HACETTEPE UNIVERSITY

GEOMATICS ENGINEERING

GMT 431 PHOTOGRAMMETRIC IMAGE ANALYSIS

MIDTERM – 2

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Getting x and y image coordinate datas from pictures:

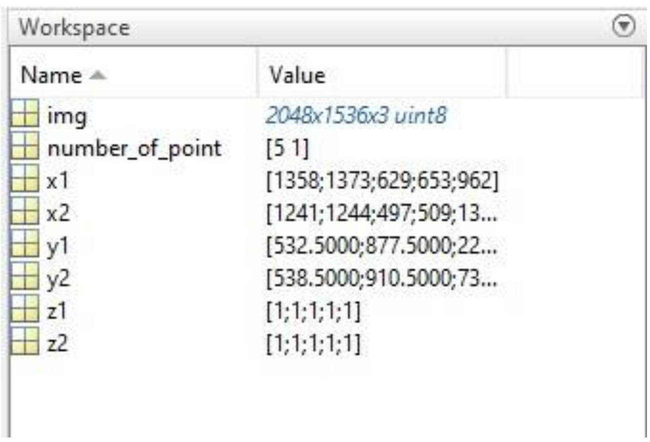
I used two different matlab code to get those image coordinates of the points data from each image1 and image2. For the part1; image2 point finder must be runned. For the part2 both image1 and image2 point finders must be runned. When we runned both matlab functions and select the points the coordinates saved in workspace of matlab. Then we can use this values in part1 and part2 codes.

Please be carefull to selecting points with same order on image1 and image2. Part2 calculating intersection with this point selection order. If you confuse on point selection order the code can make a mistake like checking intersection between wrong epipolar lines.

When you select your points with left click on the image then click to enter. Figure automaticly close and point datas saved into workspace. Don’t try to close it with right click. If you right click, it saves one more extra point where you right clicked.

Selected sample points from image1 and image2:

Workspace Results



Workspace

Name	Value
img	2048x1536x3 uint8
number_of_point	[5 1]
x1	[1358;1373;629;653;962]
x2	[1241;1244;497;509;13...
y1	[532.5000;877.5000;22...
y2	[538.5000;910.5000;73...
z1	[1;1;1;1;1]
z2	[1;1;1;1;1]

Part – 1 Drawing epipolar lines:

The code multiply fundamental matrix and selected coordinates. Then it finds a,b,c values from ax+by+c=0 function which is represent our lines.

I did normalization but it doesn't change the result. I tested it.

Epipolar lines intersect with points we selected on the image3 but we only know just the points on those lines not where is exactly.

In part 1 I used y=mx+value function instead of ax+by+c where m=-a/b and value=-c/b. I evaluate this formula from ax+by+c function leaving y alone because ax+by+c ploting syntax not work with for loop ploting correctly so code will be static with ax+by+c but I want it to dynamic. Thats the reason why I use y=mx+value function.

Epipolar Lines

- Let l be a line in the image:

$$au + bv + c = 0$$

- Using homogeneous coordinates:

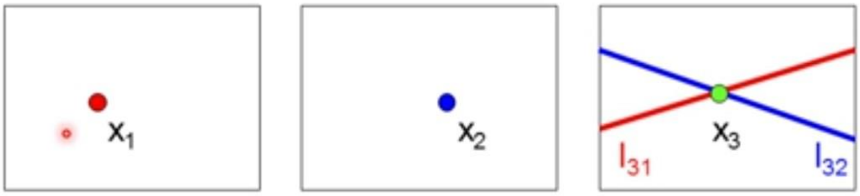
$$\tilde{p} = \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} \quad \tilde{l} = \begin{bmatrix} a \\ b \\ c \end{bmatrix} \quad \boxed{\tilde{p}^T \tilde{l} = \tilde{l}^T \tilde{p} = 0}$$

Result:

Part 2 Finding where those points exactly on image3:

For calculating this points we calculate additionally epipolar lines on image3 again but this time its from image1. Then we check to intersection between this image1_3 and image2_3 lines in a domain. The domain is size of the image. I determine a domain for faster implementation. In this section ax+by+c work with for loop for the ploting so I used ax+by+c equation directly instead of y=mx+value. Its two unknow parameter function so I use fimplicit @(x,y) to determine x and y are our unknown parameters. The intersection condition is a13*x+b13*y+c13=a23*x+b23*y+c23. When x and y true for this condition this (x,y) values is our point.

The code check the intersection between selected first point's line from image1 and selected first point's line from image2. Then it check selected second point's line from image1 and second point's line in image2 and so on. Please be careful about point selection order.



$$l_{31} = F^T_{13}\, x_1$$
$$l_{32} = F^T_{23}\, x_2$$

Result:

Part 3 Is accuracy assesment possible for this intersected points ?

The answer is yes **.**

Fundemental Matrix Error Assesment:

During to fundemantel matrix generation we work with matrix estimators and correspondence determiners. There are different type of matrix estimators and correspondence determiners but in the end all fundemantel matrix error calculate with same methods.

Some correspondence determiners examples are Speeded Up Robust Features, MSER Regions, Harris-Corner Points.

Some matrix estimators examples are Least Trimmed Squares, M-estimator Sample Consensus, Random Sample Consensus, Least Median of Squares and Normalized Eight Point Algorithm.

Every method produces a **Fundamental Matrix** with 9 parameters.

Our Condition is; [x2 y2 1] (1x3) * Fundemental Matrix (3x3) * [x1 ; y1; 1] (3x1) = 0

$$[x_2 \quad 1] * \begin{bmatrix} f_{11} & f_{12} & f_{13} \\ \vdots & \ddots & \vdots \\ f_{31} & f_{32} & f_{33} \end{bmatrix} * \begin{bmatrix} x_1 \\ 1 \end{bmatrix} = 0$$

Where [x2 y2 1] and [x1 y1 1] represent the homologous coordinates of the point pairs detected in the target and query image respectively. This will give us fundemental matrix error.

Point Accuracy Assesment:

We can check point accuracy with different methods. One of the example is template image matching.

Possible reasons of errors:

The errors caused by general camera errors, distortions (radial and decentric distortions), fundemental matrix generation methods.

Referance for part3:

https://www.researchgate.net/publication/327379375_Error_Assessment_of_Fundamental_Matrix_Parameters

https://dellaert.github.io/19F-4476/proj3.html