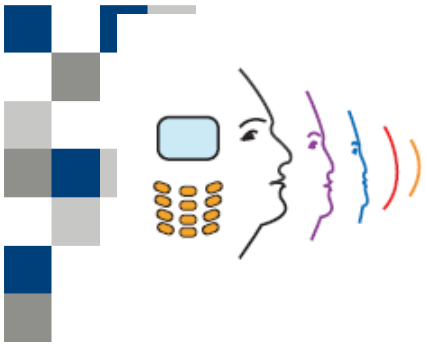
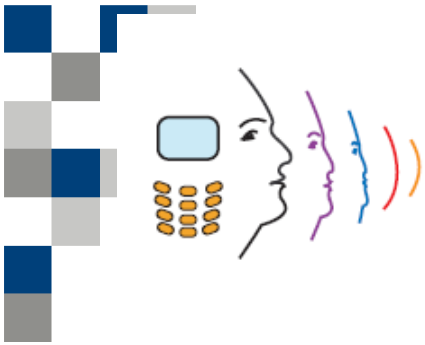


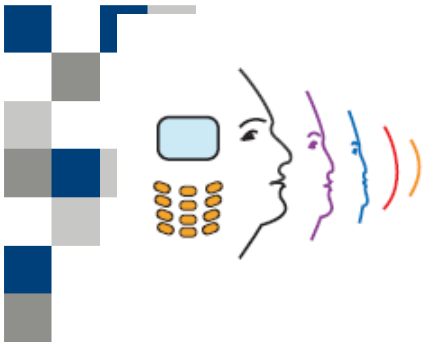
Face detection and localization

A. Hadid
July 8th, 2008
University of Oulu



Outline

1. Problem description
2. Challenges
3. SOTA approaches
4. Future research directions within MOBIO
5. Foreseen baseline for MOBIO



