CS-512 Assignment 6: Report

Russi Sinha
Department of Computer Science
Illinois Institute of Technology

Abstract

This is a report for Assignment 5 for CS512. The task given at hand is to implement a functionality that estimates the epipolar lines in an input of stereo pair.

1. Problem Statement

The program must read a stereo pair image provided by the user and the user must be allowed to select matching points on both the images by a mouse. The estimated fundamental matrix needs to be generated using the selected points. The user should then be allowed to select a point in the left/right image and then using the estimated fundamental matrix, the epipolar line needs to be displayed on the other image.

2. Proposed Solution

To mark the corresponding points, we use the OpenCV mouse events and draw functions to allow the user to mark the corresponding points. The user needs to mark at least 8 points and equal points must be marked in both images and the points are then saved in text files using keyboard commands.
For the fundamental matrix estimation, we use the marked corresponding points and normalize the points.
We then perform SVD on the formed matrix and choose the last column of V as the estimate for the fundamental matrix F.
We must ensure that the estimated matrix is a rank 2 matrix and for that we perform SVD on the estimated matrix F and set its last element of the obtained matrix D to zero.
Once you set the last element of matrix D to zero, use this new matrix D to compute F* and then get the fundamental matrix for the original points.
Once the line coefficients (a,b,c) are estimated, we set X coordinates to $(x, x_{max}) = (0, image\_shape)$ and compute Y coordinates using $y = -(c+ax)/b$
After the X and Y coordinates are known, we use the draw line function in OpenCV to draw the computed epipolar line.

For epipoles, the left epipole is computed using the formula $Fe_l = 0$ and the solution is the right null space of F i.e the last column of V found by SVD on matrix F. And the right epipole is computed using $F^T e_r = 0$ and the solution is the left null space of F i.e the last column of U found by SVD on matrix F.

3. Implementation Details

Execute the program using the command “python epipolar.py”

The user is then asked to provide the first (left) and the second image (right).

```
(base) D:\IIT semester 3 - fall 2018\CS 512 - Computer Vision\assignments\6\A6>python epipolar.py
Provide image 1: corridor-l.tif
Provide image 2: corridor-r.tif
```

Use the help function by typing ‘h’ on the keyboard at any point to get a list of commands and their corresponding actions.

```
1 - Mark points in Image 1
2 - Mark points in Image 2
s - Save marked points for Image 1
w - Save marked points for Image 2
e - Get the estimated fundamental matrix from the marked images and reset images
l - Enter the point from the left image to find the epipolar line for the right image
t - Display the right image with epipolar line
r - Enter the point from the right image to find the epipolar line for the left image
j - Display the left image with epipolar line
p - Print the epipoles in homogenous coordinates
esc - Quit
```

Mark the images in the first and second image by typing ‘1’ and ‘2’ and saving the points for each image using ‘s’ and ‘w’.

After saving the points get the estimated fundamental matrix by pressing the key ‘e’. The estimated matrix will be printed on the screen.

To get the epipolar line on an image select a point in the left/right image by pressing ‘l’ (for left) and ‘r’ (for right) and to display the epipolar line on the other image press ‘t’ (to display the epipolar line on the right image for a point selected in the left image) or ‘j’ (to display the epipolar line on the left image for a point selected in the right image).

To print the epipoles in the homogeneous coordinates press ‘p’.

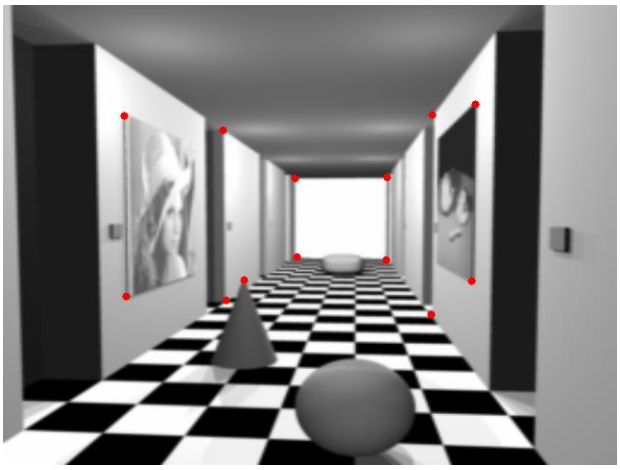
Press ‘esc’ to terminate the program.

