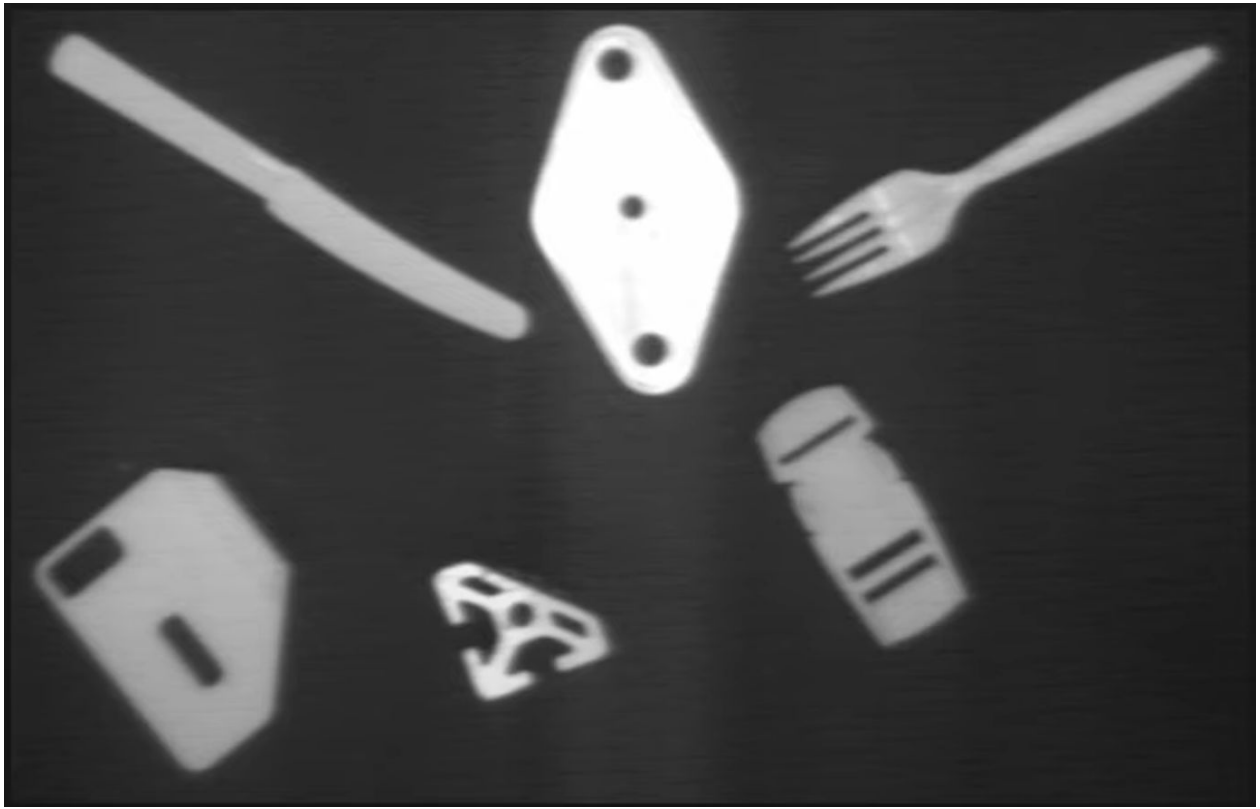
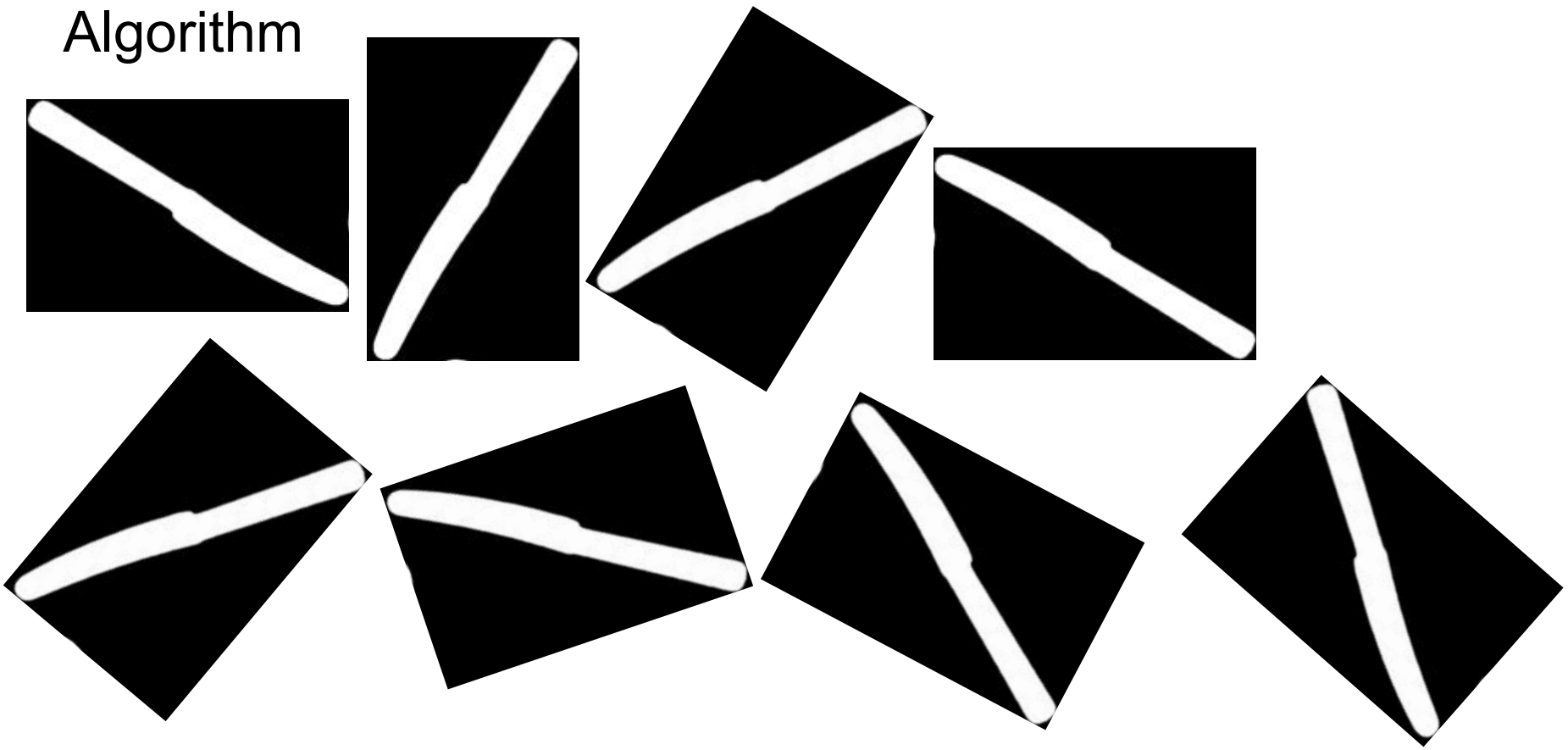
SIFT - Detector and Descriptor