Face detection and localization

1. Problem description

Face detection and localization

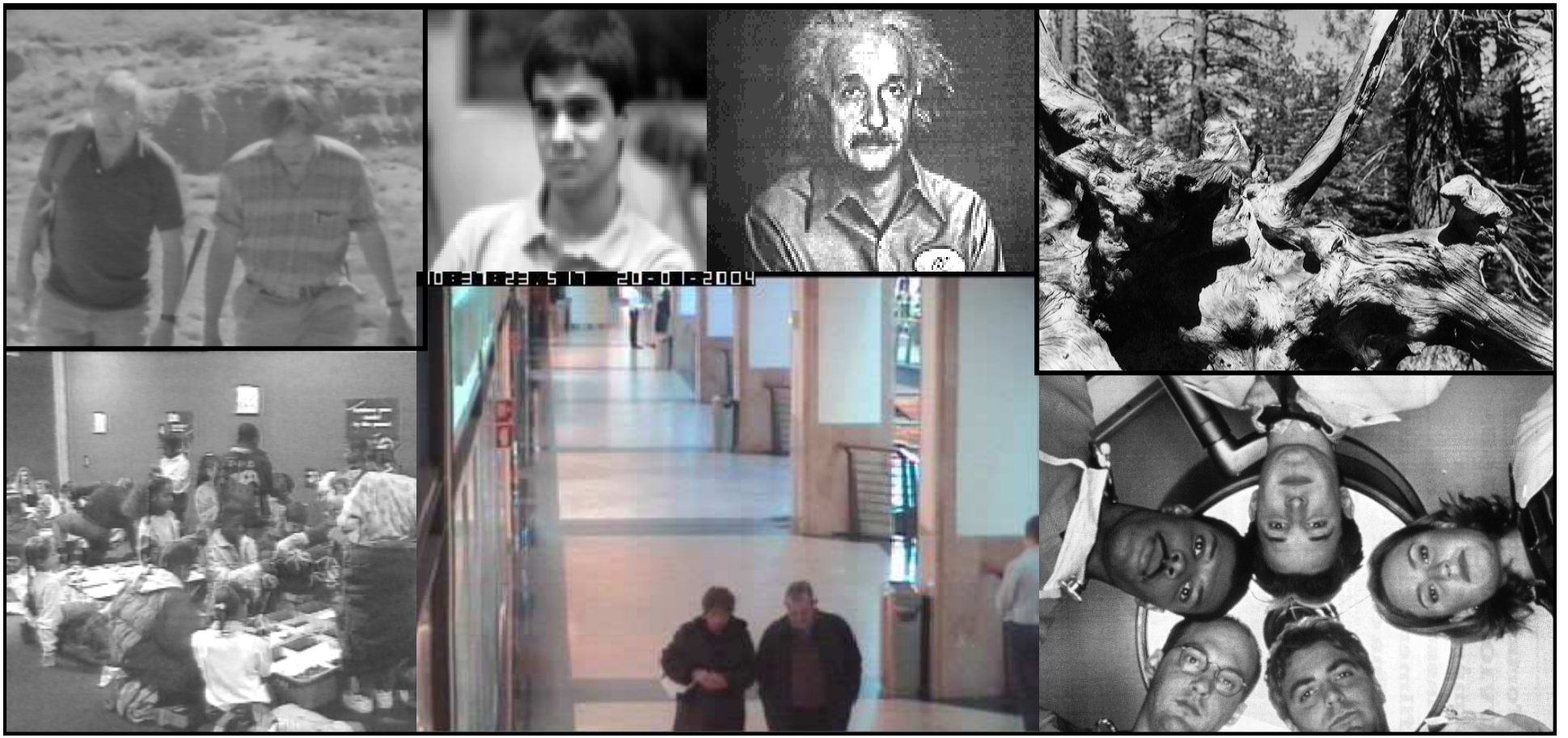
1. Problem description

Face Detection?

It aims to determine whether there are faces present in an image (or video) and find the location & size of each face.

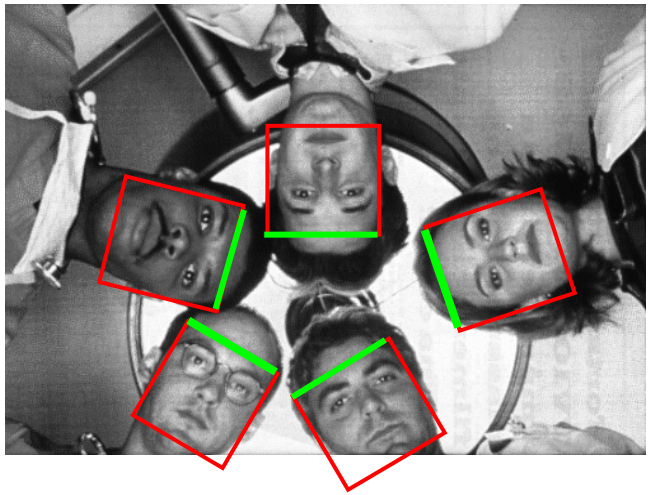
A robust face detector?

It should be then able to find the faces regardless of their number, colour, positions, occlusions, orientations, facial expressions…



