

CS 556: Computer Vision

Lecture 4

Prof. Sinisa Todorovic

sinisa@eecs.oregonstate.edu

Outline

- Point descriptors -- SIFT, HOG

Point Descriptors

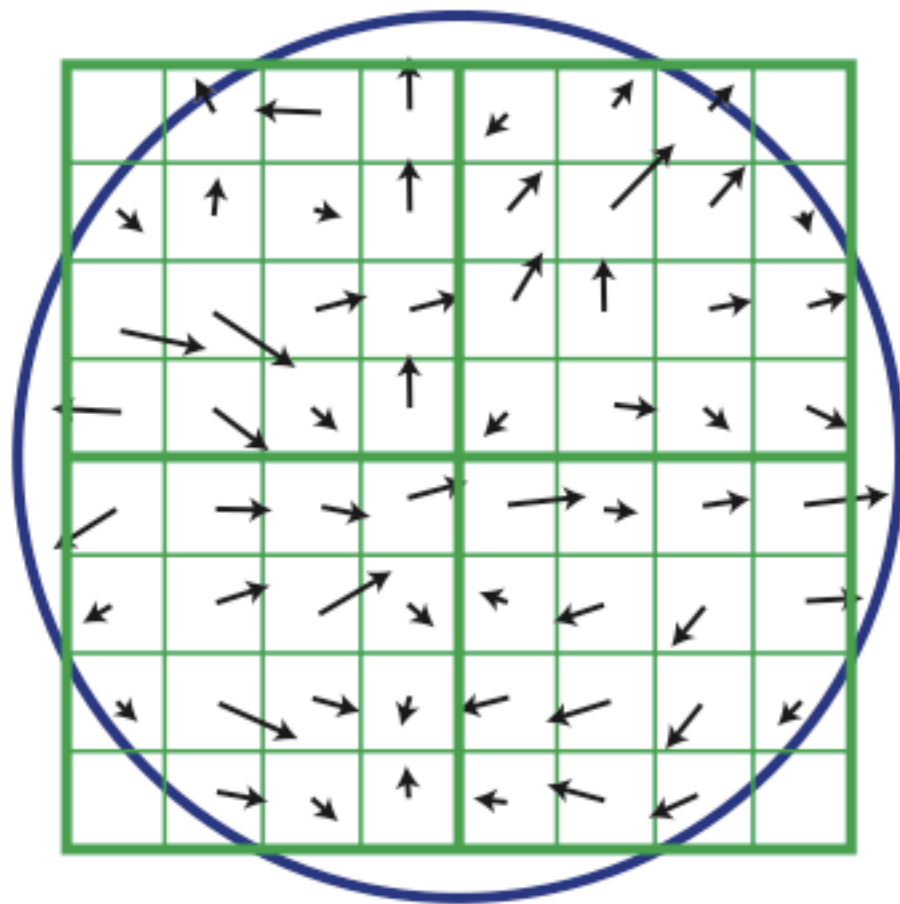
- Describe image properties in the neighborhood of a keypoint
- Descriptors = Vectors that are ideally affine invariant
- Popular descriptors:
 - Scale invariant feature transform (SIFT)
 - Steerable filters
 - Shape context and geometric blur
 - Gradient location and orientation histogram (GLOH)
 - Histogram of Oriented Gradients (HOGs)