Laxminarayen

Recognize the following objects



Algorithm

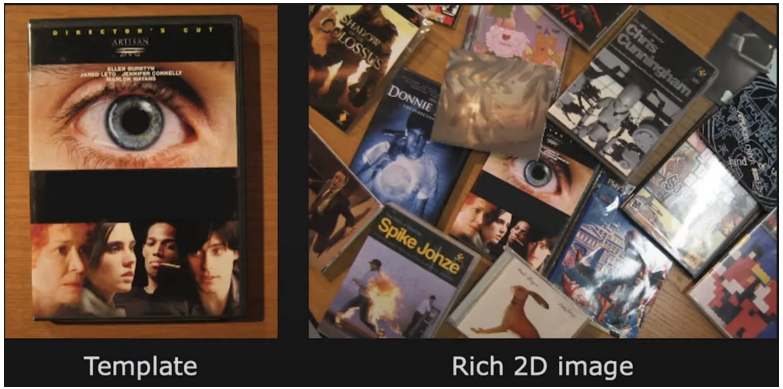


Here?


DIRECTOR'S CUT
ARTISAN
ELLEN BURSTYN
JARED LETO JENNIFER CONNELLY
MARLON WAYANS
SHADOW OF THE COLOSSUS
DONNIE
Chris Cunningham
Spike Jonze
Template
Rich 2D image

What is the problem?

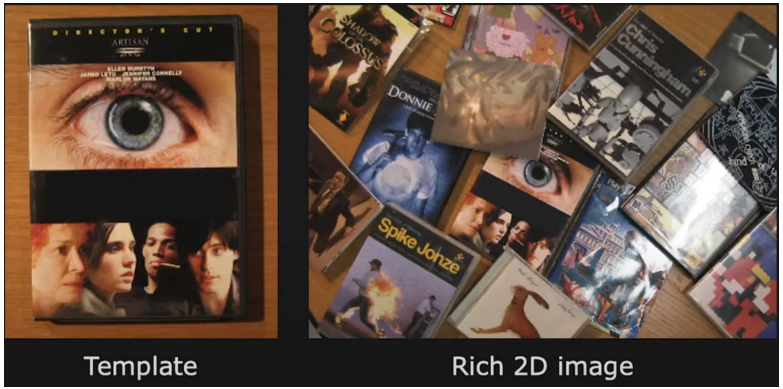
1. Orientation?
2. Scale?
3. Occlusion?
4. Lighting?
5. Rotation?



CAN Edges? Corners? Thresholding help?

What is the problem?

1. Orientation?
2. Scale?
3. Occlusion?
4. Lighting?
5. Rotation?



CAN Edges? Corners? Thresholding help?

NEED MORE INTERESTING POINTS or FEATURES

SOLUTION

SIFT - SCALE INVARIANT FEATURE TRANSFORM

1. Image Alignment and Stitching
2. 2D Object Recognition

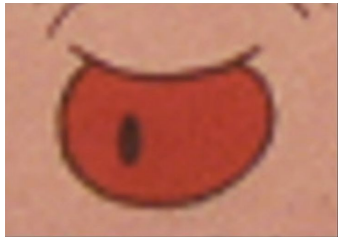
What is an Interest Point

1. Area in CV research
    a. In Research from 1970
    b. What are interesting points for robot vision?

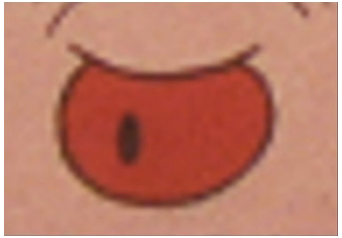
Interest point

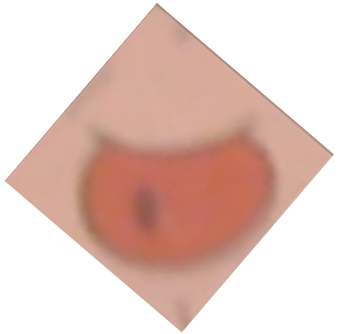
Different Size, Orientation, Lighting, Brightness, etc.,