Face detection and localization

1. Problem description



Example of expected detection results

Face detection and localization

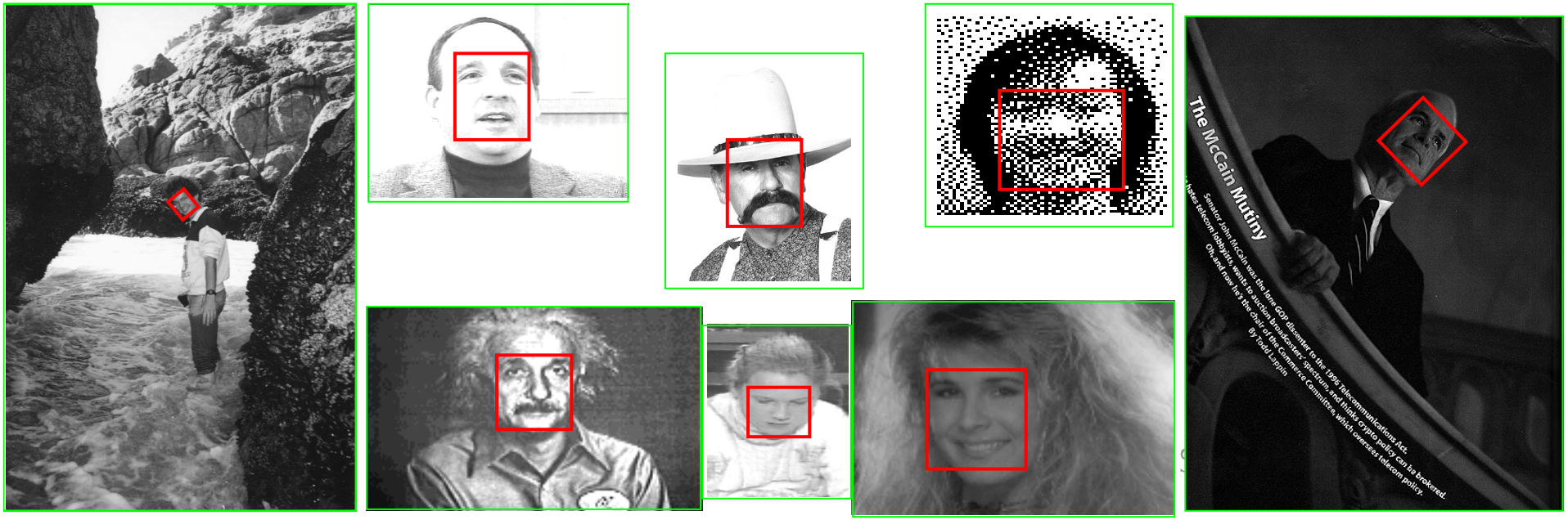
1. Problem description

SEVENTH FRAMEWORK PROGRAMME

Face localization vs. face detection vs. facial feature localisation!!

Face localization is a simplified detection problem with the assumption that an input image contains only one face

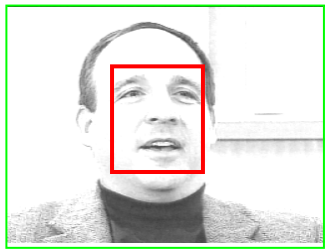
Facial feature localization aims to determine the individual features of the face such as: the eyes, mouth, nose etc (given a localized face image)

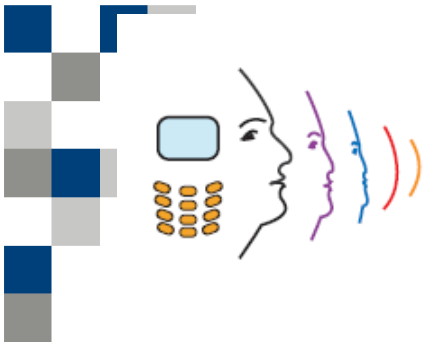


Face detection and localization

1. Problem description

Q: In MOBIO, are we targeting face localization or detection?





Face detection and localization

2. Challenges

2. Challenges

❑ The challenges associated with face detection can be attributed to the following factors:

❑ **Lighting conditions**
❑ **Pose and orientation (in-plane, out-of-plane, tilt)**
❑ **Complex background**
❑ **Occlusions**
❑ **Facial expressions**
❑ **Degraded imaging conditions (Low resolutions, blur, etc.)**
❑ **Q: How to evaluate face detection systems??**
(especially multi-view detection systems)

Face detection and localization

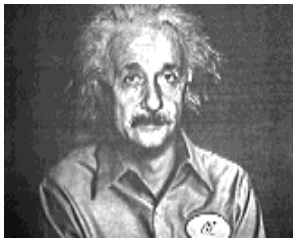
2. Challenges

Q: What is a face?

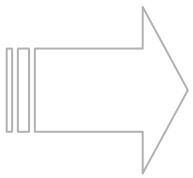
Face detection and localization

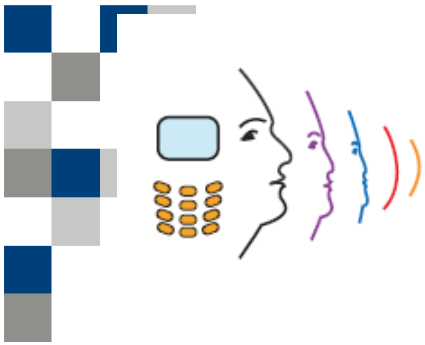
2. Challenges

Q: What does a correct detection mean?



Input Image





Face detection and localization

3. SOTA approaches

Face detection and localization

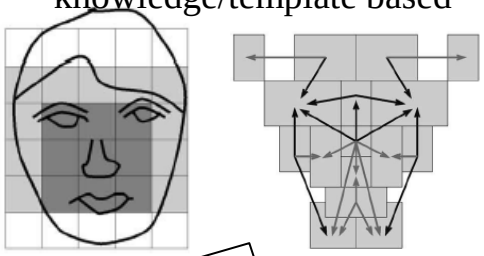
3. SOTA approaches

Roughly, the methods can be divided into two categories:

More successful & received con. attention

feature based

knowledge/template based



→ **Explicit use of face knowledge**

+ ☺ Relative insensitivity to illumination conditions, occlusions and viewpoint.

