Image - Based Measurement Laboratory
Lab1 - Uncalibrated Sensors

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Winter - Term 2017/2018

Teaching Goals

This first laboratory is comprised of four exercises. Each exercise demonstrates a different application of uncalibrated image sensors. You will work with differently controlled illumination conditions and apply MATLAB and its image processing toolbox to perform simple image-based measurements.

Important Note!

Please strictly adhere to the following rules when working in the laboratory:

- **Never** use a camera without a suitable mount such as a tripod!
- Be careful when re-connecting a camera to the PC! Some interfaces require you to completely power down the PC prior to any camera handling.
- **Never** touch the unprotected surface of a sensor!

Exercise 1 - Image stitching

Shoot two consecutive pictures containing the target and combine them into a single image. Make use of the target to define point correspondences, which were used to calculate an according homography. The MATLAB function `PanoramaStiching.m` is provided and displays the stitched image given the two images and extracted correspondences.

- Try different numbers of point correspondences.
- Vary the distance between selected corners (i.e. select corners near each border of the target. Next time choose four corners placed around a single square).
- Why are some correspondences better than others? How can certain differences along the line of intersection be explained? Compare and discuss your results.

Exercise 2 - Auto-Focus

Take a sequence of about $N = 10$ images of a static scene using a linearly varying focus parameter of the provided camera. Determine scene properties which make the scene well suited for an auto-focus algorithm. Develop a MATLAB script to determine the best focus image out of this sequence. Repeat your analysis with different image sequences and discuss your results.

Exercise 3 - Sensor Dynamics

You are required to acquire an image of a detail on a rotating disc. Perform the following tasks:

- Find a suitable acquisition setup (camera and illumination) using the provided camera. Investigate the use of different shutter modes.
- Use an integrating sensor and synchronise your light source and the rotating disc. Vary the parameters of your setup.
- Compare and discuss your results.

Exercise 4 - Perspective Invariants

Investigate the Cross Ratio (CR) of four co-linear points A, B, C, and D as given by

$$CR_{A,B,C,D} = \frac{\overline{AC}}{\overline{BC}} : \frac{\overline{AD}}{\overline{BD}} \tag{1}$$

The CR is invariant under perspective projections. Use a CR-Target to acquire $N = 10$ images under varying viewing conditions and perform the following tasks:

- Extract the required points A, B, C, and D using a corner detector.
- Complete the MATLAB function `CrossRatio.m` to measure the CR.
- Determine the histogram, mean-value, and standard deviation of the CR over all images.
- Visualise and discuss your results.

Useful MATLAB functions: *imread*, *im2double*, *imshow*, *rgb2gray*, *markCorners*, *fft2*, *fftshift*, *imgradient*