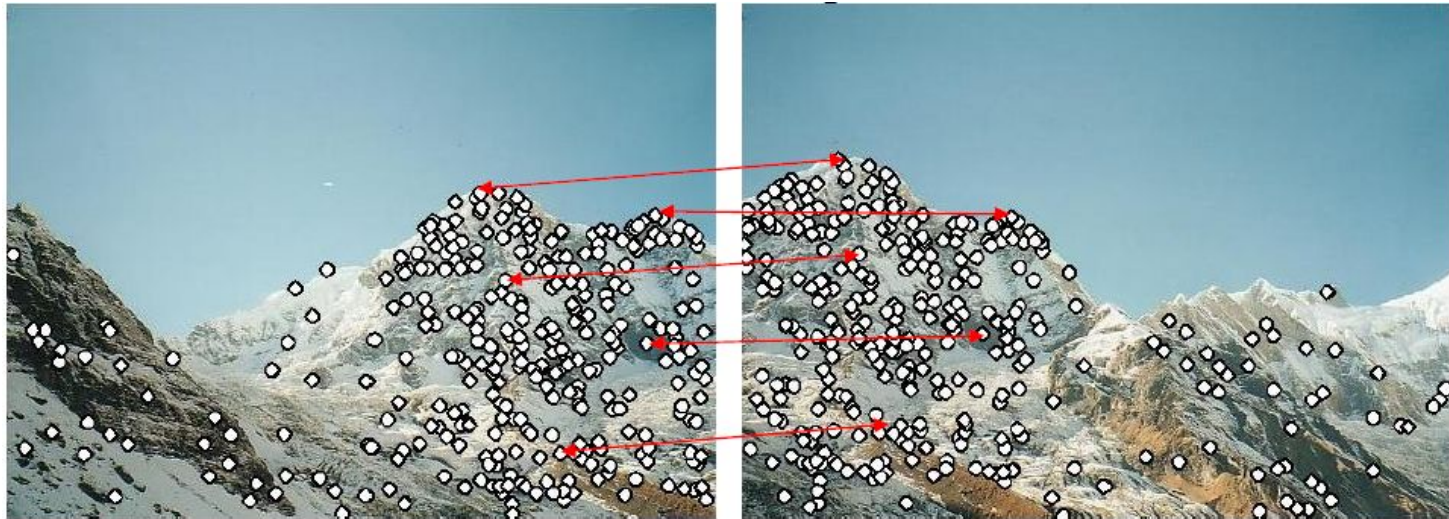


Scale Invariant Feature Transform

Tutorial 3, CSC420 2017Fall
Hang Chu

Introduction

1. Correspondence is fundamental to many core problems in computer vision.
 - a. Recognition / Detection
 - b. Tracking
 - c. Reconstruction
2. Features are the key.



Introduction

1. Three steps in finding correspondences.

- Find interest points
- Compute descriptors
- Match

2. Alternatives

- Learning-based
- Direct method

Detected
Interest Points/Regions

Descriptors



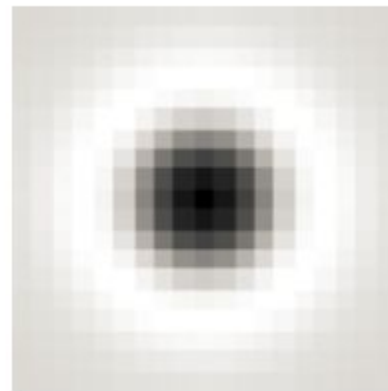
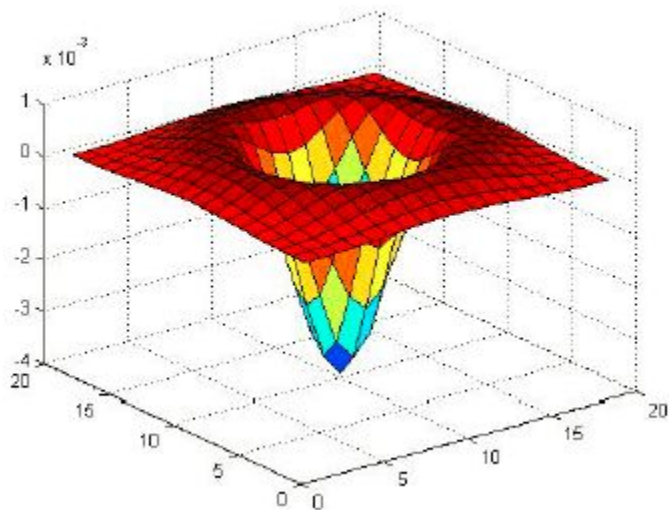
<0 12 31 0 0 23 ...>