Interest point

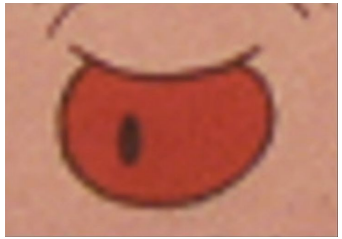


Different Size, Orientation, Lighting, Brightness, etc.,

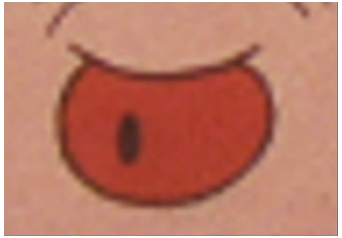


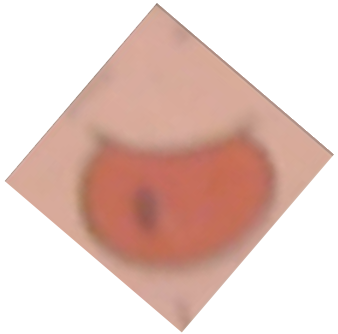


Interest point

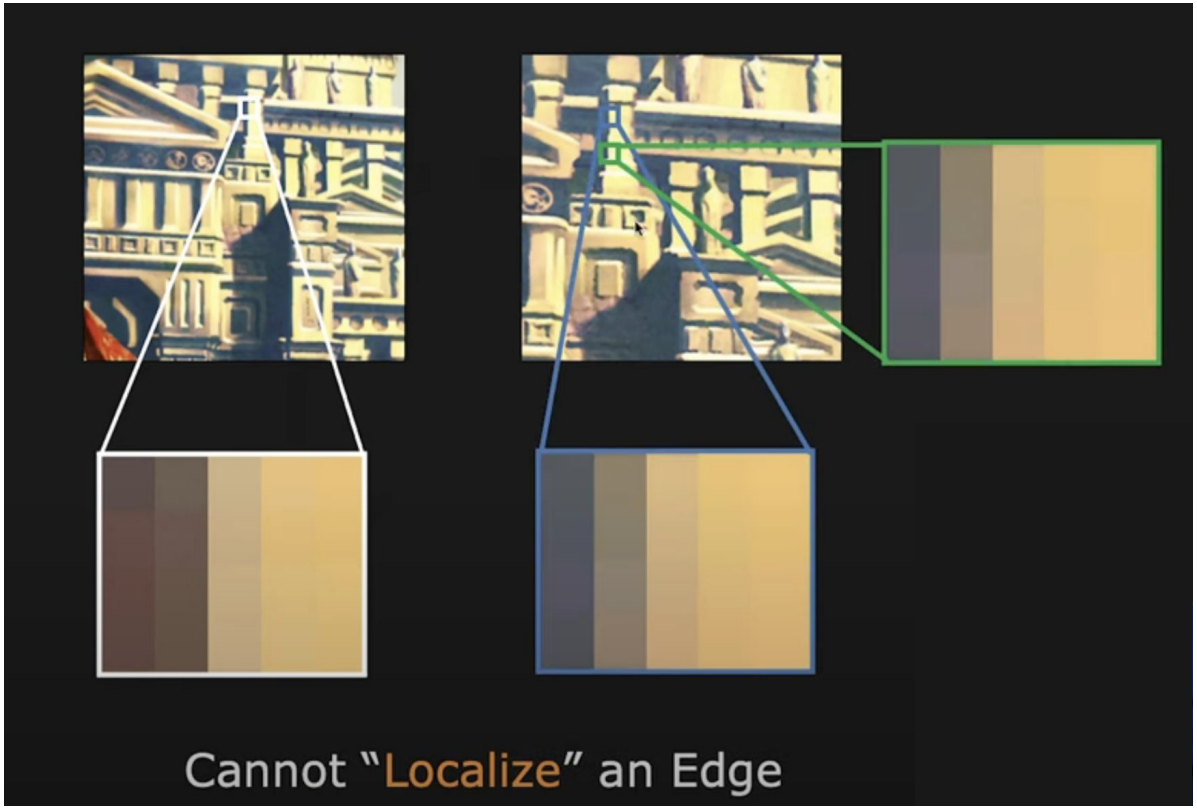


1. Has rich image content
2. Has well-defined representation
3. Has well-defined position in the image
4. Should be invariant to image rotation and scale

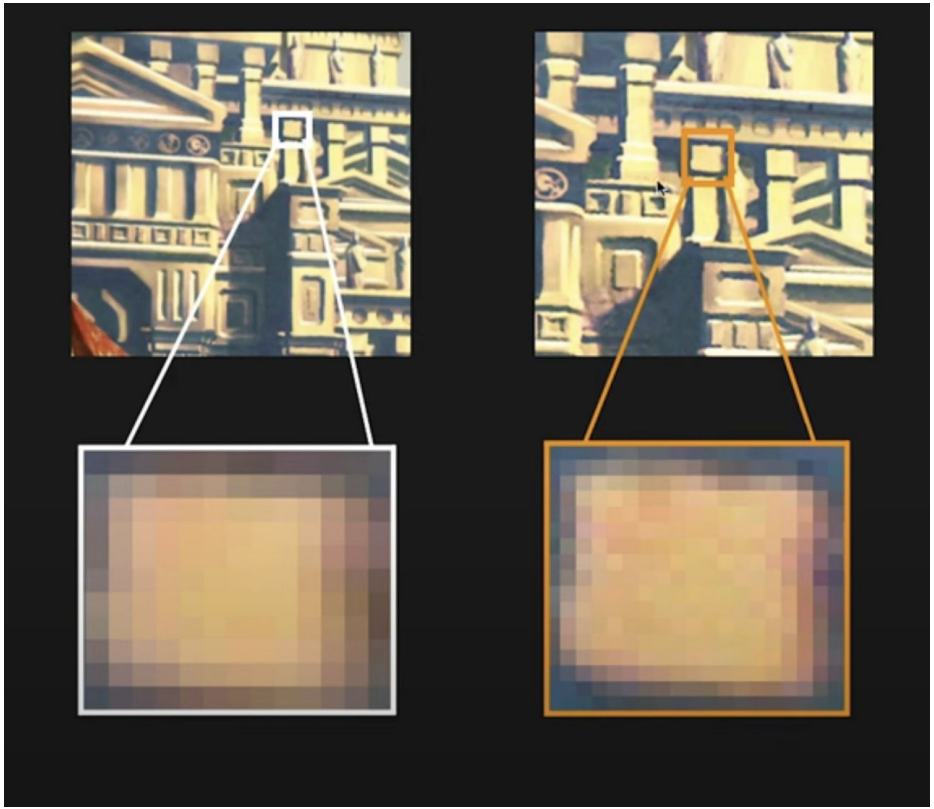




Are Lines / Edges Interesting?