+ ☺ The localization of the facial features is often useful for further analysis

- ☹ Complex analysis (computationally expensive)

- ☹ Difficulties to deal with low-quality images

- ☹ Difficulties to detect multiples faces.

Appearance based

Image based

→No explicit use of face knowledge

→Face detection = 2 class pattern recognition pb.

→ Learning: rely on training sets to capture the large variability in facial appearance

+ ☺ Can handle also low-quality images

+ ☺ Can handle multiples faces

- ☹ Large training sets are needed

Face detection and localization

3. SOTA approaches

Roughly, the methods can be divided into two categories:

feature based

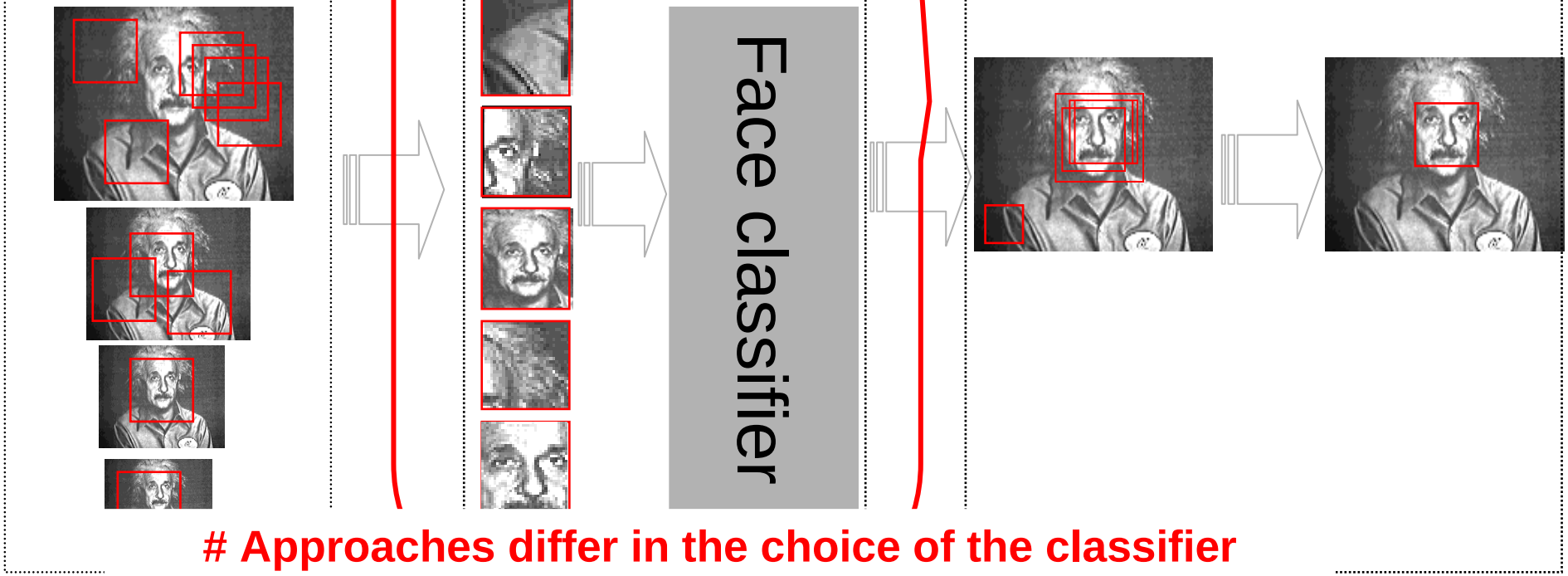
Appearance based face detection

1. Scan the input image @ different locations and scales

2. Each window is fed into a face classifier to decide whether it is a face or not

Face classifier