<5 0 0 11 37 15 ...>

<14 21 10 0 3 22 ...>

Interest Points

1. The Laplacian of Gaussian (LoG)
 - a. Detect blob-like structures



Interest Points

1. The Laplacian of Gaussian (LoG)

a. Similar to Difference of Gaussian (DoG)

Kernels:

$$\nabla^2 g = \frac{\partial^2 g}{\partial x^2} + \frac{\partial^2 g}{\partial y^2}$$

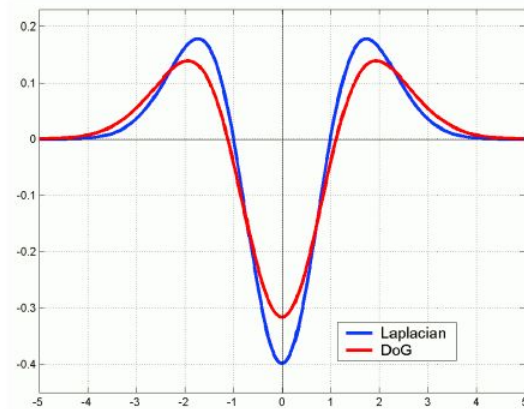
(Laplacian)

$$DoG = G(x, y, k\sigma) - G(x, y, \sigma)$$

(Difference of Gaussians)

where Gaussian

$$G(x, y, \sigma) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

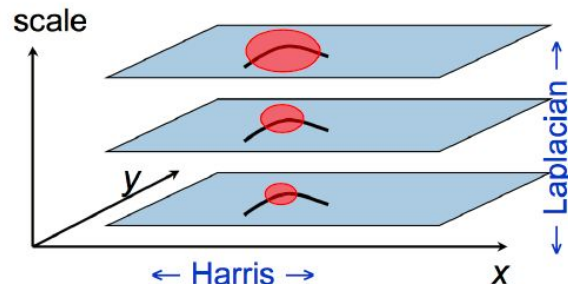


Interest Points

- **Harris-Laplacian**¹

Find local maximum of:

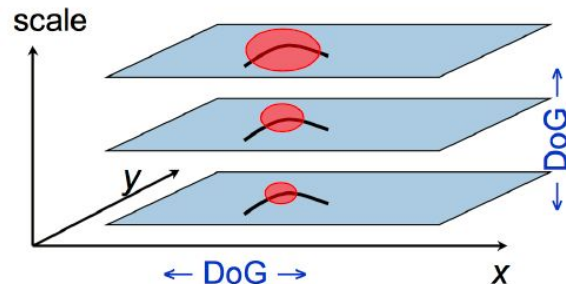
- Harris corner detector in space (image coordinates)
- Laplacian in scale



- **SIFT (Lowe)**²

Find local maximum of:

- Difference of Gaussians in space and scale

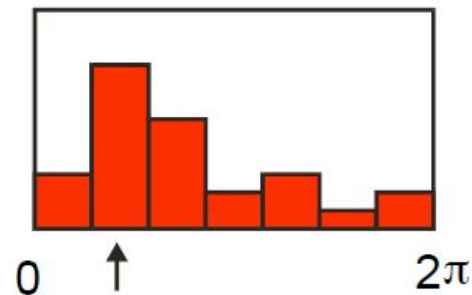
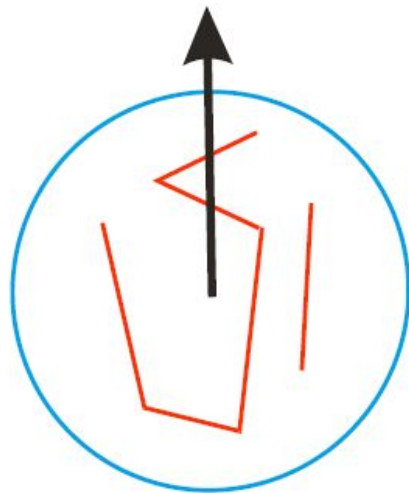


¹ K.Mikolajczyk, C.Schmid. "Indexing Based on Scale Invariant Interest Points". ICCV 2001

² D.Lowe. "Distinctive Image Features from Scale-Invariant Keypoints". IJCV 2004

SIFT Descriptor

1. Orientation of interest points
 - a. Compute orientation histogram
 - b. Gaussian weighted around center
 - c. Select dominant orientation



SIFT Descriptor

1. Orientation of interest points

- 4x4 window, 8 direction histogram per window
- Gaussian weighted around center
- $4 \times 4 \times 8 = 128$ dimensional descriptor