SIFT and HOG

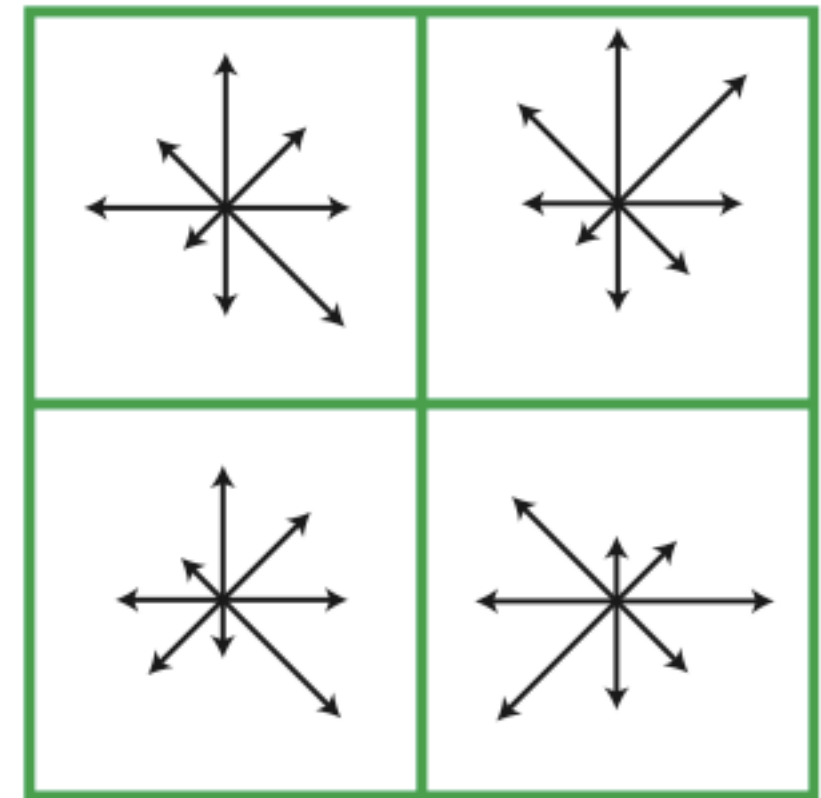
The key idea is that
local object appearance and shape
can be described by the distribution of
intensity gradients or edge directions.

SIFT Descriptor

128-D vector = (4x4 blocks) x (8 bins of histogram)



