

Face recognition: The problems, the challenges and the proposals

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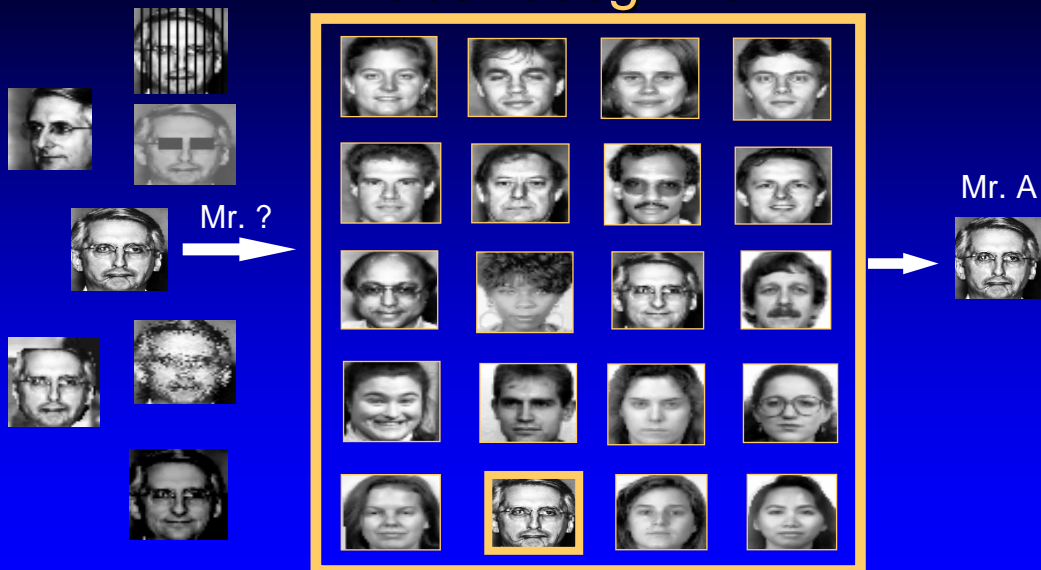
Outline

- Introduction
- The problems
- Face recognition scenarios
- Face recognition proposals
- Conclusions

Acknowledgements

- Alberto Albiol
- Josep Vilà
- Emiliano Acosta
- Luis Lorente

Face recognition



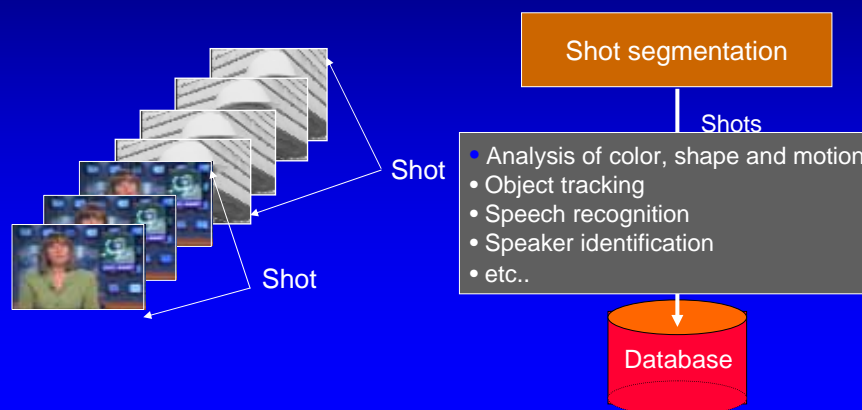
Typical applications

Areas	Specific Applications
Entertainment	Video Game/Virtual Reality/Training Programs Human-Computer-Interaction/Human-Robotics
Smart Cards	Drivers' Licenses/Passports/Voter Registrations/Entitlement Programs Welfare Fraud/Passports/Voter Registration
Information Security	TV Parental control/Desktop Logon/Personal Device (Cell phone etc) Logon/Database Security/ Medical Records/Internet Access
Law Enforcement & Surveillance	Advanced Video Surveillance/CCTV Control Shoplifting/Drug Trafficking/Portal Control

Wen-Yi Zhao: The Advances in Face Processing -- Face Recognition -- ICIP 2003

There are other things than security applications !!!