3. Merge overlapped detection and remove isolated ones



 # Approaches differ in the choice of the classifier

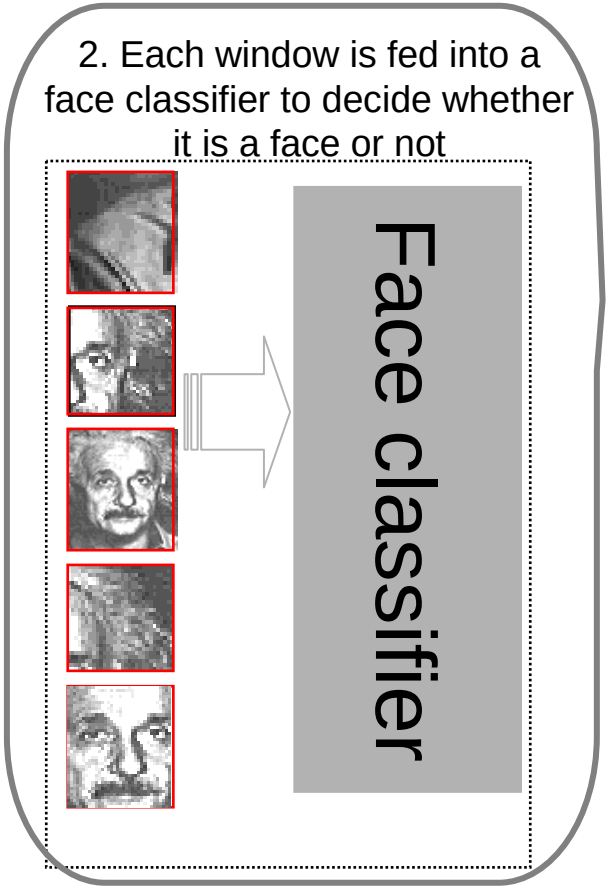
Face detection and localization

3. SOTA approaches

Roughly, the methods can be divided into two categories:

feature based

Appearance based face detection



Different Approaches differ in the choice of the classifier:

- Support Vector Machines
- Neural Networks
- Bayesian classifiers

- Breakthrough in [2001]: AdaBoost + Haar-like by [Viola and Jones, 2001]

→ First real time face detection system

Face detection and localization

3. SOTA approaches

Roughly, the methods can be divided into two categories:

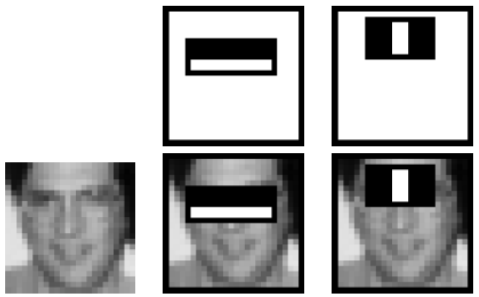
feature based

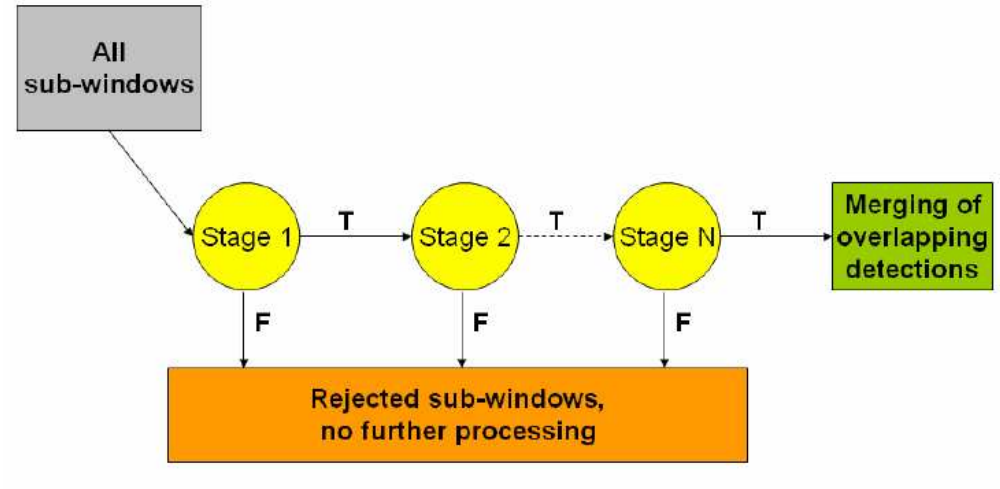
Appearance based face detection

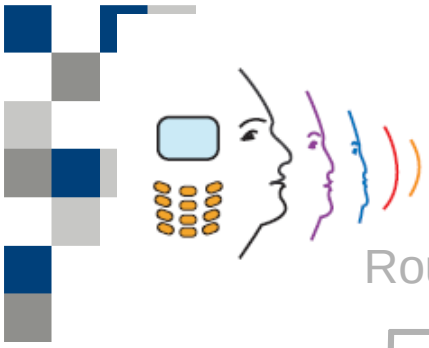
Breakthrough: Viola and Jones' face detection [2001]