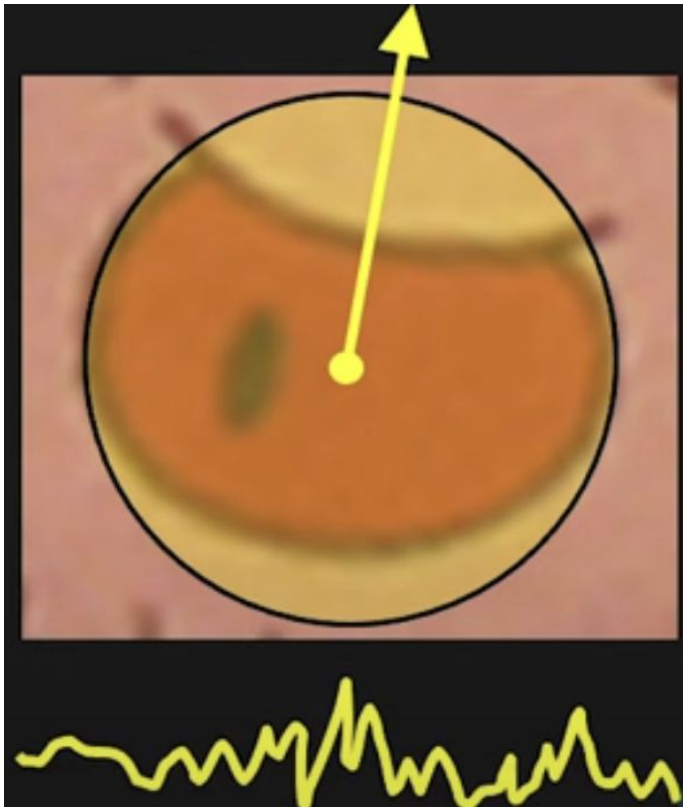
Are Blobs interesting?



1. Def yes have unique signatures per region
2. Has fixed position
3. And has definite size

How to handle blobs?

1. Locate the Blob
2. Determine its size
3. Determine its orientation
4. Formulate a description or signature that is independent of its size and orientation