Video indexing
Content access



Face recognition scenarios

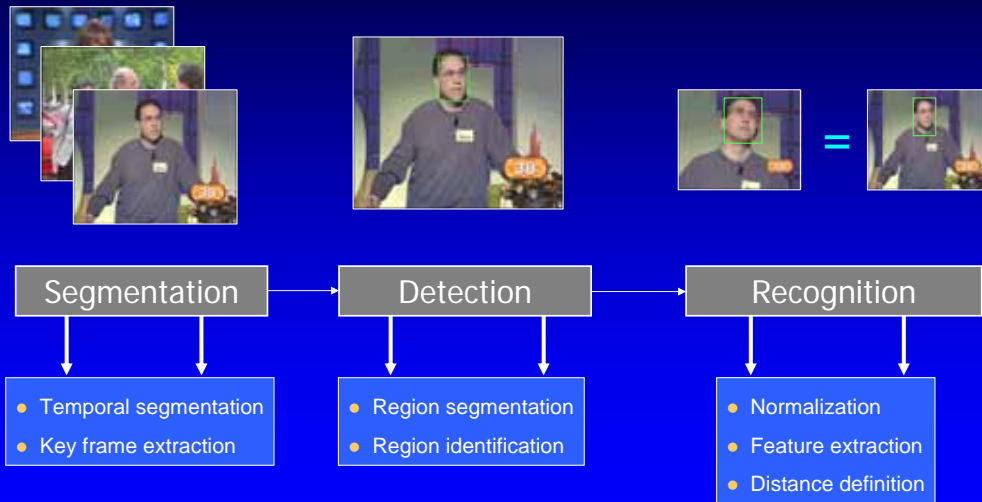
The problems

Face detection

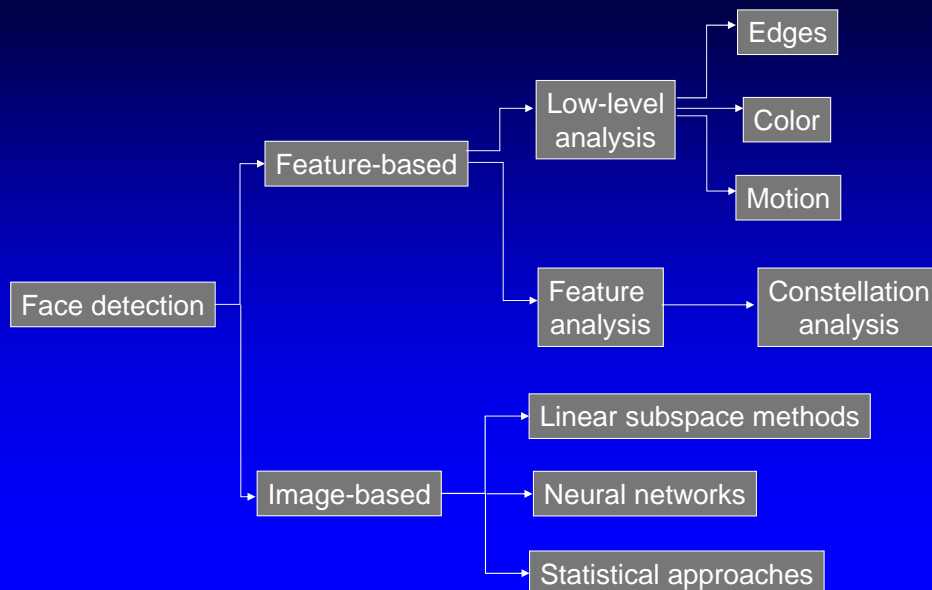


Face detection goes first!!!