Key ideas:

- ❑ Use simple features which can be calculated very fast using Integral images
- ❑ Weak classifiers are combined into a strong classifier using AdaBoost
- ❑ A cascade of strong classifiers (from simple to more complex) is built







Face detection and localization

3. SOTA approaches

Roughly, the methods can be divided into two categories:

feature based

Appearance based face detection

Breakthrough: Viola and Jones' face detection [2001]

Since then, many extension & improvements were proposed:

- ❑ Alternative features: e.g. Extended Haar-like, LBP etc.
- ❑ Alternative boosting: e.g. Gentle AdaBoost, FloatBoost, FFS etc.
- ❑ Alternative architecture: e.g. decision tree, nested cascade etc.
- ❑ Applications to multi-view face detection: Work of S. Li & Zhang [2004]

Challenges and future directions:

- ❑ Robust multi-view face detection
- ❑ Detection under severe conditions: illuminations, occlusions, very low-res. etc.
- ❑ Unifying the evaluation of face detection systems
- → Use of more discriminative features or combination of features..
- → Novel techniques for constructing the cascade of weak classifiers..

Face detection and localization

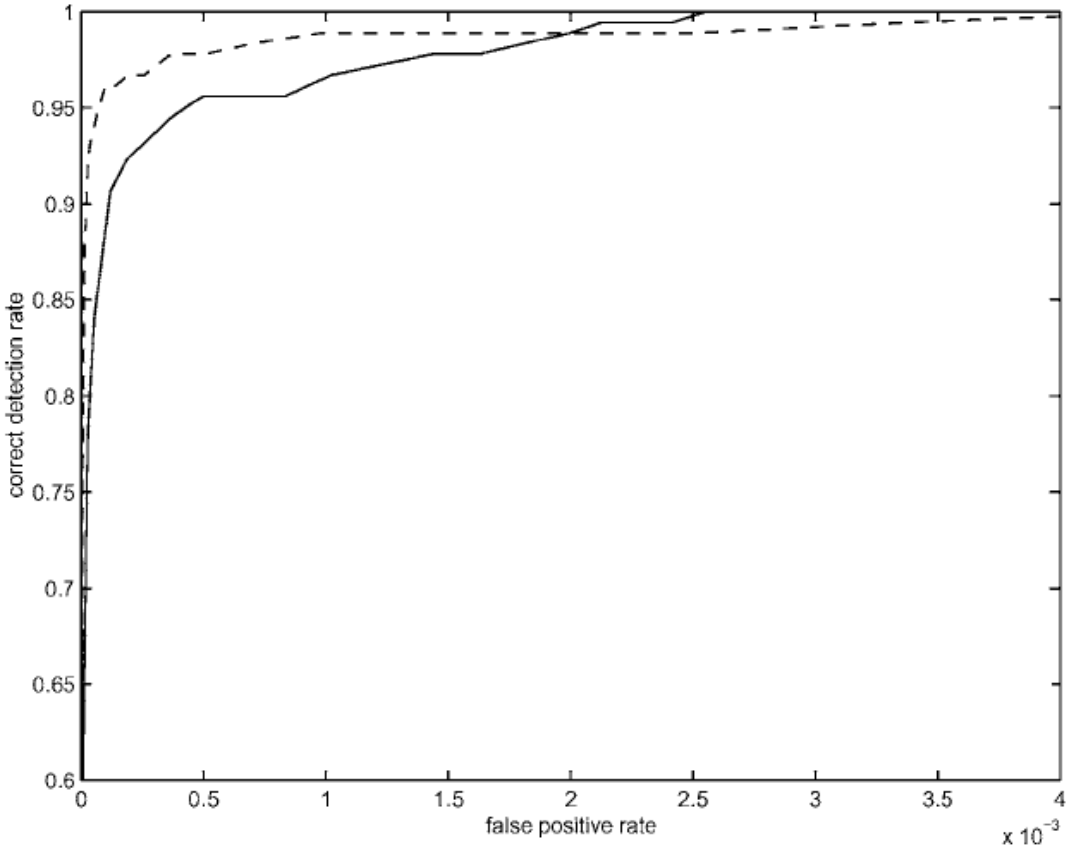
3. SOTA approaches

How to evaluate face detection systems??