gradients of a 16x16
patch centered at
the point



histogram of gradients
at certain angles
of a 4x4 subpatch

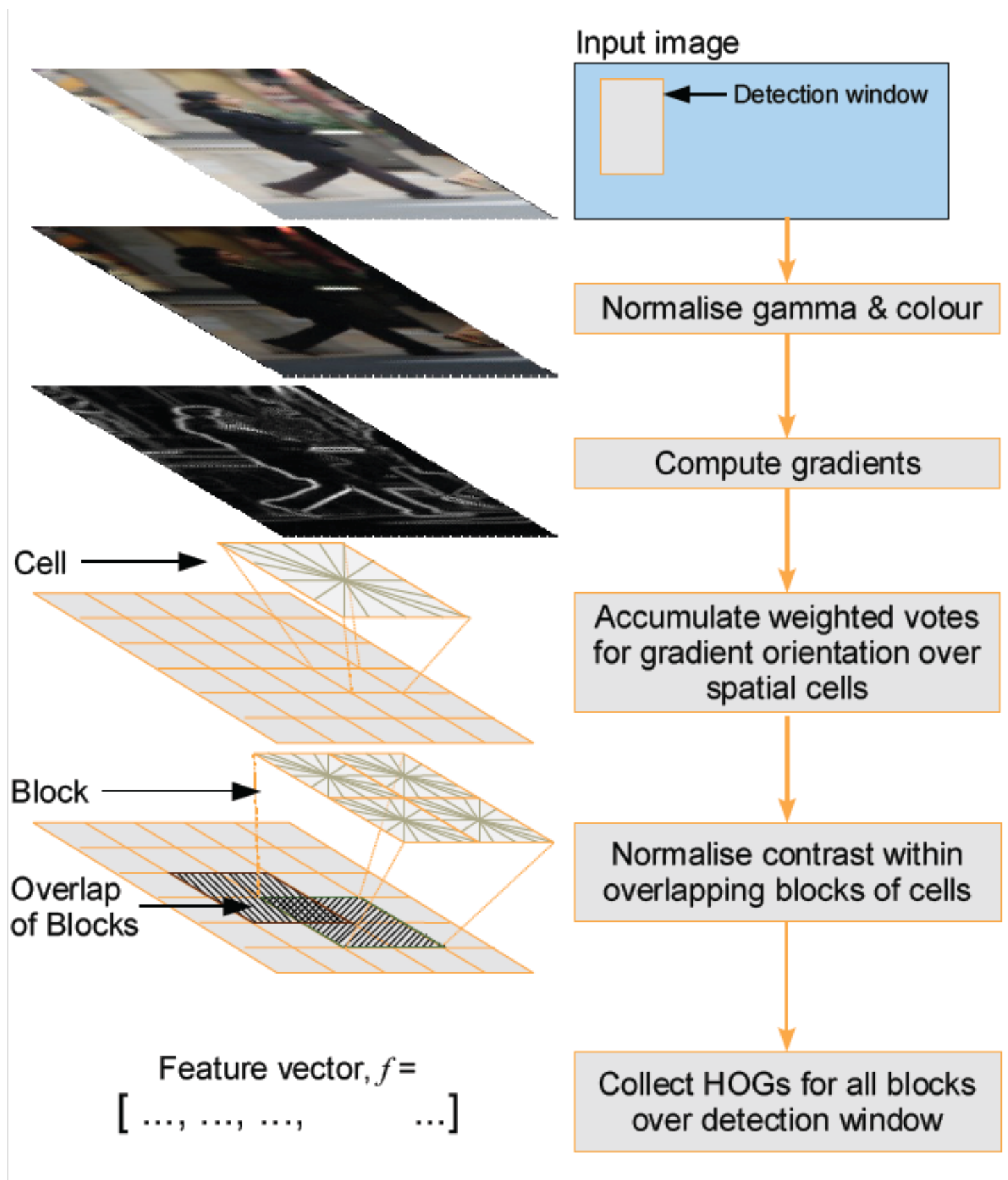
The figure illustrates only 8x8 pixel neighborhood
that is transformed into 2x2 blocks, for visibility