Face detection / recognition



Face detection techniques



Face detection results (1)



Linear subspace methods (as an example)

Face detection results (2)



Skin detection + segmentation + region merging
(as an example)

Face detection FOR recognition

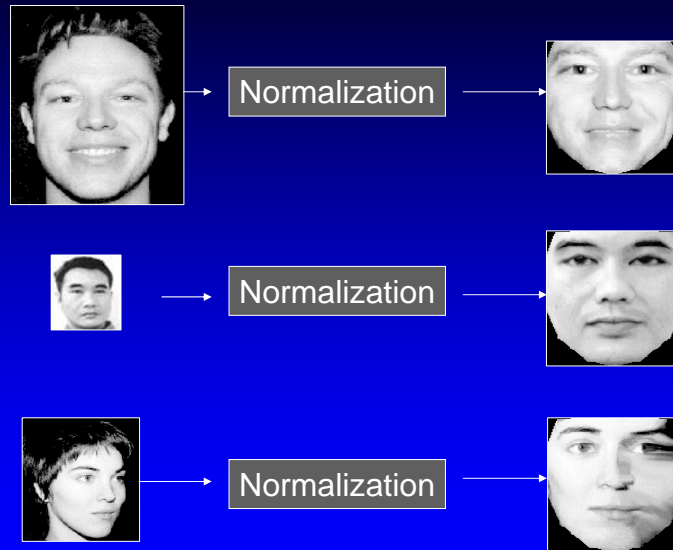


Wen-Yi Zhao: The Advances in Face Processing
ICIP 2003



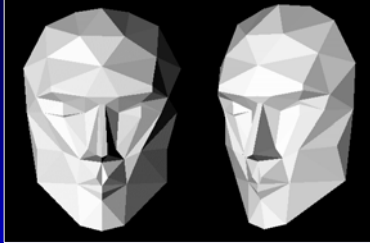
Which is a correct detect FOR face recognition?

Face normalization (1)



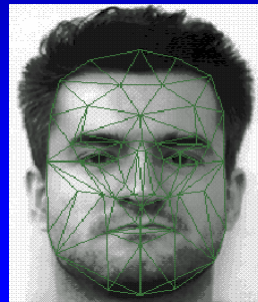
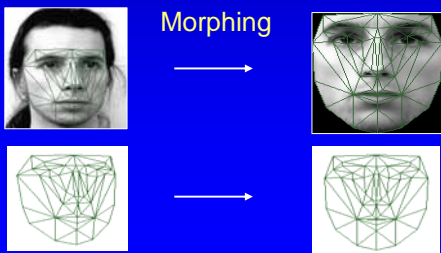
Frontal faces

Face normalization (2)

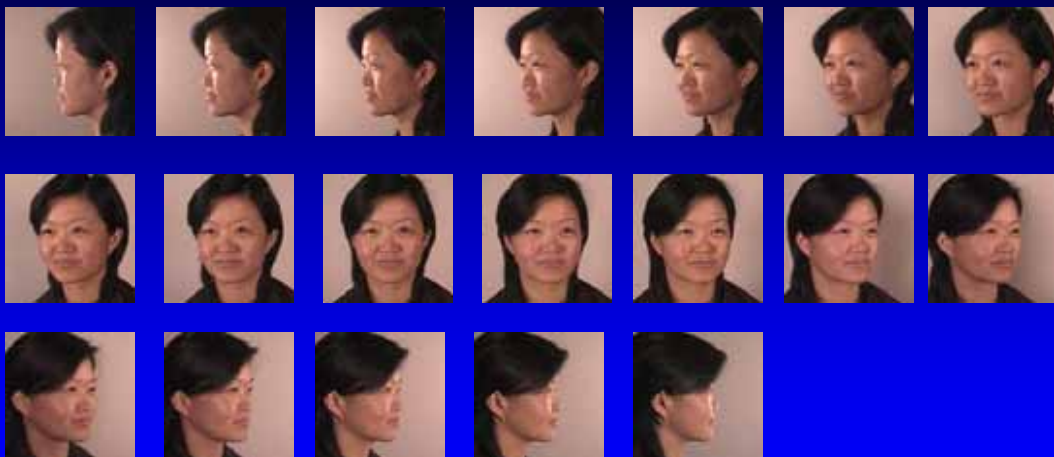


Candide model

- Morphing
- "Candide" model simplified
 - Standard model through training images.
 - Texture mapping



More problems: pose



FacePix database

More problems: illumination



FacePix database

More problems: illuminants



Different camera calibration and illumination conditions

<http://www.ee.oulu.fi/research/imag/color/pbfd.html>

More problems: the data base (to compare results among different techniques)

- FERET
- XM2VTS
- CMU PIE Database
- AT&T
- Oulu Physics Database
- Yale Face Database
- Yale B Database
- MIT Database
- UPC data base
- Others

Face recognition scenarios

The challenges

Face recognition – *easy* scenarios



Problem *almost* solved

Face recognition – *solvable* scenarios



Work is needed!!!