4. Results and Discussion

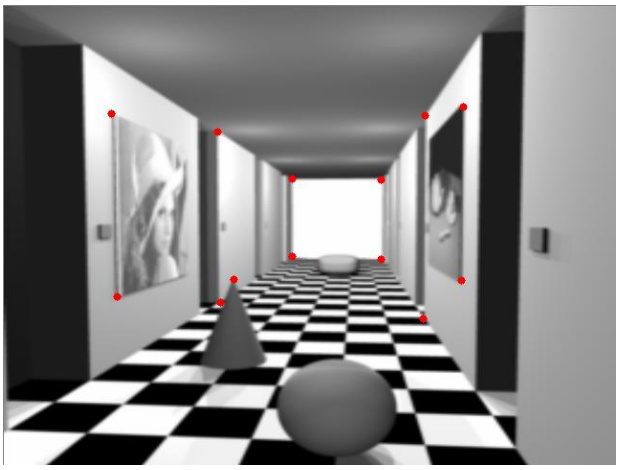
Left image

Right image

Selected points on left image



Selected points on right image



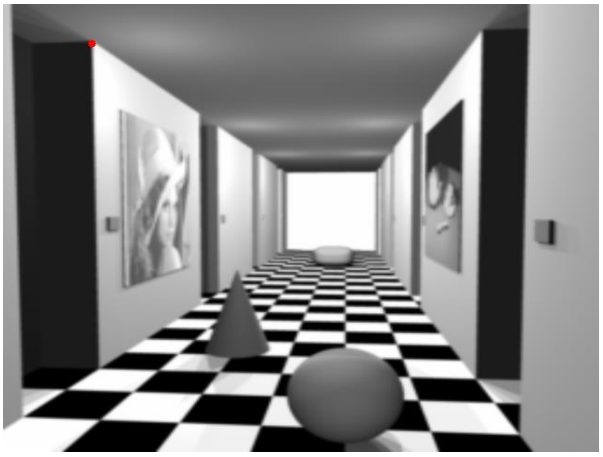
Estimated matrix:

```
('Estimated Fundamental matrix is', array([[-5.79576967e+03,  6.16691670e+03,  5.32946428e+05],
       [-2.55033049e+03,  2.71364678e+03,  2.34514431e+05],
       [ 1.43864030e-01, -1.53076722e-01, -1.32289343e+01]]))
```

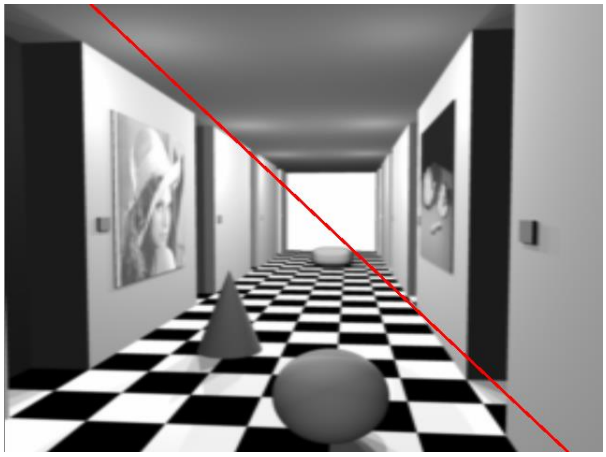
The images are reset after fundamental matrix estimation

Select a point on the left image for the epipolar line to be displayed on the right image

Point selected on left image

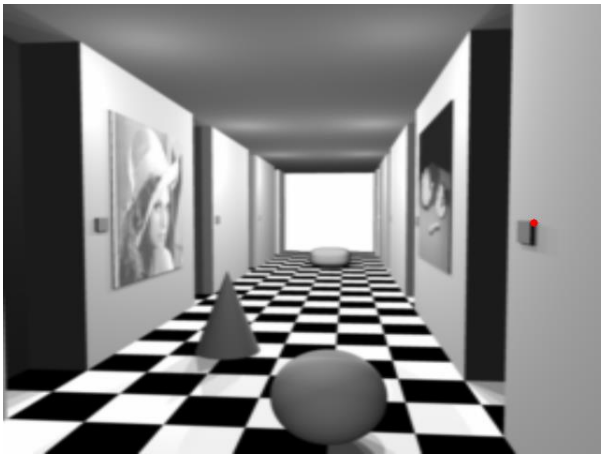


Corresponding epipolar line on right image

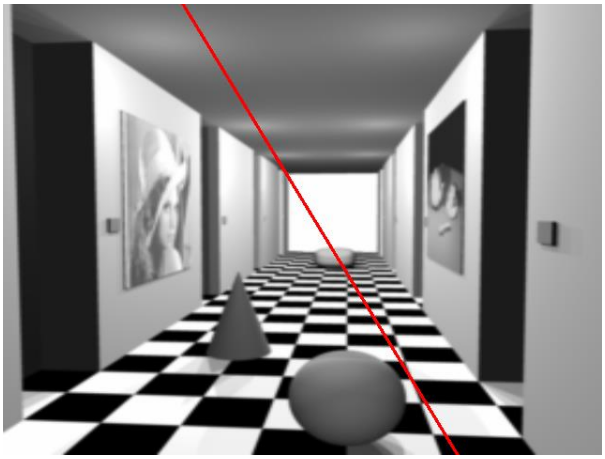


Similarly,

Point selected on right image



Corresponding epipolar line on left image



The epipoles in homogenous coordinates computed using the estimated fundamental matrix F are

```
('Left Epipole', array([0.75210947, 0.65903568, 0.0018238 ]))
('Right Epipole', array([1.42177601e-05, 2.51434862e-05, 1.00000000e+00]))
```