Computer Vision and Image Analysis
Assignment Sheet 6 - 25.11.2014

Next exercise group: 28.11.2014

- Deadline for exercise: **4.12.2014, 18:00**, hard deadline.
  Please submit solutions either on our Ilias web page (preferred method), or via e-Mail in a single ZIP-Archive to `ole.johannsen@uni-konstanz.de`.
- You may work in groups of up to three students, make sure all participants are clearly mentioned or assigned to the submission in Ilias.

Exercise 6.1 (SIFT library, 5+5+5 points)

(a) Download and install the *VLfeat* library for Matlab by following the instructions at `http://www.vlfeat.org/install-matlab.html`. You might want to opt for the permanent setup option, since we will use it frequently.

Under "Getting started" on the same web page, there is an example script for SIFT feature detection, try it out and see what happens. Also check out the tutorial at `http://www.vlfeat.org/overview/sift.html`. To gain the points for this part of the exercise, submit a screenshot of one of your own images with the feature descriptor visualization included.

(b) Take a camera (or mobile phone, or whatever you have which can take pictures). Keep the camera location fixed, and capture ten images $I_1, \dots, I_{10}$. Between each two images, rotate the camera by five degrees around the vertical axis, so that at image I_{10}, the camera is finally rotated by a total of 45 degrees compared to I_1 (to get the rotation angle approximately right, you can for example draw some auxiliary lines on a sheet of paper, and use these to align the camera). Compute SIFT features for all images, and use `vl_ubcmatch()` (see tutorial page) to compute matches between I_1 and all of the other images. Then visualize

- the number of matches detected, and
- the matching scores of the five best matches

as a function of rotation angle of the camera.

(c) Take a second series of images. This time, keep the location of the camera fixed, and vary illumination - daylight, artificial lighting of different colors, brightness, and direction, candles, or whatever comes to your mind. Take five different images, and examine how well feature detection works between them. What is the most difficult situation? Can you find two illumination conditions where feature detection fails completely (maybe except for a pitch black room)?

Exercise 6.2 (Image transformations I, 5+5(+5) points)

(a) Let T_1, T_2 be two affine transformations of $\mathbb{R}^2$ with matrices A_1, A_2 for the linear part and translation vectors t_1, t_2, respectively. Show that $T_2 \circ T_1$ (i.e. apply T_1 first, then T_2) is again affine. What is the matrix and translation vector of $T_2 \circ T_1$?

(b) Grab a camera, and try to capture two images which are related to each other by a pure (non-zero) translation. What kind of scene and camera motion do you think you need for this? Compute SIFT features and matches for the two images as in exercise 6.1, and compute the translation vector for each feature match. Then, compute a final estimate for the overall translation by averaging all of these (possible improvement: take a weighted average according to a function of the matching scores, assigning a larger weight to a better score). Check visually if the estimate looks correct.

(c) **(Bonus exercise, requires some additional thinking).** As a variant of 6.2(b), capture two images which are related to each other by a rigid motion. Take the two best feature matches from SIFT (or select two matches manually), then compute the rotation and translation parameters from these two (you can do this with pen and paper). Rotate the image by the estimated rotation angle in your favourite paint program (or MATLAB), and verify if the result looks correct.