

Exercises in Tracking & Detection

Exercise 1 Multi-scale Harris and Harris-Laplace Corner Detectors

In the lecture you have learned about the multiscale Harris and Harris-Laplace corner detectors based on the basic Harris detector.

Basic Harris Detector: The response R is computed by:

$$R(\mathbf{x}, \sigma_{I_n}, \sigma_{D_n}) = \det(M(\mathbf{x}, \sigma_{I_n}, \sigma_{D_n})) - \alpha \cdot \text{trace}(M(\mathbf{x}, \sigma_{I_n}, \sigma_{D_n}))^2, \quad (1)$$

where

$$M(\mathbf{x}, \sigma_{I_n}, \sigma_{D_n}) = \sigma_{D_n}^2 g(\sigma_{I_n}) * \begin{bmatrix} L_x^2(\mathbf{x}, \sigma_{D_n}) & L_x L_y(\mathbf{x}, \sigma_{D_n}) \\ L_x L_y(\mathbf{x}, \sigma_{D_n}) & L_y^2(\mathbf{x}, \sigma_{D_n}) \end{bmatrix} \quad (2)$$

and $L_x(\mathbf{x}, \sigma_{D_n})$ and $L_y(\mathbf{x}, \sigma_{D_n})$ are the first-order derivatives in x and y -direction respectively on an image smoothed with σ_{D_n} . For this sheet you can use the MATLAB convolve for Gaussian smoothing/derivative functions.

- a) Implement the multiscale Harris detector with different parameters determining the scale level n , the initial scale value s_0 , the scale step k , the constant factor α and a threshold value t for the Harris response R .
- b) Implement the Harris-Laplace detector as described in the Mikolajczyk *et al.* 2001 paper "Indexing Based on Scale Invariant Interest Points" by using the multi-scale Harris detector implemented in a). Use the Laplacian scale selection as presented in Eq. 2. Do not forget to incorporate the scale normalization as described in section 2 of the paper ($F(x, s_n)$ with $s_n = k^n s_0$; $s = s_n$ in Eq. 2). Use the parameters as mentioned in the paper on page 5 (under **Interest points**). But, instead of using a scale representation with 17 resolution levels you are allowed to use only 5 resolution levels.
- c) Apply the multi-scale Harris and Harris-Laplace detectors on the images provided on the web page. Adjust the parameters in order to obtain a similar response to the given sample outputs.
- d) Apply the multi-scale Harris and Harris-Laplace detectors on the uploaded images with three scale levels $n = 0$, $n = 5$, $n = 17$.