Object Detection in Images

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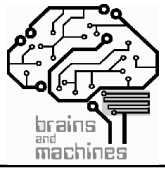


Overview

-Object Detection

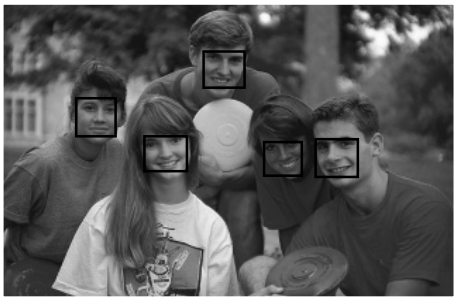
-Face Detection

- Preprocessing
- Feature Extraction
- Classifier

Object Detection in Images

Task

Given an input image, determine if there are objects of a given class (e.g. faces, people, cars..) in the image and where they are located.



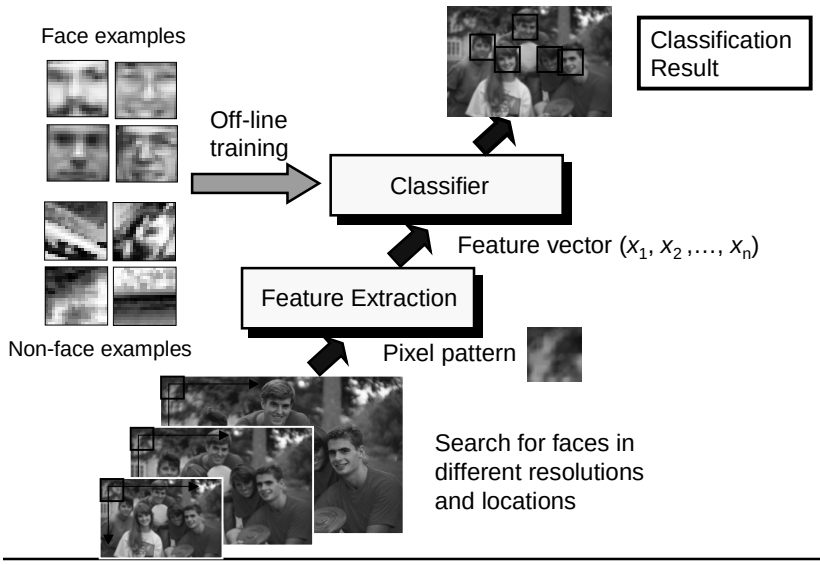
Applications

-Surveillance

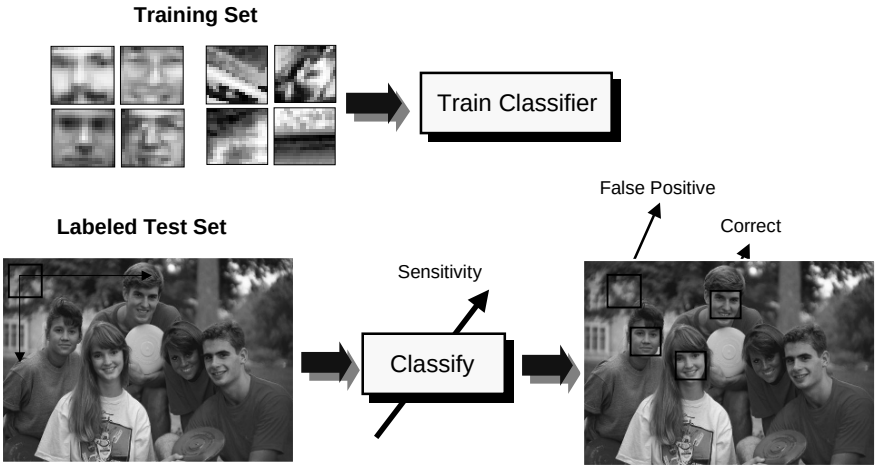
-Robotics

-Autonomous Navigation

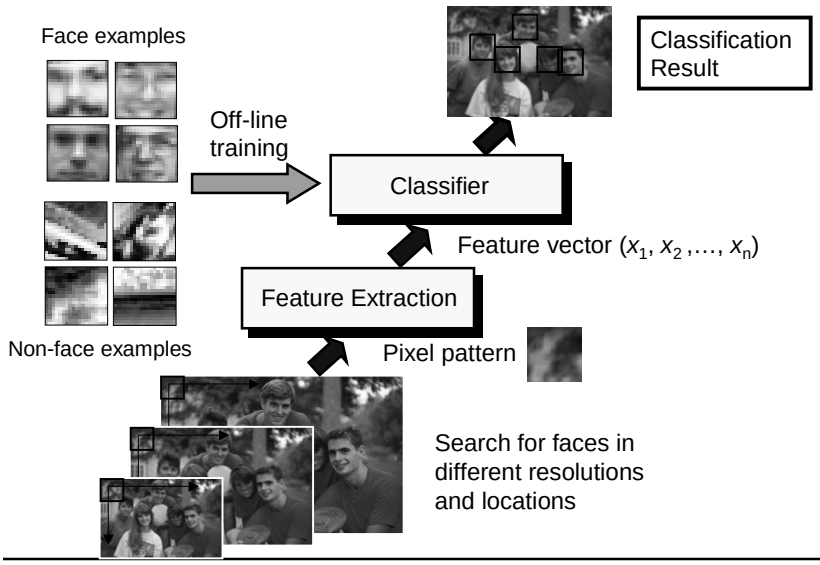
Face Detection



