# SGN-45006 Fundamentals of Robot Vision
# Exercise Round 7

### April 15, 2019

For these exercises you will need Python or Matlab which should be available on the university computers. Return your answers as a pdf along with your modified code to Moodle. Exercise points will be granted after a teaching assistant has checked your answers. Returns done before the solution session will result in maximum of 3 points, whereas returns after the session will result in maximum of 1 point.

**Task 1.** Fundamental matrix estimation. (Programming exercise) (1 point)

See the comments in `Fmatrix_example` and implement the two missing functions:

  *a)* Implement the eight-point algorithm in `estimateF`. The algorithm is described below and in the lecture slides.

  Let's denote $\mathbf{x} = (u, v, 1)^\top$ and $\mathbf{x}' = (u', v', 1)^\top$.

  The eight-point algorithm can be implemented by solving the following homogeneous linear system:

$$(u'u, u'v, u', v'u, v'v, v'u, v, 1) \begin{pmatrix} f_{11} \\ f_{12} \\ f_{13} \\ f_{21} \\ f_{22} \\ f_{23} \\ f_{31} \\ f_{32} \\ f_{33} \end{pmatrix} = 0$$

  This solution is then enforced rank-2 constraint by taking SVD and then reconstructing using only the two largest singular values.

  *b)* Implement the missing denormalization used in normalized eight-point algorithm `estimateFnorm`. If $\mathbf{T}$ and $\mathbf{T}'$ are the normalizing transformations in the two images, the fundamental matrix in original coordinates is $\mathbf{T}'^\top \mathbf{T} \mathbf{F} \mathbf{T}$

The epipolar lines obtained with both F-matrix estimates should be close to those visualized by the example script. **Include an image with the epipolar lines obtained with both F-matrix estimates, as well as your version of the code.**

**Task 2.** Two-view structure from motion. (Programming exercise) (2 points)

In this exercise you will estimate the fundamental matrix for a pair of uncalibrated images and recover a pair of camera projection matrices that are compatible with the estimated fundamental matrix. Thereafter, triangulation of point correspondences using the aforementioned projection matrices gives a projective reconstruction of the scene, which is visualized in the example script.

Run the script `two_view_structure_from_motion_example` and proceed as follows (do the tasks and answer the questions):

*a)* The first part of the code calibrates the cameras using known dimensions of the shelf and visualizes a wireframe model of the shelf projected onto the images. How are the cameras calibrated here?

*b)* The second part triangulates and visualizes a projective reconstruction of the wireframe model. Give an explanation why the model looks distorted but is anyway correct. (See discussion in the lecture slides.)

*c)* In the third part you should project the distorted wireframe model onto the two images and check that it matches the outlines of the book shelf. **Include a picture that illustrates the projected model, as well as your version of the code.**

*d)* Finally, describe what kind of information could be used to upgrade the projective reconstruction to a similarity reconstruction, where angles and ratios of lengths are the same as in the real one, without knowing the dimensions of the book shelf. (Hint: See lecture slides.)