

## Exercises in Tracking & Detection

### Exercise 1      Harris Corner Points

In the lecture you have learned about the multiscale Harris corner detector whose 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

$L_x(\mathbf{x}, \sigma_{D_n})$  is the first derivative in x-direction on an image smoothed with  $\sigma_{D_n}$ ,  $L_y(\mathbf{x}, \sigma_{D_n})$  respectively in y-direction,  $\sigma_{D_n} = 0.7\sigma_{I_n}$ ,  $\sigma_{I_n} = s_0 * k^n$ ,  $s_0 = 1.5$  and  $k = 1.2$ . 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  $\alpha$  and a threshold value  $t$  for the Harris response  $R$ .
- b) Apply the multiscale Harris detector with the parameter settings mentioned above for three scale levels  $n = 0, n = 5, n = 17$  on the Lena image.

### Exercise 2      Harris-Laplace Detector

In the lecture the Harris-Laplace detector was introduced to you. Please, read the corresponding ICCV paper of Mikolajczyk et al., which you can find on the web-page.

Implement the Harris-Laplace detectors as described in the ICCV paper by using the multiscale harris detector implemented in the first exercise of this sheet. Use the laplacian scale selection as presented in Equ. 2. Don't 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 Equ. 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 use 5 resolution levels. Apply the detector to the Lena image.