CS512 Assignment 6 : Sample Report

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Problem Statement:

To write a program to input a pair of stereo image and should be displayed next to each other and perform the following:

a) Allow user to input corresponding points using mouse

b) Normalize the selected corresponding point by using mouse from both the image

c) Using normalized points estimate a fundamental matrix related to two images and print it

d) Make the matrix of rank 2

e) Using this matrix if person mark a point in one image should display the epipolar line in the other image and vice versa .

Next will compute and display the epipoles on both the images using fundamental matrix.

Proposed Solution:

In this section, we will discuss about the stereo pairs, how to normalize the points, how to define and calculate fundamental matrix and how to calculate epipole and draw epipolar line.

a) First, you must read the pair of stereo image, now we have to select corresponding points on both the image by using cv2.EVENT_LBUTTONDOWN function. Make sure that the you have to **select at least 8 points** for both the image.

b) Now, normalized the points of both the image using following defined function:

$$\begin{bmatrix}\hat{x}_i\\ \hat{y}_i\\ 1\end{bmatrix}=\begin{bmatrix}(x_i-\bar{x})/\bar{d}\\ (y_i-\bar{y})/\bar{d}\\ 1\end{bmatrix}=\begin{bmatrix}1/\bar{d} & 0 & -\bar{x}/\bar{d}\\ 0 & 1/\bar{d} & -\bar{y}/\bar{d}\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}x_i\\ y_i\\ 1\end{bmatrix}$$

c) Now we have saved the normalized points of both left and right image separately in two variables. Now, to calculate the Fundamental matrix we have to rearrange the equation as a system of linear equation represented as P^F^ = 0 where P^ is a Nx9 matrix and F^ is the vectorized version of F.

$$\begin{bmatrix} u & v & 1 \end{bmatrix} \begin{bmatrix} F_{11} & F_{12} & F_{13} \\ F_{21} & F_{22} & F_{23} \\ F_{31} & F_{32} & F_{33} \end{bmatrix} \begin{bmatrix} u' \\ v' \\ 1 \end{bmatrix} = 0$$

$$\begin{bmatrix} uu' & uv' & u & u'v & vv' & v & u' & v' & 1 \end{bmatrix} \begin{bmatrix} F_{11} \\ F_{12} \\ F_{13} \\ F_{21} \\ F_{22} \\ F_{23} \\ F_{31} \\ F_{32} \\ F_{33} \end{bmatrix} = 0$$

In above image **u,v** represent **normalized points of left image** and **u',v'** represents **normalized points of right image**.

d) Now the matrix F can be estimated by SVD decomposition the P^ matrix into U,D,V(T) and selecting the right null space of V.

e) Now, we must make sure that F is rank 2 matrix or not, for that we again must take SVD of F which makes F as a rank 2 matrix.

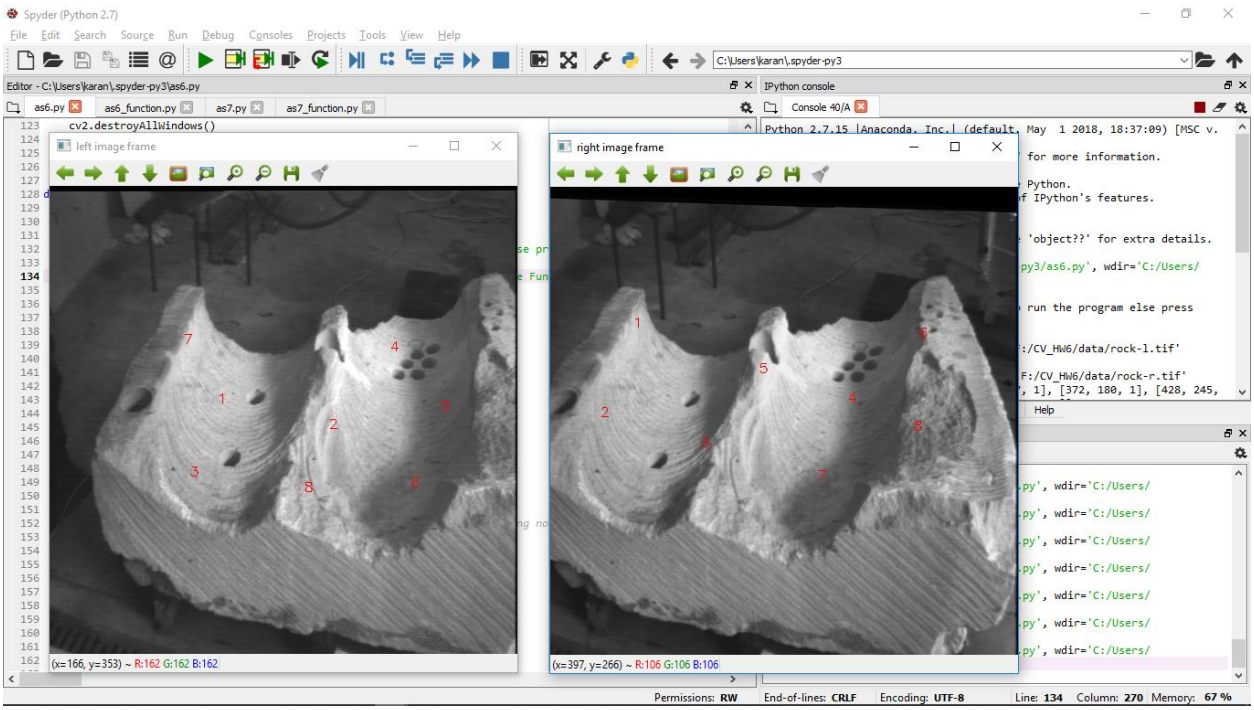
f) Now we will find epipole using this F matrix, by take left epipole as last column of V and right epipole as last column of U.