Training and Testing



Face Detection



Preprocessing: Skin Detection in Color Images

Skin forms a dense manifold in the color space

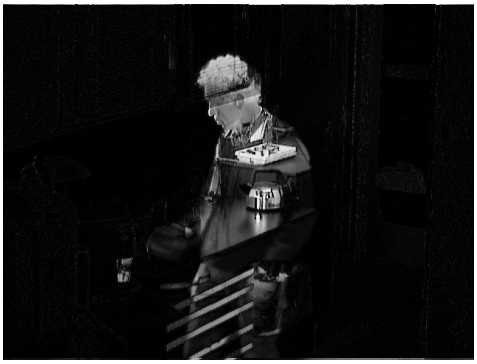
- Choice of color space: r-g, HSV, Luv...
- Choice of classifier: single, multiple Gaussian distribution, empirical distribution (histogram), trainable classifiers (NN, SVM..)

Problems:
- color constancy
- type of camera

Preprocessing: Background Subtraction

Use static background image for detection of moving objects

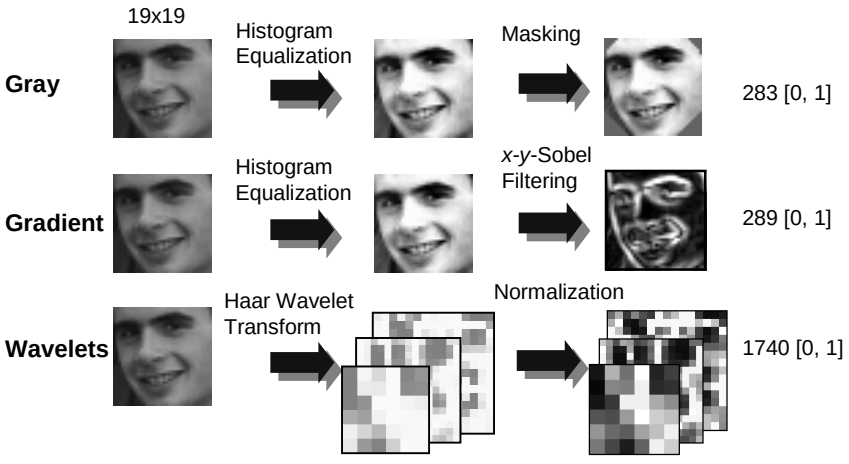
- Update of background image
- Modeling of shadows
- Modeling of noise



Problems:

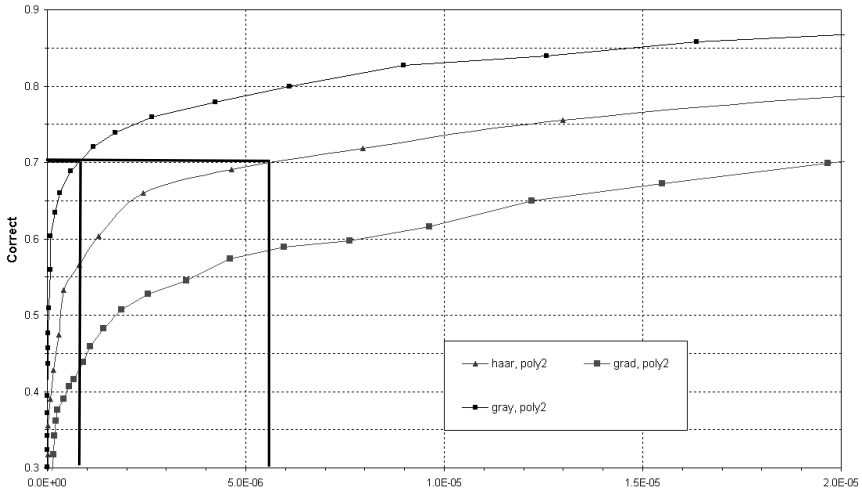
- Color contrast
- Shadows
- Noise
- Illumination changes (Outdoor)

Feature Extraction



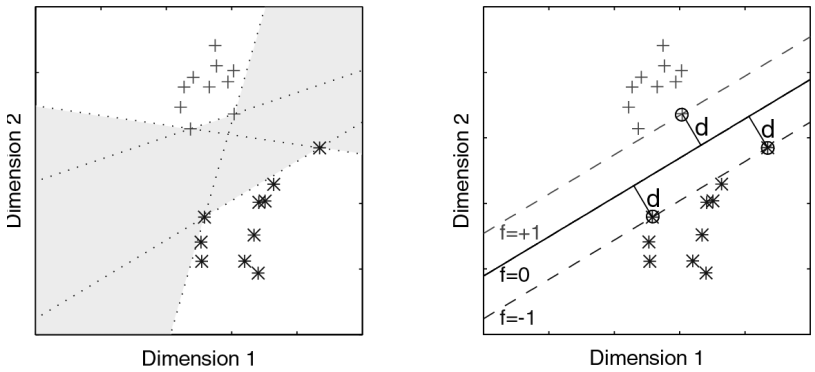
Features

(CMU Testset 1, 127 images, 479 faces, 56.774.966 windows, res 19x19, pos 2429, neg 19932)

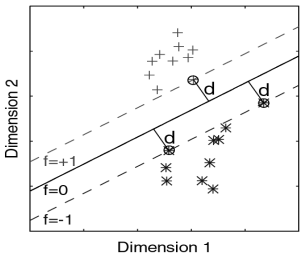


0.7 E-06 = 1 FP in 1 428 000 5.7 E-06 = 1 FP in 175 000 FP / inspected window

Linear Classifier



SVM linear



$$sign\left(\sum_{i=1}^{N} y_i\ \alpha_i\ \mathbf{x}_i \cdot \mathbf{x} - b\right)$$

