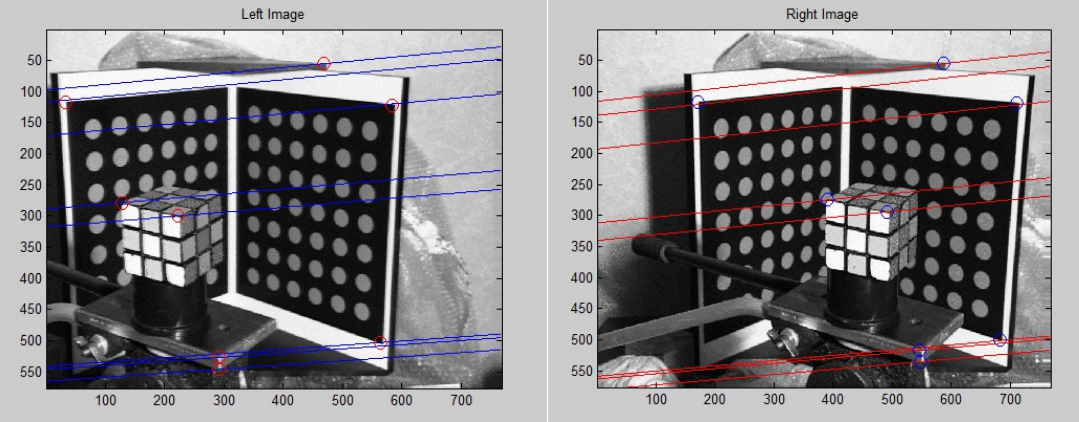
$$\begin{bmatrix} x_1'x_1 & x_1'y_1 & x_1' & y_1'x_1 & y_1'y_1 & y_1' & x_1 & y_1 & 1 \\ x_2'x_2 & x_2'y_2 & x_2' & y_2'x_2 & y_2'y_2 & y_2' & x_2 & y_2 & 1 \\ & . & . & . & . & . & . & . & \\ x_n'x_n & x_n'y_n & x_n' & y_n'x_n & y_n'y_n & y_n' & x_n & y_n & 1 \end{bmatrix} \begin{pmatrix} f_{11} \\ f_{12} \\ . \\ . \\ . \\ f_{33} \end{pmatrix} = 0$$

4. Perform SVD of A for Solution to AF=0 the Last column of the right Singular Vactors.
5. Force the rank of F to be 2, again use the SVD to Decompose the Matrix F=UWVt, set W(3,3)=0,recomputed the final F:F=UWVt.
6. Denormalize F.

1. Display the Epipolar lines with the corresponding Epipolar points for both the images.

RESULTS

For 8 points



For 10 points