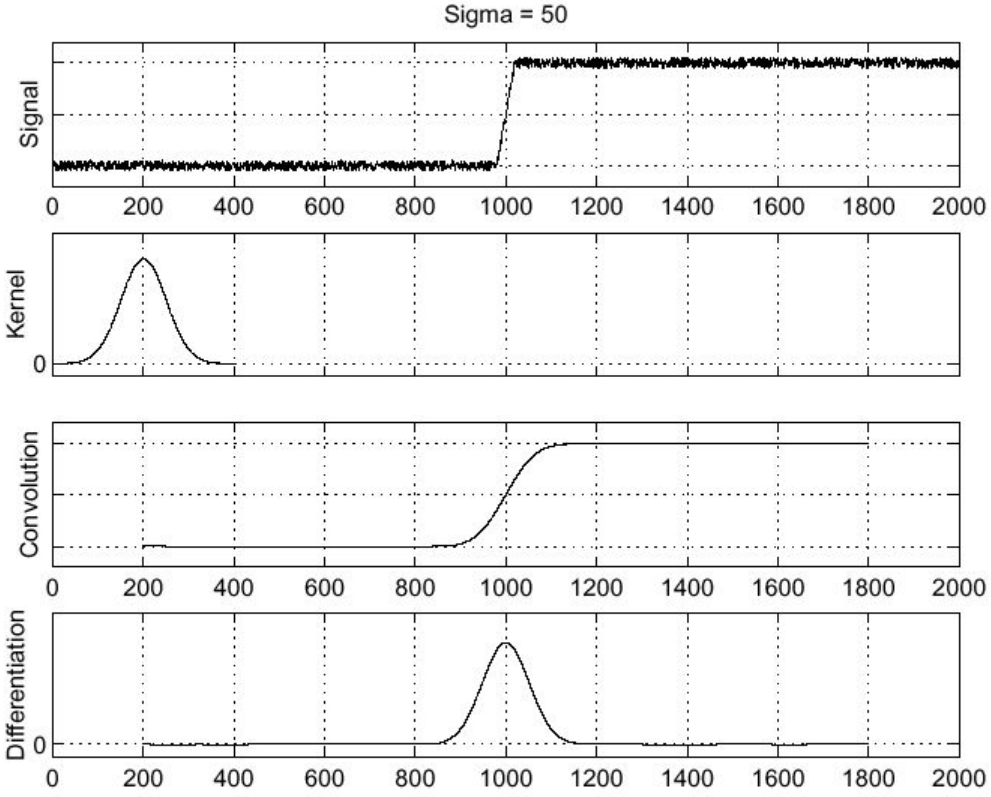
Step 1

f

h

$h \star f$

$\frac{\partial}{\partial x}(h \star f)$



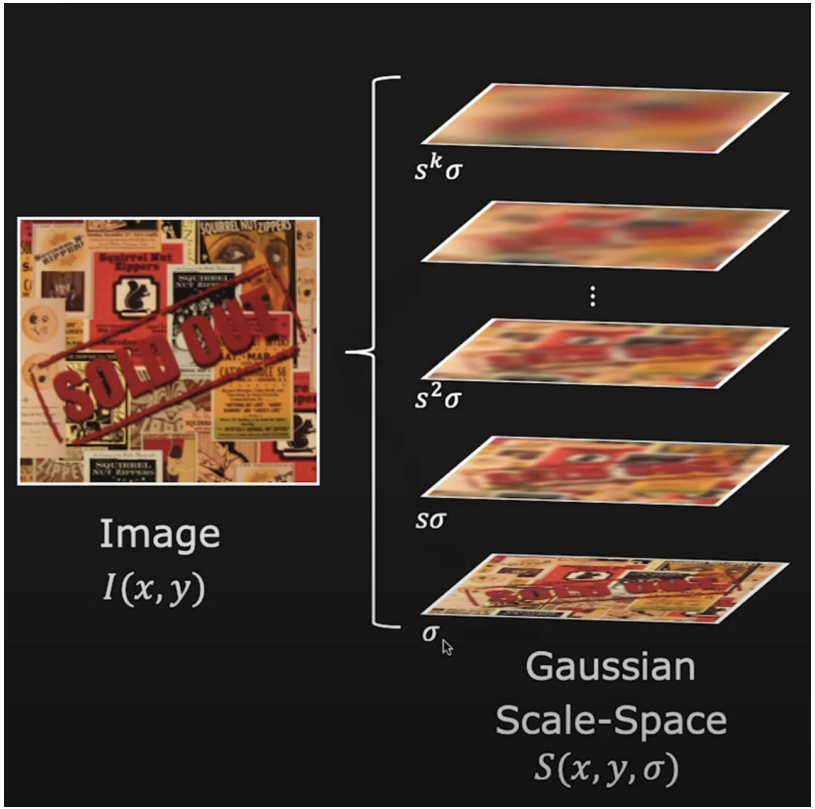
Where is the edge?