y_i : Label $\{0,1\}$

α_i : Lagrange multiplier

$\mathbf{x}_i$: Support vector

$\mathbf{x}$: Feature vector

N : Number of support vectors

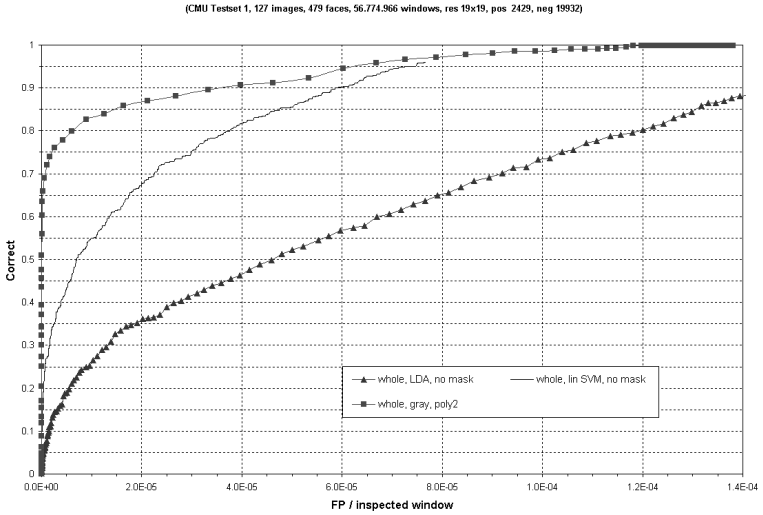
b : Constant

$$sign\left(\mathbf{x} \cdot \mathbf{w} - b\right)$$

$$\mathbf{w} = \sum_{i=1}^{N} y_i\ \alpha_i\ \mathbf{x}_i$$

$\mathbf{w}$: Normal vector on hyperplane

Classifiers



Rotation

Rotation out of image plane

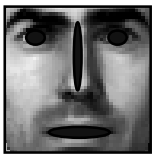
- Component-based classification
- Train on rotated faces

Rotation in the image plane

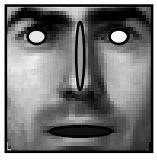
- Rotation invariant features
- Apply 2D rotations to image

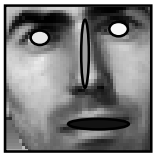
Components

Single template

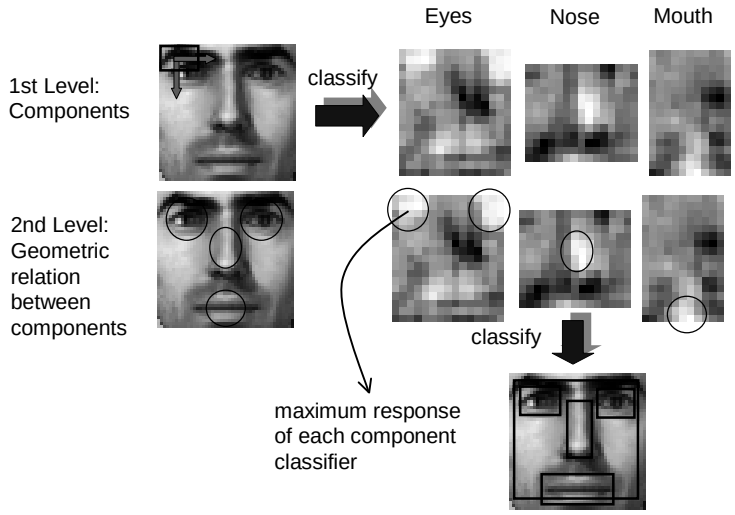
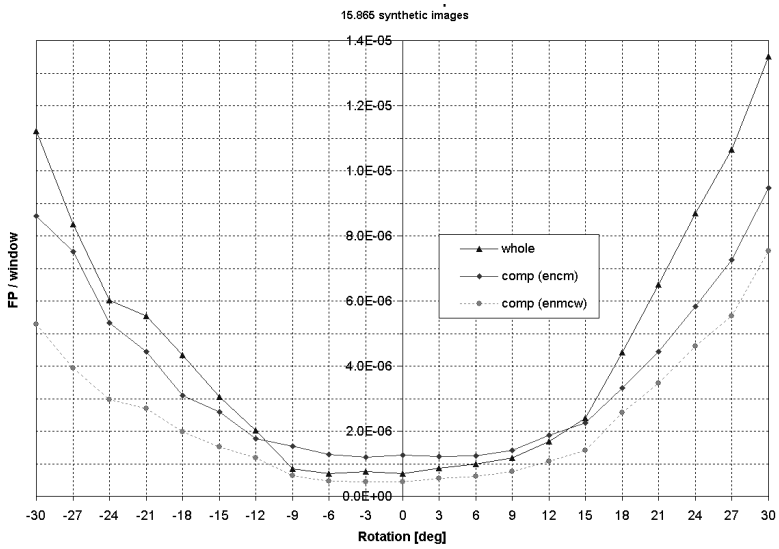


Component templates





Hierarchical Classifier



Rotation in Depth