Face recognition – difficult scenarios



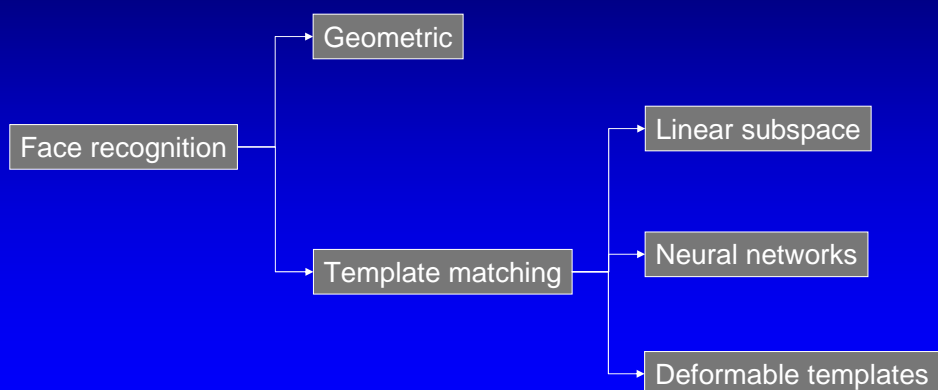
A LOT of work is needed!!!

Face recognition – very difficult scenarios



A LOT of work is needed during MANY years !!!

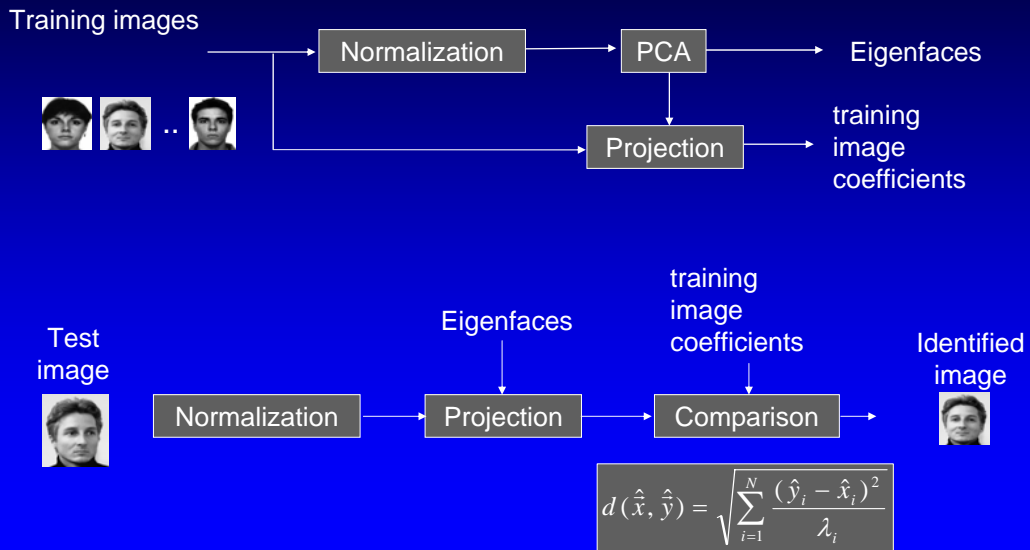
Face recognition approaches - 1



Face recognition approaches - 2

Approach	Representative Works
Holistic methods <u>Principal Component Analysis</u> Eigenface Fisherface/Subspace LDA SVM ICA Other Representations LDA/FLA PDBNN	Direct application of PCA FLD on eigenspace Two-class problem based on SVM ICA-based feature analysis FLD/LDA on raw images Probabilistic decision based NN
Feature based methods Pure geometry methods Dynamic Link Architecture Convolution Neural Network	Earlier methods, recent methods Graph matching methods SOM learning based CNN methods
Hybrid methods Modular eigenface Hybrid LFA Component-based	Eigenface & eigenmodules Local & global feature method Face region and components

