Introduction to Computer Vision

Exercise 5 (last exercise)

Due Date: Sunday, Feb. 4, 2018
Submission: in pairs

General Instructions

How and what to submit?
Please submit your solutions electronically as .zip to regular link (both .mat and .pdf files)

Part 1 – One plane scene

In this part you will use the two images from directory 'part1' to compute the homography between the first image and the second one.

1.1- Sample corresponding points

- Identify corresponding points from both images in order to recover the homography matrix (how many do you need?)
- You may find the function ginput() helpful

1.2- Recover the Homography matrix

- From each pair of corresponding points construct 2 equations where the 8 parameters of H are unknown.
- Recall, when applying homography one should multiply by H and scale by z:

$$\begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix} = \alpha \cdot H \begin{pmatrix} x \\ y \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix} = \frac{1}{h_7 x + h_8 y + h_9} \begin{pmatrix} h_1 x + h_2 y + h_3 \\ h_4 x + h_5 y + h_6 \\ h_7 x + h_8 y + h_9 \end{pmatrix}$$

- Define: $h_9 = 1$
- Formalize all the equations above as:

$$A \begin{pmatrix} h_1 \\ . \\ . \\ . \\ h_8 \end{pmatrix} = b \text{ where } A \text{ is an } 8 \times 8 \text{ matrix}$$

- Note: The matrix calculated here is not the pure homography but the homography for the uncalibrated coordinates:
$$H = K^t \overline{H} K^{-t}$$

1.3- Apply the Homography

Use the recovered homography to warp the first image to the second.

- Implement the function **I_trans = apply_homography(I, H)**, where H is the recovered homography and I, I_trans are the source and target images respectively.
- To do that, create a grid of all pixels in target image using **meshgrid()** and then calculate for all coordinates their matching coordinates in source image.
- Most of the calculated source coordinates will not be integers, so you will need to use **interp2()** to interpolate the values in these locations.
- Please do not use some readymade MATLAB warping function, the goal here is that you implement this yourselves.
- Avoid using loops over the coordinates. Use matrix manipulations instead, note that **interp2()** can be activated on meshgrids.

1.4- For the report

- Specify the matrix P from section 1.2
- Repeat 1.1 -1.3 while in 1.1 choose points that are close to each other. Attach
    - the warped image with the points taken for the reconstruction marked on (use scatter()).
    - The absolute differences image
- Repeat 1.1-1.3 while in 1.1 choose points that are far from each other. Attach
    - the warped image with the points taken for the reconstruction marked on (use scatter()).
    - The absolute differences image
- Align the magazine to be the output image
    - In the first image choose the 4 corners of the magazine
    - What should the corresponding coordinates be?
- Write in your report
    - Which approach is better
    - Explain why it is better

Part 2 – Two planes scene

In this part you will use the two images from directory ‘part2’ to compute the fundamental matrix

2.1 Compute 2 Homographies

Repeat sections 1.1-1.2 for each of the two planes (wall and table) in the image to calculate the homography from image3 to image4.

2.2 Plane + parallax

Apply both homographies (wall and table) calculated to image3. Your report should contain the following:

- One figure with the following 4 images (use subplot()) For each of the cases:
    - Image3
    - Image4
    - New aligned image
    - Absolute differences image between the aligned image and image4.
    - Points used for the homography calculation should be marked on all of the above images except the last one.
- Explain what happens to the plane that the corresponding points were not taken from (for example, the wall when the points were taken from the table).
- Explain what is the effect of the location of the epipole over the transformed locations of the non-planar points.

2.3 Fundamental matrix

Use both homographies from the previous sections to calculate the fundamental matrix.

- Hint: use your solution from exercise 3 question 6
- Include the theoretic process for recovering the fundamental matrix in you report. Specify what is the linear equations system that needs to be solved.
- Calculate the fundamental matrix and attach it to the report.
- Think of a way to check that your calculation is good enough, explain it in the report and add some documentation of how you applied it in your case.

Good Luck!!!