Look for peaks in $\frac{\partial}{\partial x}(h \star f)$

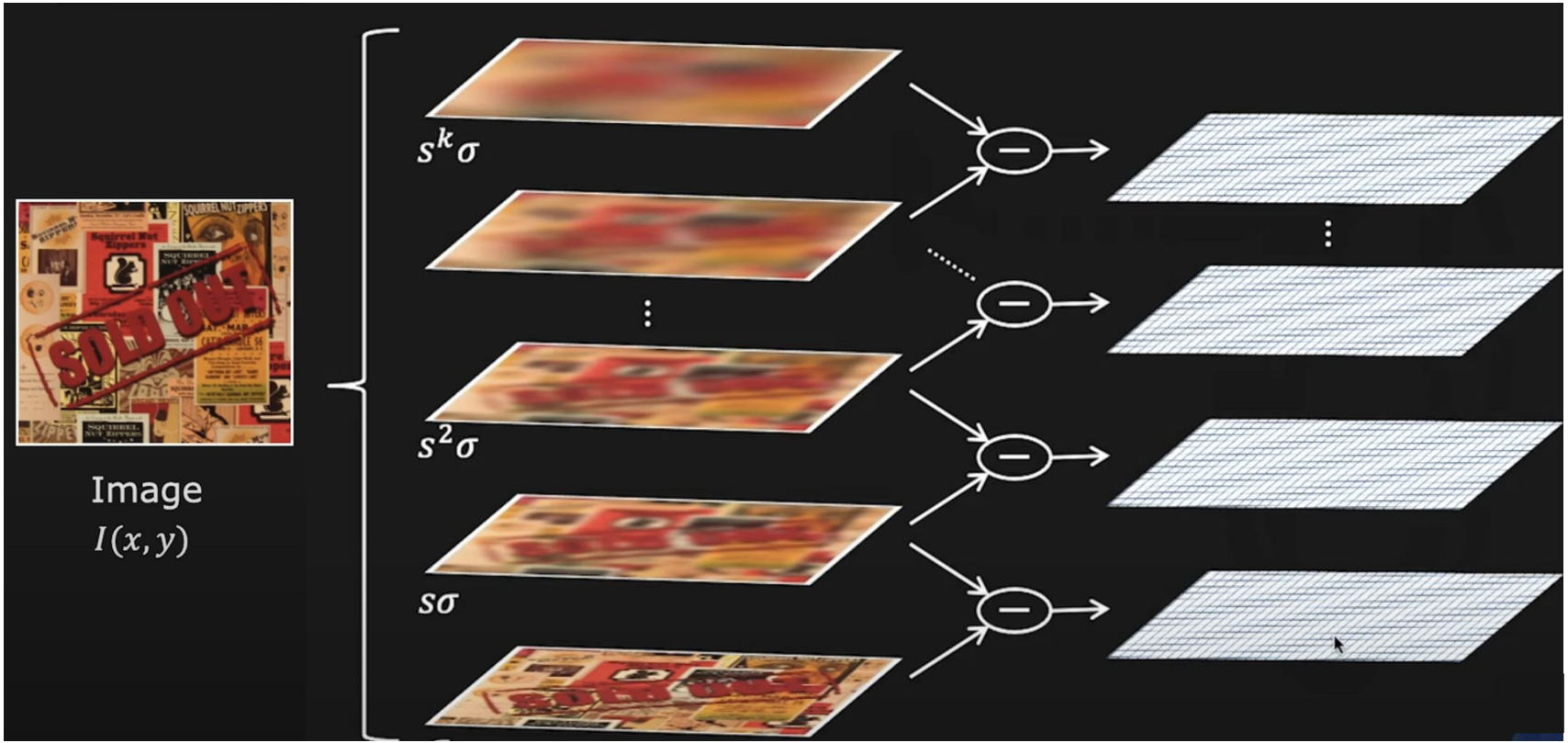
Increasing the scale smoothens features

DOGs

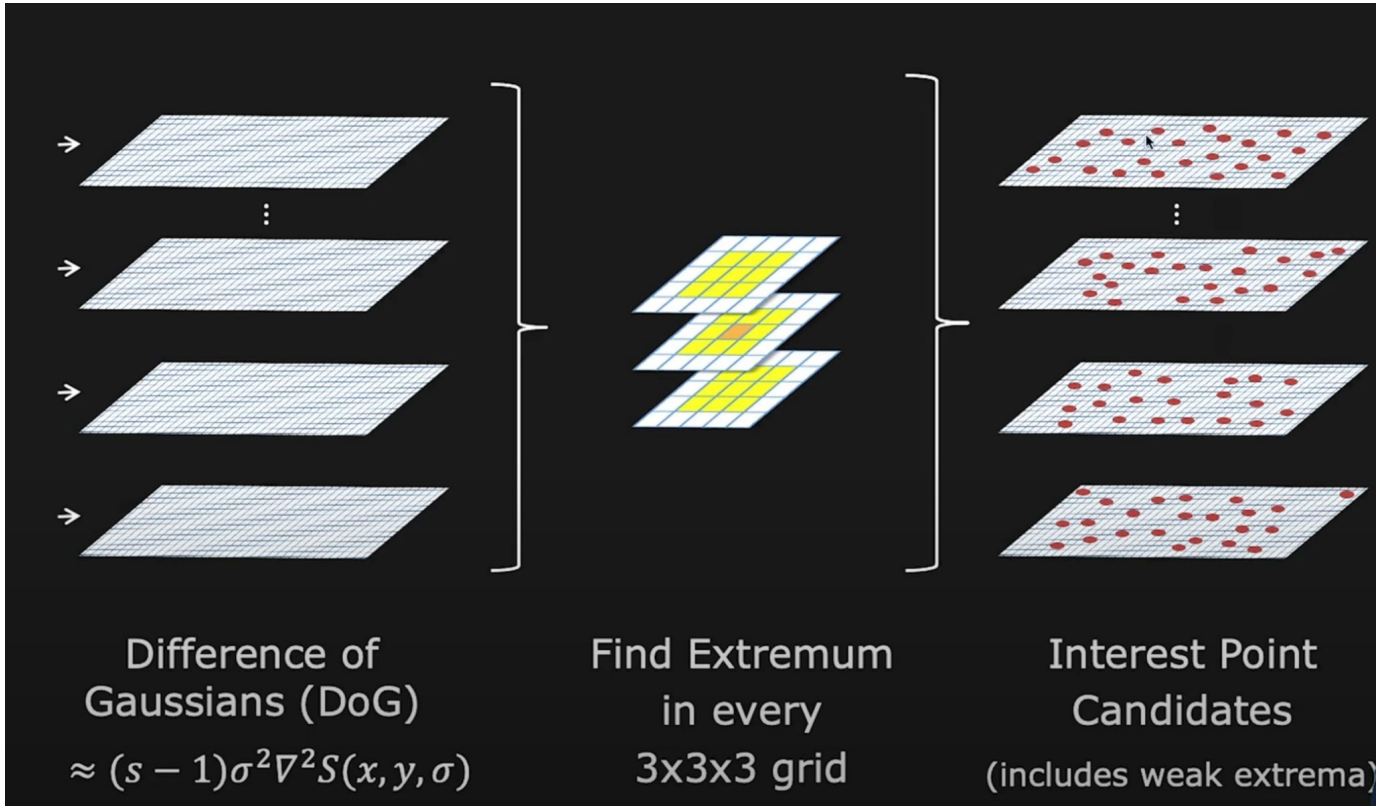
Difference of Gaussians - DOGs



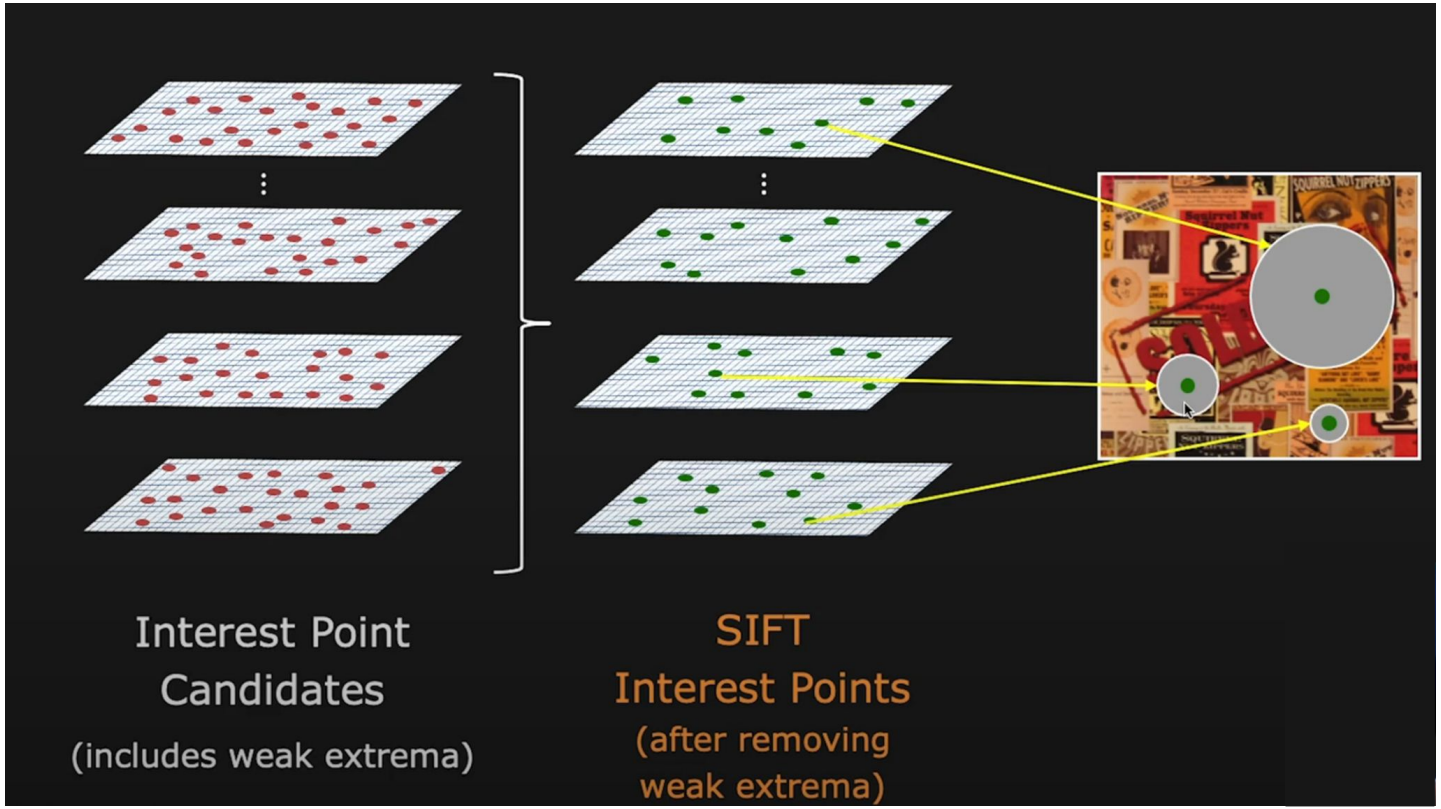
Difference of Gaussians - DOGs



Find Extremes



Extracting interest points