Principal component analysis



Eigenfaces – manual normalization



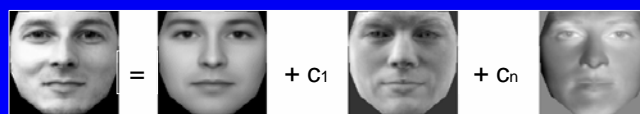
Originals



Shape Normalized



Eigenfaces



Reconstruction

Self eigenfaces – PCA



"Rosa"

→ PCA



Eigenfaces "Rosa"
(automatically normalized)

Principal component analysis



$$\vec{X}_1 = [x_1, \dots, x_M]$$



⋮



$$\vec{X}_N = [x_1, \dots, x_M]$$

$$\begin{aligned} \bar{\Sigma}_x &= E[(\vec{X}_i - \bar{\mu})(\vec{X}_i - \bar{\mu})^T] \\ &\approx \frac{1}{N} \sum_{i=1}^N (\vec{X}_i - \bar{\mu})(\vec{X}_i - \bar{\mu})^T \\ &= \frac{1}{N} \bar{M}_x \bar{M}_x^T \end{aligned}$$

$$\bar{\Sigma}_x \vec{A}_i = \lambda_i \vec{A}_i$$

Computational problem with \vec{A}_i

$$\bar{M}_x = \bar{U} \bar{\Lambda}^2 \bar{V}^T$$

The columns of \bar{U} , \bar{V} are the eigenvectors of $X X^T$

Face unknown - recognition

$$\tilde{x} = a_1 x_1 + a_2 x_2 + a_3 x_3 + a_4 x_4$$

eigenfaces "Julio"

$$\tilde{x} = b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4$$

Test image

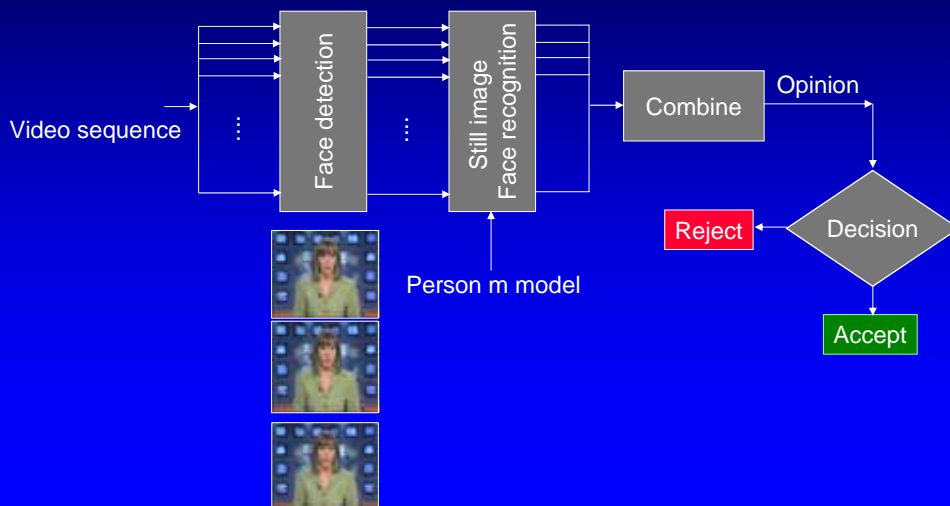
eigenfaces "Rosa"

Reconstruction error < threshold \longrightarrow Unknown = Julio

Can face recognition be helped?

- Face detection + face recognition
- Video-based FR
- Multimodal-based FR
- Use of color information

Face detection + face recognition



Face detection + recognition results (1)



Faces detected and recognized automatically

92% success in a news sequence

Face detection + recognition results (2)



Faces detected and recognized automatically

92% success in a news sequence

Video based face recognition



- Good frames can be selected
- Video provides temporal continuity
 - reuse of recognition information
- Video allows tracking of images
 - facial expressions
 - and pose variations can be compensated for
- Motion, gait and other features can help
- Depth information is also useful

Video based face recognition (compressed sequences)



