Scale Invariant Feature Transform

Tutorial 4, CSC420 2018Spring
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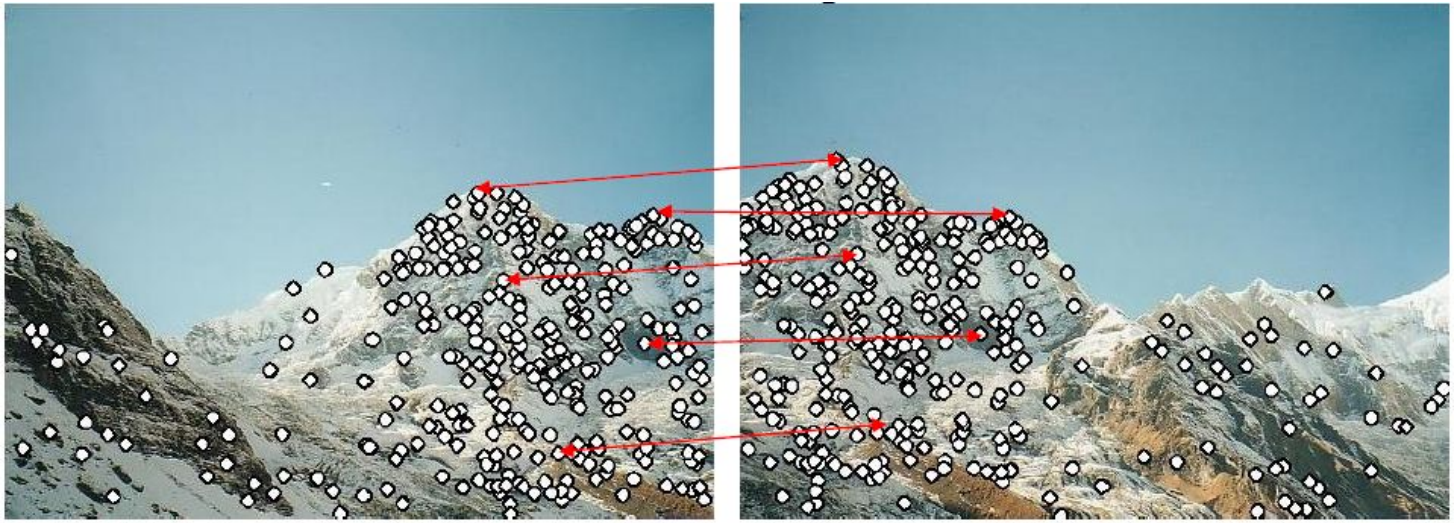
Based on slides from Ofir Pele, Sebastian Thrun, Jana Kosecka, Neeraj Kumar, and Kavita Bala

