Assignment 9

This exercise is part of the course assignment. **Deadline for the assign ment 30.11.2022 at 23:59**

The topic of this assignment is two view geometry and 3d reconstruction. For this assignment you should return

- The files trianglin.m and estimateFnorm.m. Each file should contain your name and student number (of both students if you work in pairs).
- Your answers to the questions in the analysis part. At the end of the course, you should return a single pdf containing the answers to all questions of the assignments. The report should contain also your name and student number (of both students if you work in pairs).

Coding part (5pt)

1. First, run demo9.p to get a taste of the assignment.
2. Complete the function estimateFnorm.m which computes the fundamental matrix from given point correspondences using the normalised 8 points algorithms. Particularly you should
   - Normalise the points (this is done for you)
   - Construct the homogeneous system and solve it using homogeneous least squares (**hint:** slide 61 of lecture 10)
   - Impose that the fundamental matrix has rank 2
   - Denormalise the fundamental matrix (**hint:** slide 66 of lecture 10)
3. Complete the function trianglin.m that performs linear triangulation given the camera projection matrices and corresponding 2D points. Let $\mathbf{X} = [X, Y, Z]^\mathsf{T}$ a 3D point in homogeneous coordinates and $\mathbf{x}_1$, $\mathbf{x}_2$ the corresponding 2D points in homogeneous coordinates in the first and second image, i.e. $\lambda_1\mathbf{x}_1 = \mathbf{P}_1\mathbf{X}$ and $\lambda_2\mathbf{x}_2 = \mathbf{P}_2\mathbf{X}$. Then we can construct the homogeneous linear system

$$\begin{bmatrix}[\mathbf{x}_1]_\times \mathbf{P}_1 \\ [\mathbf{x}_2]_\times \mathbf{P}_2\end{bmatrix} \mathbf{X} = \mathbf{0} \tag{1}$$

   Your task is to assemble this linear system and solve it with homogeneous least squares. Note that the function takes the Euclidean coordinates of the image points as input and should return the Euclidean coordinates of the 3D point as output.

4. When you are done, run the script `main9`. This scripts first computes the fundamental matrix, then it extracts the projection matrices from the fundamental matrix (you can look at the function `vgg_P_from_F.m` in you are interested in seeing how this works) and finally uses the extracted projection matrices to triangulate the corners of the shelf. At the end the script visualizes the 3D reconstruction of the shelf (figure 3) and its reprojection to the original images (figure 1).

Analysis part (5pt)

- How many degrees of freedom does the fundamental matrix have? What about the essential matrix? Motivate your answer (2pt)
- Explain why the 3D reconstruction of the shelf looks like it looks. What could you do to remove the result? (3pt)