SIFT Detection - Code

Rotation Info

Use the histogram of gradient directions

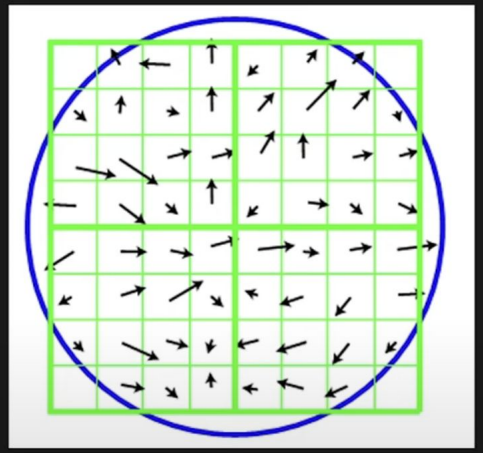
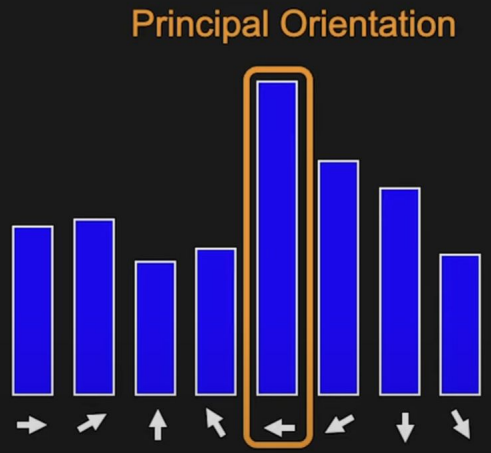


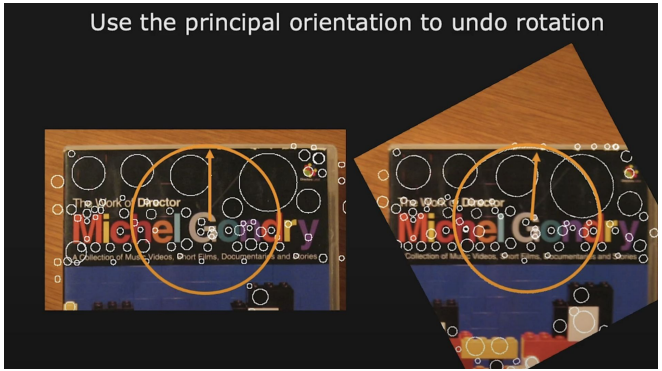
Image gradient directions

$$\theta = \tan^{-1}\left(\frac{\partial I}{\partial y} / \frac{\partial I}{\partial x}\right)$$