PCA-SIFT

- Instead of using 8 fixed bins for the histogram of gradients
- Learn the principal axes of all gradients observed in training images
- For a given interest point
 - Compute SIFT with
 - Gradients in the vicinity of the point projected onto the principal axes

Histogram of Oriented Gradients

HOG is a histogram of orientations of the image gradients within a patch

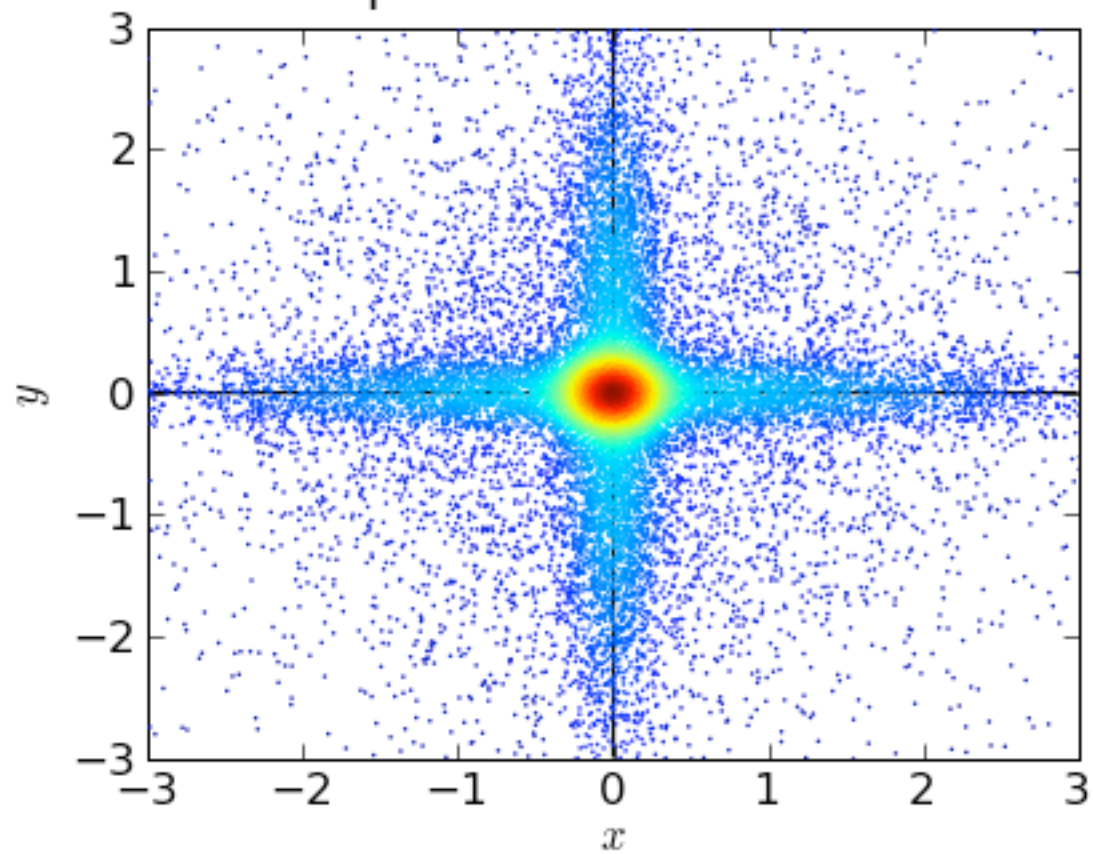


MATLAB Code for SIFT

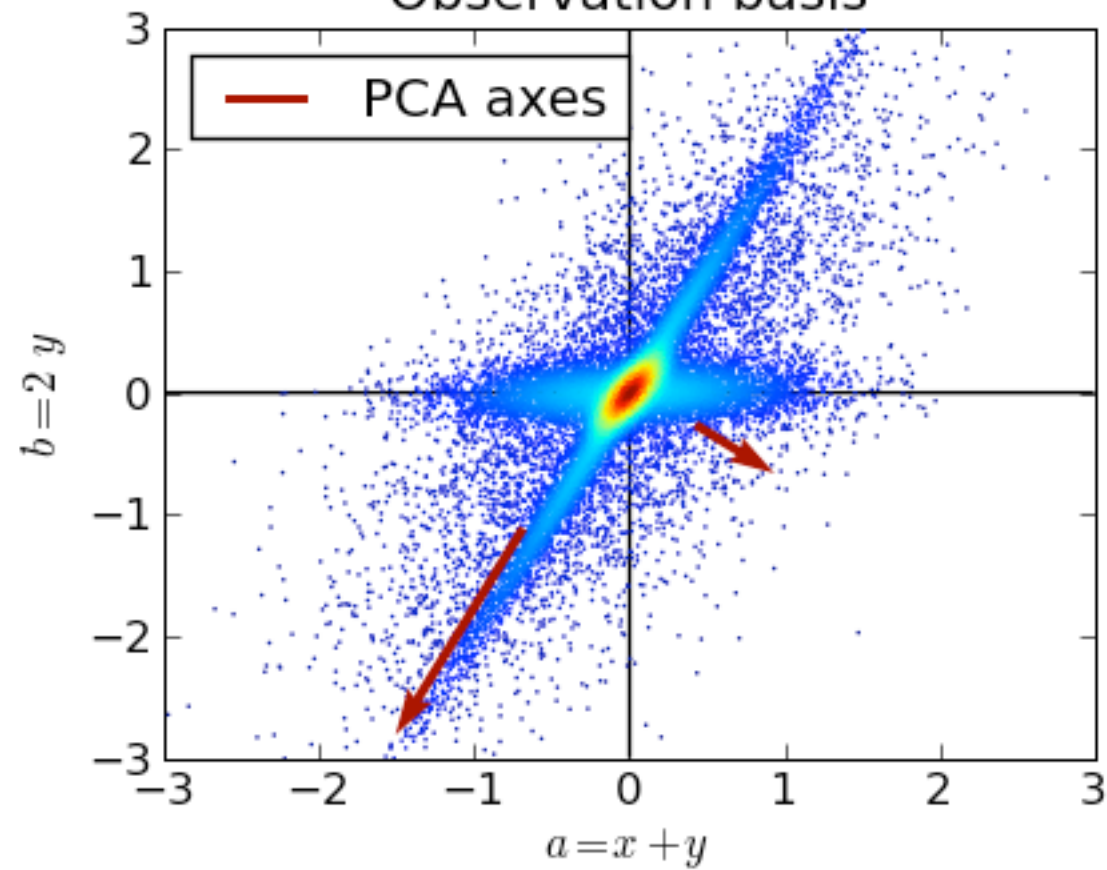


PCA

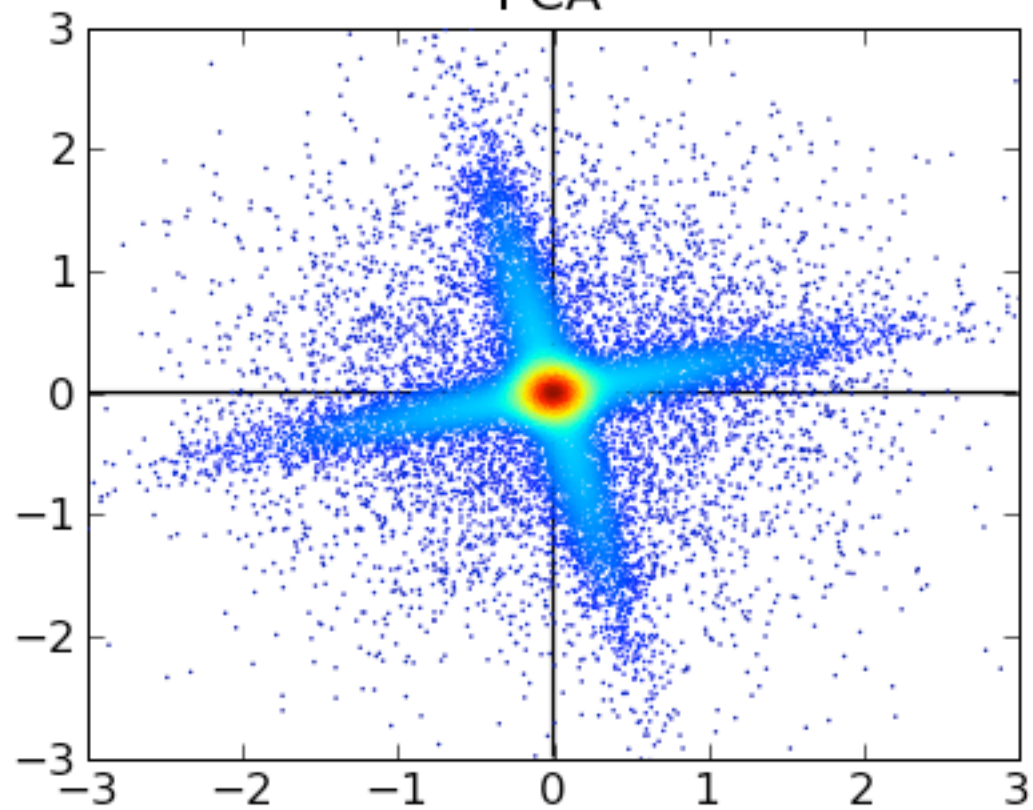
Independant-variable basis



Observation basis



PCA



PCA - Review

- Define an $(d \times n)$ data matrix X , with zero mean, where each column represents a data sample
- Find the SVD decomposition $X = U \Sigma V^T$
 - U is an $(d \times d)$ matrix of feature eigenvectors of XX^T
 - Σ is an $(d \times n)$ diagonal matrix of non-negative singular values
 - V is an $(n \times n)$ matrix of data eigenvectors of X^TX
- Find data projections onto eigenvectors: $Y = U^T X$

OpenCV Implementation of HOG

