Computer Vision
and Geometry Lab

Computer Vision

Exercise Session 1

Assignment 1

4 Tasks

- Harris corner detection
- Image patch extraction
- Feature matching
- Comparison with SIFT.

Harris Corner Detector

- Compute intensity gradients in x- and y-direction
- Blur images to get rid of noise
- Compute Harris response
- Threshold the response image
- Apply non-maximum suppression

Image Intensity Gradients

- 1st derivative of image intensities in 2D
- Rate of change of gray scale value at one pixel
- Simplest way, compute:

$$I_x = \frac{p_{x+1,y} - p_{x-1,y}}{2}$$

$$I_y = \frac{p_{x,y+1} - p_{x,y-1}}{2}$$

...or use gradient() in MATLAB

Blurring an Image

- Check the following functions:
  - fspecial('gaussian')
  - imfilter()

Harris Response

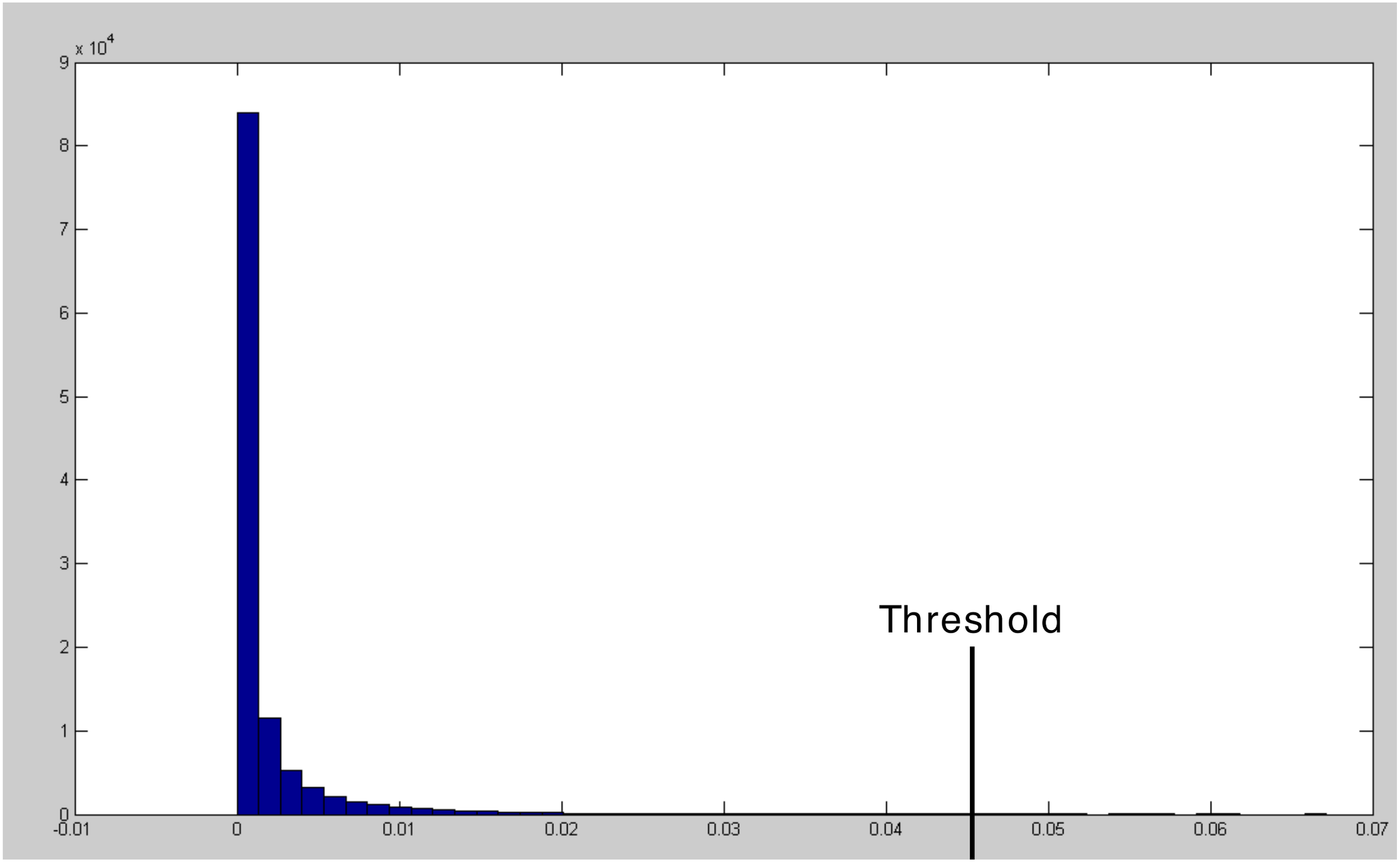
- First the Harris Matrix is calculated from the gradients

$$H = \sum_{\text{neighbours}} \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}.$$