Most systems use ROC curves: Detection rate versus number of false alarms

false positive?

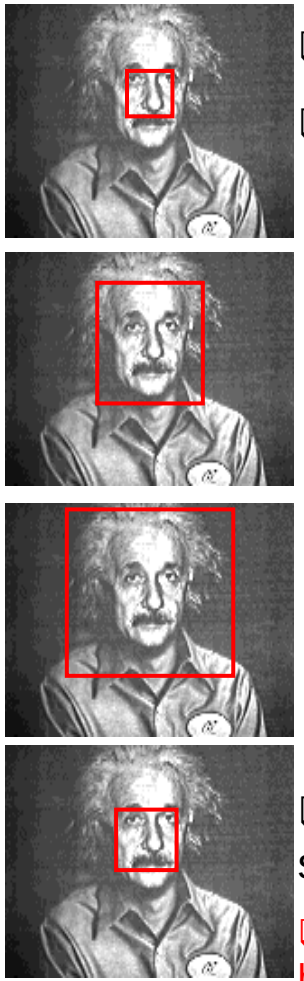
Correct detection?



Face detection and localization

3. SOTA approaches

…But what does a correct detection mean ?



- ❑ Manual counting (visual observations)?
- ❑ A face criteria should be used?

  →Rowley et al:

  Center of the detected bounding box is within 4 pixels and the scale is within a factor of 1.2 of ground truth.

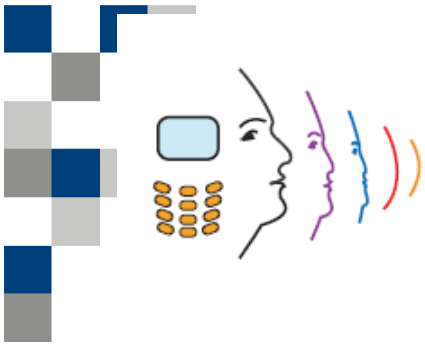
  → Lienhart et al.

  Euclidean distance between the centers of the detected and true face is < 30% of the width of the face & the width of the detected face is within 50% of that of the true face.

  → Jesorsky's relative error measure:

  Max. distance (error) between the detected and expected eye centers is < 25% of the distance between the two eyes (d_{eye}<0.25)

- ❑ Evaluate only the face classifiers with face and non-face icons (excluding the scanning and merging parts)?
- ❑ Probably, there is no absolute definition of what a good face detection/localization is ☹ because a correct detection criteria may depend on the purpose of the detector!!



Face detection and localization

4. Future Research Directions within MOBIO

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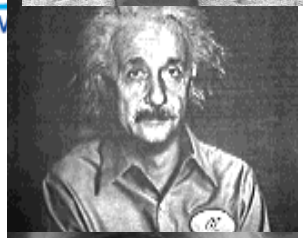
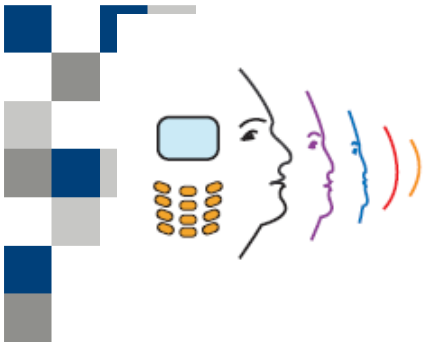


- Study face localization under severe conditions
  - Illuminations
  - occlusions
  - very low-res.
- Use of more discriminative features or combination of complementary features.
- Consider novel techniques for constructing the cascade of weak classifiers
- Exploit the prior information on the face such as:
  - Face location in previous frames (temporal information)
  - Face size range (the distance between the user's face and mobile phone)
  - Focus on face localization (max. one face is present)
- Adopt a proper evaluation of the face localization systems

Q: Should we consider and investigate multi-view face detection within MOBIO?



Face detection and localization

5. Foreseen baseline for MOBIO

5. Foreseen baseline for MOBIO

- Requirements: Fast and accurate face localization
- Baselines for MOBIO:
  - Simplified Viola and Jones's face detector
  - A basic frontal face detector using LBP and AdaBoost or SVM (from IDIAP or Oulu).