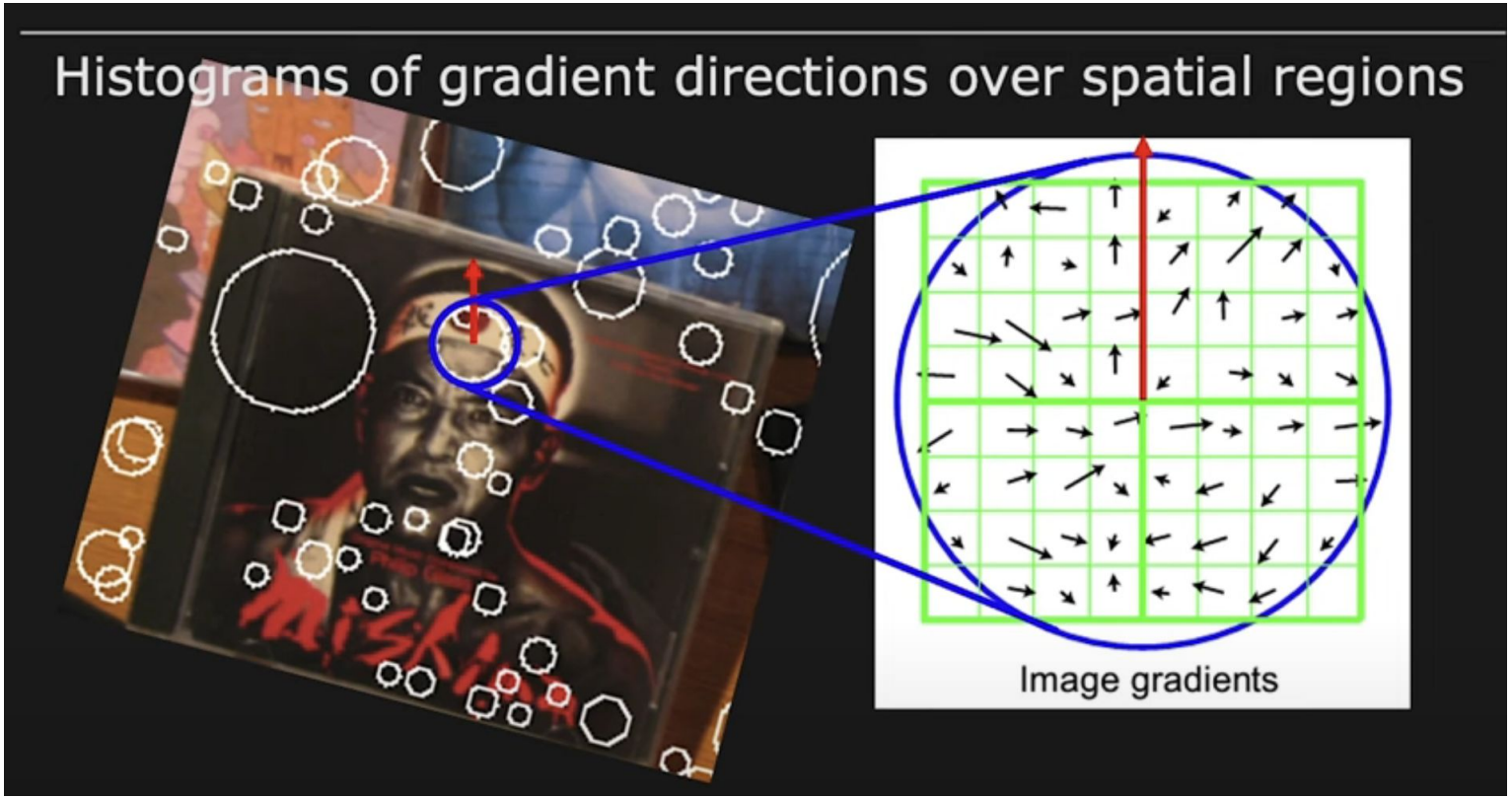


Choose the most prominent gradient direction

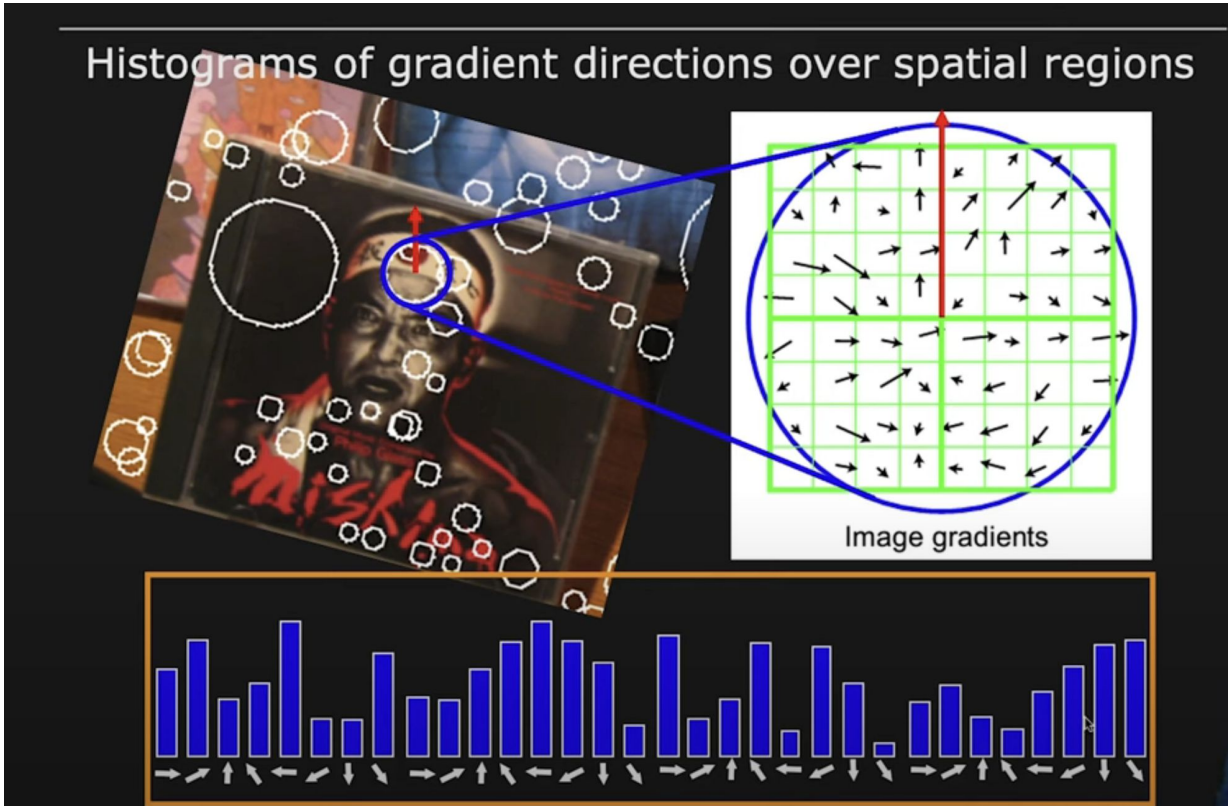
Use the principal orientation to undo rotation



Descriptors



Signature


Histograms of gradient directions over spatial regions
Image gradients

Signature

Essentially comparing two arrays of data.

Let $H_1(k)$ and $H_2(k)$ be two arrays of data of length N.

L2 Distance:

$$d(H_1, H_2) = \sqrt{\sum_k \left(H_1(k) - H_2(k)\right)^2}$$

Smaller the distance metric, better the match.

Perfect match when $d(H_1, H_2) = 0$