- Using this matrix, the response is given by:

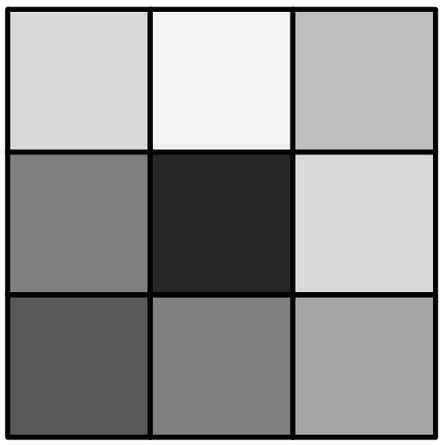
$$K = \frac{det(H)}{trace(H)}$$

Harris Response Histogram

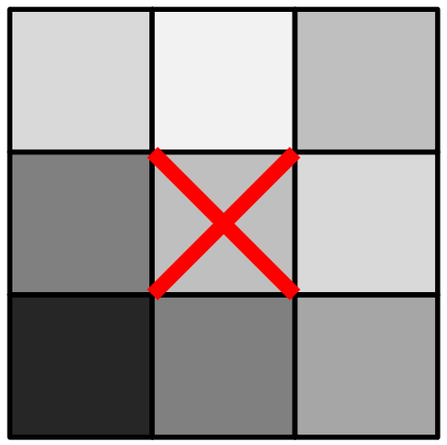


Non-maximum Suppression

- For every pixel above the threshold, check the surrounding pixels inside a window for the maximum response intensity
- If the center pixel response is smaller than a pixel inside the window, remove the center pixel from the corner candidates



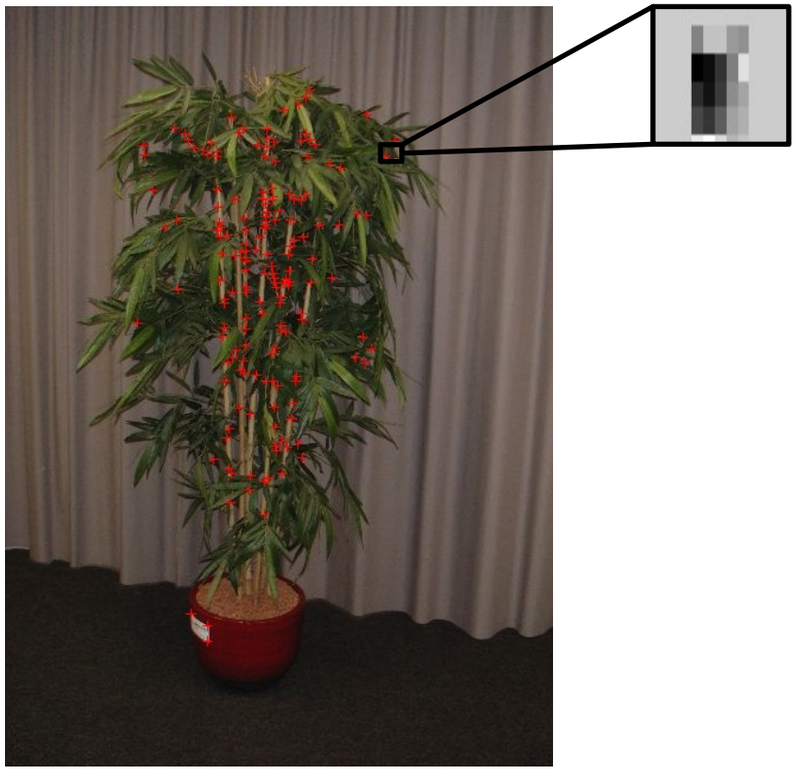
Center pixel has maximum response inside window



Center pixel not maximum, suppress

Patch Descriptor

- For each keypoint, extract an image patch of 9x9 pixels and store it as descriptor vector



Matching Descriptors

- For each keypoint in one image find the corresponding keypoint in the other image
- Compute the sum of squared differences (SSD) between the two descriptor vectors d_A and d_B

$$ssd = \sum_i (d_{A,i} - d_{B,i})^2$$

- Small differences denote a high similarity

SIFT

- Download and install VLFeat, SIFT feature extractor from Andrea Vedaldi (http://www.vlfeat.org)
- Go through the tutorial and learn how to extract, match and visualize SIFT features
- Compare the result of your implementation with the one obtained using SIFT features

Hand-In

- Write up a short report explaining the main steps of your implementation
- Include images showing the final results