g) Now we will draw a epipolar line using: We will first find that if the prospective line we are going to draw is going to be horizontal or vertical by checking the x and y coordinate of the point for who we have to get respective epipolar line.
Now if x coordinate is more, that is line is going to be horizontal then for each x in in other image we will determine y=(-c-ax)/b and plot the line. Similarly we will check if the vertical coordinate is more so for each y in 0ther image we will determine x=(-c-by)/a and plot the line

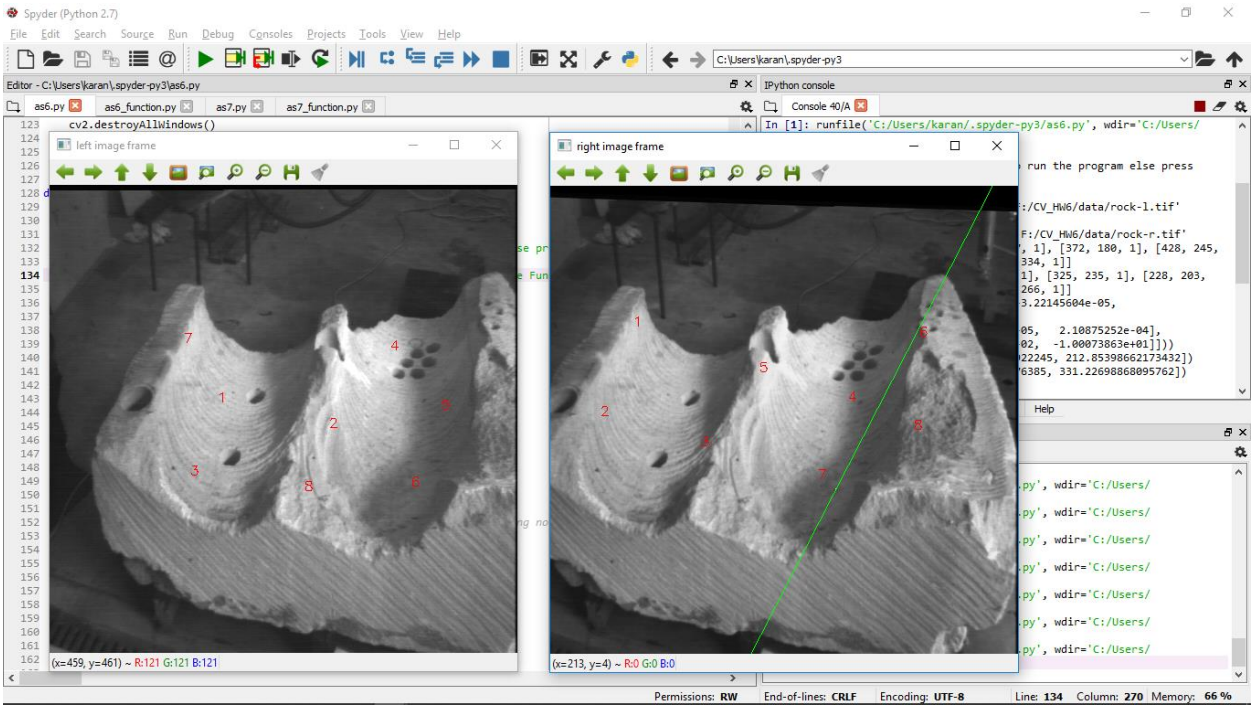
How To Run the Program:

a) First you have to run the as6.py file using the python.
b) Now it will ask to enter the input, if you want to see the help function enter ‘h’ else enter ‘c’ to run the program.
c) Now you have to pass the path of both left and right image.
d) Then the first left image will pop up, now you have to select at least 8 points by pressing left and pressing ‘l’ button of keyboard to select the corresponding points. After selecting all the points press esc key.
e) Then the right image will pop up, now you have to select at least 8 points by pressing left and pressing ‘r’ button of keyboard to select the corresponding points. After selecting all the points press esc key.
f) After selecting all points, Fundamental Matrix and epipole of both left and right image will display.
g) Now to mark epipolar line, select the point in left image and it will a draw a corresponding epipolar line on right image. Now press esc to do the same to draw the epipolar line on left image for right image points.

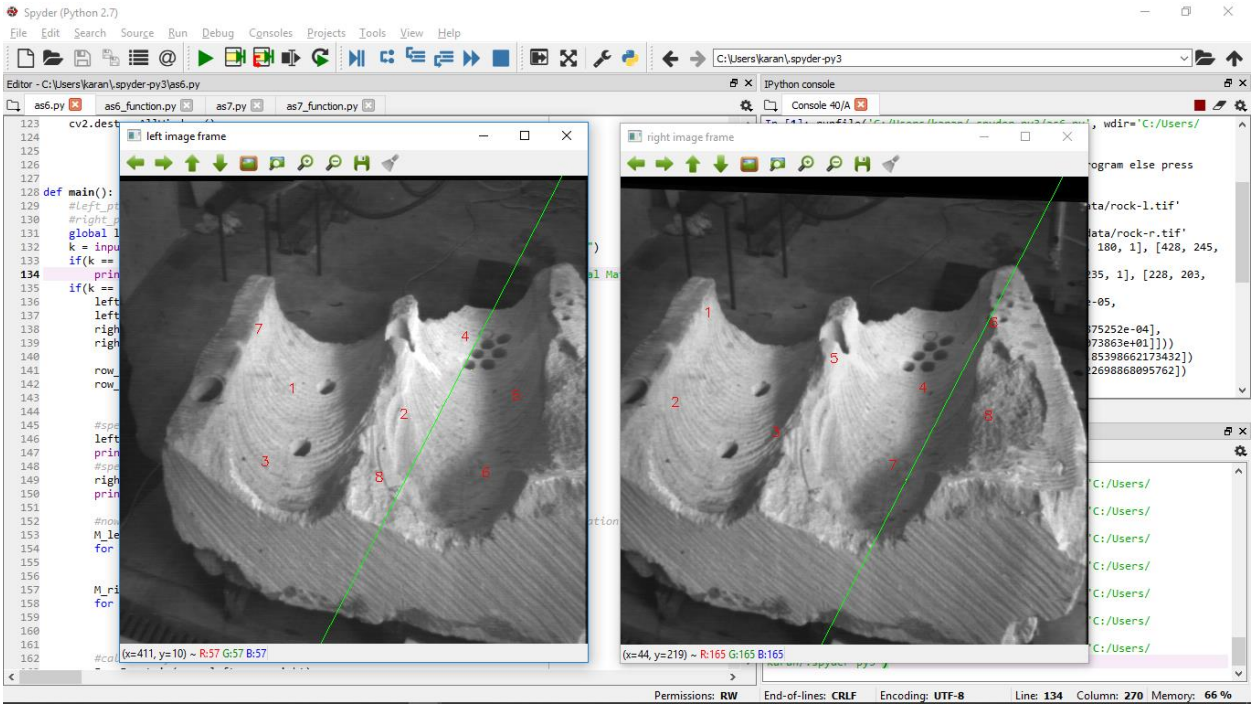
Results:



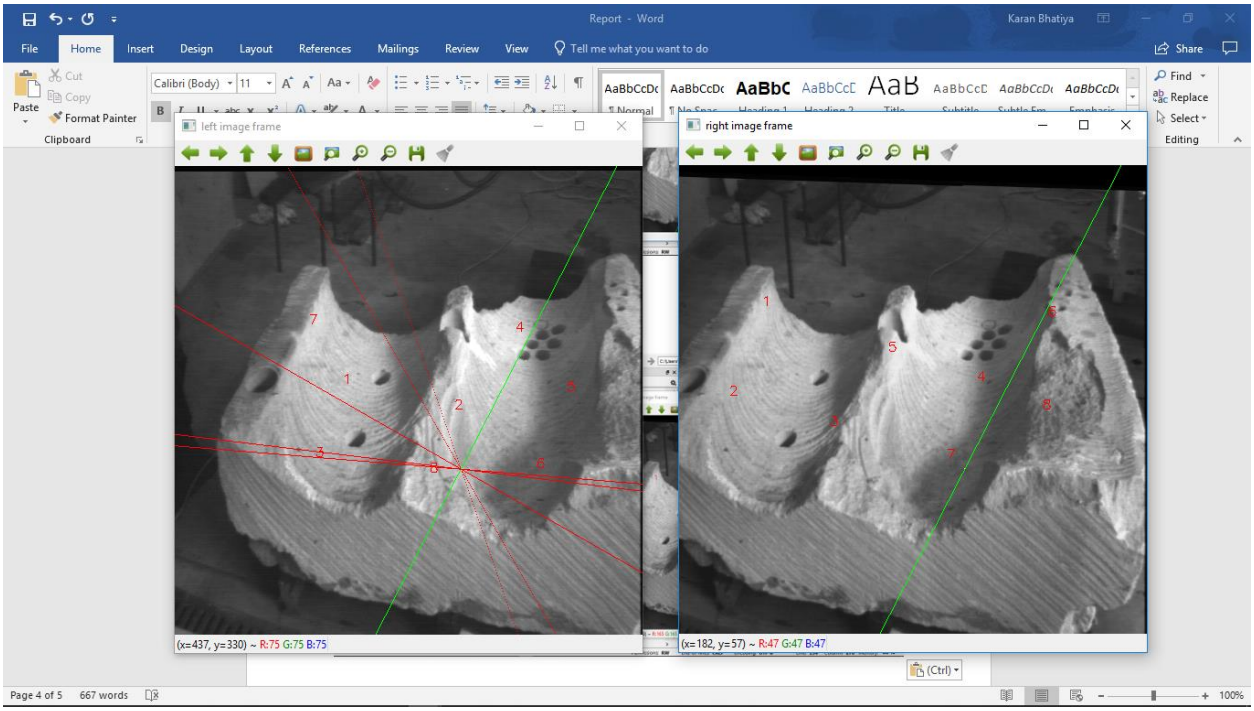
In the above image you will see the points marked first at left image then at right image and it shown by number.



Here you will see the epipolar line of right image



Here you will see the epipolar line of left image.



Here you will see the corresponding epipolar line on left image of points of the right image. Similarly you will get the epipolar line on right image of corresponding point of left when you click on those points by mouse.

Below, image represent the value of points we selected on both left and right image and epipole we get for left and right.

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Press h for help function to know how to run the program else press
c:'c'

Enter the path of the left file image:'F:/CV_HW6/data/rock-l.tif'

Enter the path of the right file image:'F:/CV_HW6/data/rock-r.tif'
[[183, 237, 1], [305, 265, 1], [153, 317, 1], [372, 180, 1], [428, 245,
1], [395, 329, 1], [146, 172, 1], [278, 334, 1]]
[[90, 153, 1], [54, 251, 1], [164, 284, 1], [325, 235, 1], [228, 203,
1], [403, 164, 1], [292, 320, 1], [397, 266, 1]]
('\nFundamental Matrix :\n ', array([[ -3.22145604e-05,
-9.09468583e-05,   3.17527649e-02],
       [  3.15703109e-05,  -5.80556081e-05,   2.10875252e-04],
       [ -3.74873973e-04,   4.76928670e-02,  -1.00073863e+01]]))
('left epipole point:\n', [384.74414787922245, 212.85398662173432])
('right epipole point\n:', [312.966091576385, 331.22698868095762])

In [2]:
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