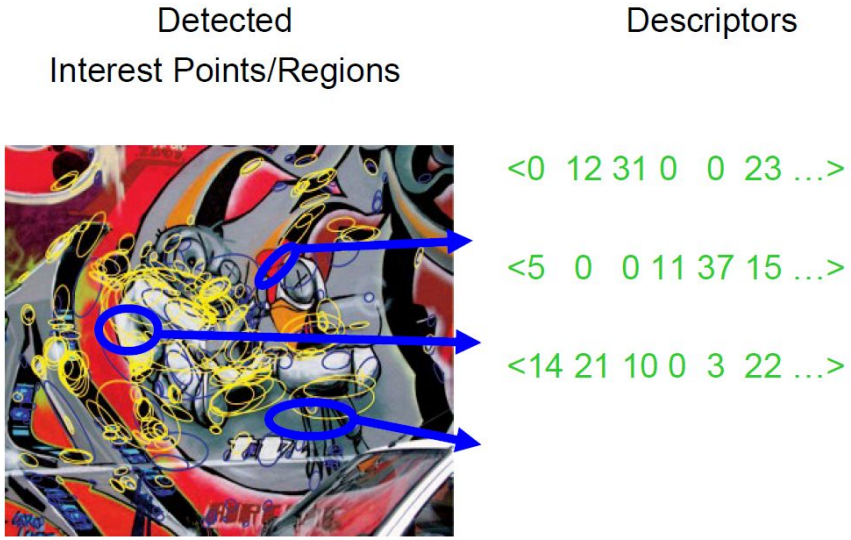
Introduction

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



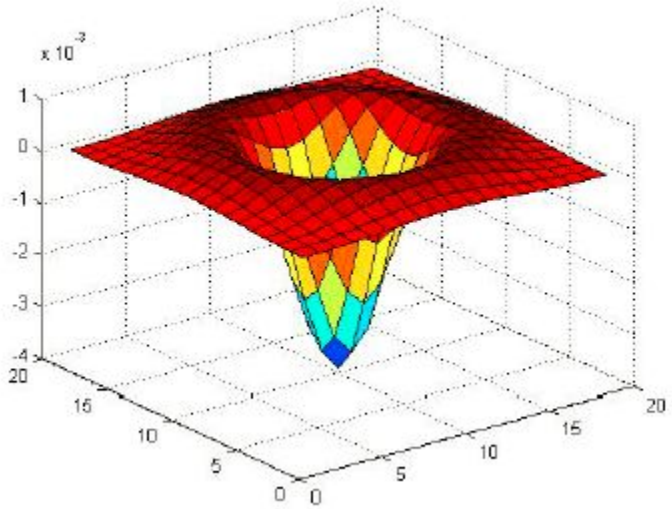
Introduction

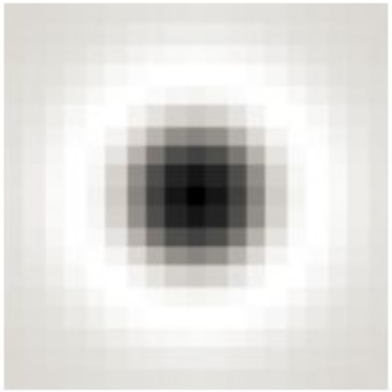
1. Three steps in finding correspondences.
   a. Find interest points
   b. Compute descriptors
   c. Match
2. Alternatives
   a. Learning-based
   b. Direct method



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:

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

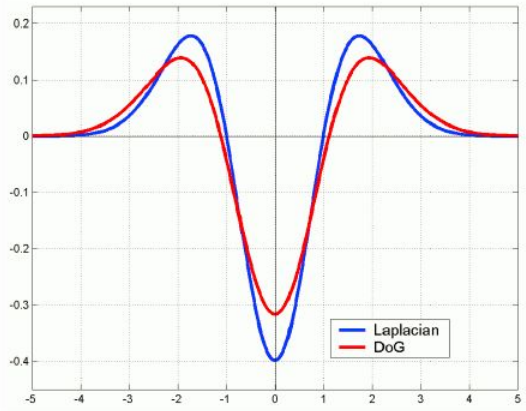
(Laplacian)

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

(Difference of Gaussians)

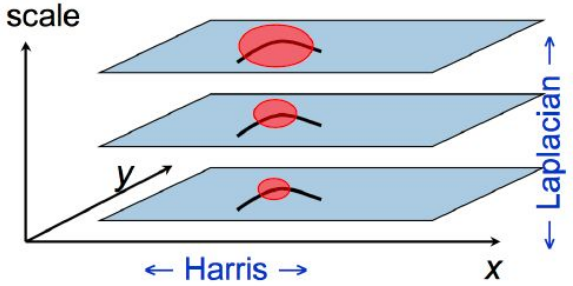
where Gaussian

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

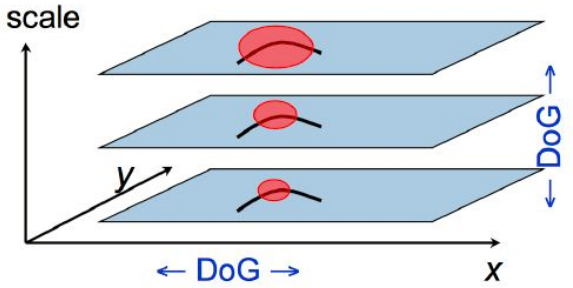


Interest Points

- **Harris-Laplacian**[1]
  Find local maximum of:
  - Harris corner detector in space (image coordinates)
  - Laplacian in scale



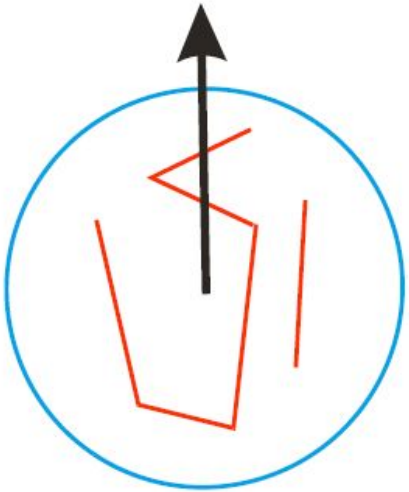
- **SIFT (Lowe)**[2]
  Find local maximum of:
  - Difference of Gaussians in space and scale

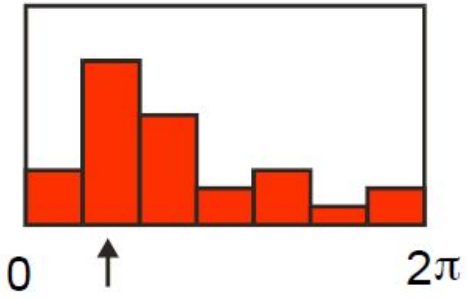


[1] K.Mikolajczyk, C.Schmid. "Indexing Based on Scale Invariant Interest Points". ICCV 2001
[2] D.Lowe. "Distinctive Image Features from Scale-Invariant Keypoints". IJCV 2004

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
   a. 4x4 window, 8 direction histogram per window
   b. Gaussian weighted around center
   c. 4x4x8=128 dimensional descriptor