SGN-45007 Computer Vision
Exercise Round 5

For these exercises you will need Python or Matlab and a webcam 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.

If you are using Python, make sure you have *OpenCV* library for Python installed. For TC303 computers, open command prompt by searching *cmd* and use the command below to install the package (note that there are two dashes before *user* and *upgrade*).

pip install –user –upgrade opencv-python

If you are using Matlab, make sure you have *Support Package for USB Webcams* installed. This can be done through the add-on explorer.

Task 1. Similarity transformation from two point correspondences. (pen & paper) (1 point)
A similarity transformation consists of rotation, scaling and translation and is defined in two dimensions as follows:

$$\mathbf{x}' = s\mathbf{R}\mathbf{x} + \mathbf{t} \quad \Leftrightarrow \quad \begin{pmatrix} x' \\ y' \end{pmatrix} = s \begin{pmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} t_x \\ t_y \end{pmatrix} \tag{1}$$

Describe a method for solving the parameters s, θ, t_x, t_y of a similarity transformation from two point correspondences $\{\mathbf{x}_1 \rightarrow \mathbf{x}'_1\}$, $\{\mathbf{x}_2 \rightarrow \mathbf{x}'_2\}$ using the following stages:

a) Compute the correspondence between vectors $\mathbf{v}' = \mathbf{x}'_2 - \mathbf{x}'_1$ and $\mathbf{v} = \mathbf{x}_2 - \mathbf{x}_1$ using the similarity transform above. Use corresponding unit vectors to solve the scale factor s from this correspondence. *Hint: There should be no scaling in a transformation between two unit vectors*

b) Solve also the rotation angle θ from the vectors' correspondence by using the corresponding unit vectors.

c) After acquiring s and θ, solve $\mathbf{t}$ using equation (1) and either one of the two point correspondences.

d) Use the procedure to compute the transformation from the following point correspondences: $\{(\frac{1}{2}, 0) \rightarrow (0, 0)\}$, $\{(0, \frac{1}{2}) \rightarrow (-1, -1)\}$.
(Hint: Drawing the point correspondences on a grid paper may help you to check your answer.)

Task 2. Real-time face point tracking (Programming task) (2 points)
We'll be using KLT-tracker to track points detected from a face. Open *tracking* (Python or Matlab) and follow the instructions written in the comments. Answer the following questions in your pdf. **Return also your version of the code. You do not have to include an output image.**

After implenting the tracker, answer to the following questions:

a) How does this program work, i.e. what are its main parts?

b) Do you notice any problems with the tracking? How do you think these could be avoided?