B - frame

I - frame

P - frame

In case of compressed sequences,
adequate frame must be used

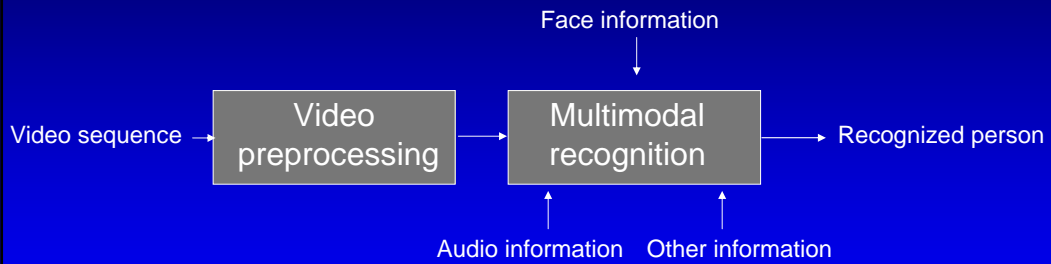
Multimodal based face recognition (1)



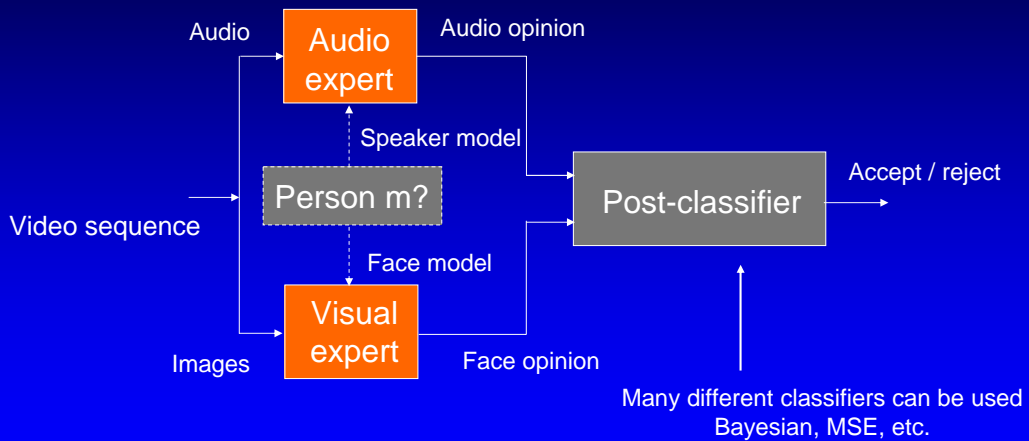
- Fusion of different information
- audio, text, close-captions, color, etc.

If there is information, USE IT

Multimodal based face recognition (2)



Multimodal based face recognition (3) (a possible model)



Multimodal information brings up to 5% of recognition improvement

Use of color

- Practically all works on face recognition have been done only with the luminance information
 - Why not to use the color for face recognition ?

Use of color - RGB



R



G



B

Use of color – Y u v



Y

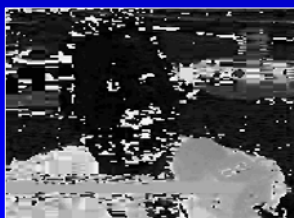


U



V

Use of color - HSV



H

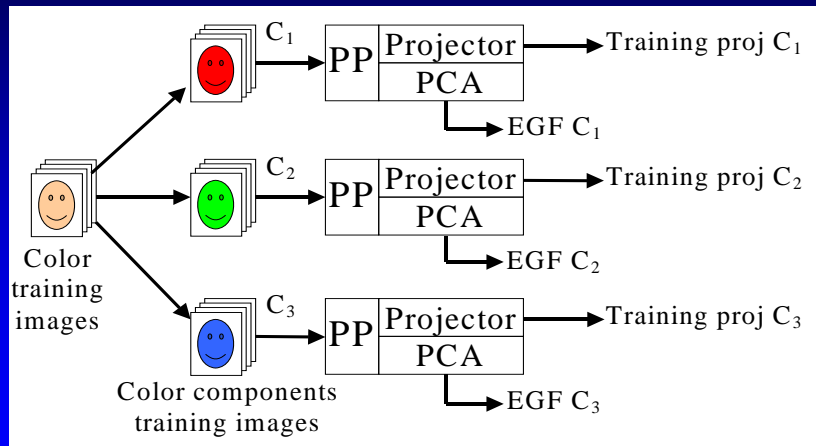


S

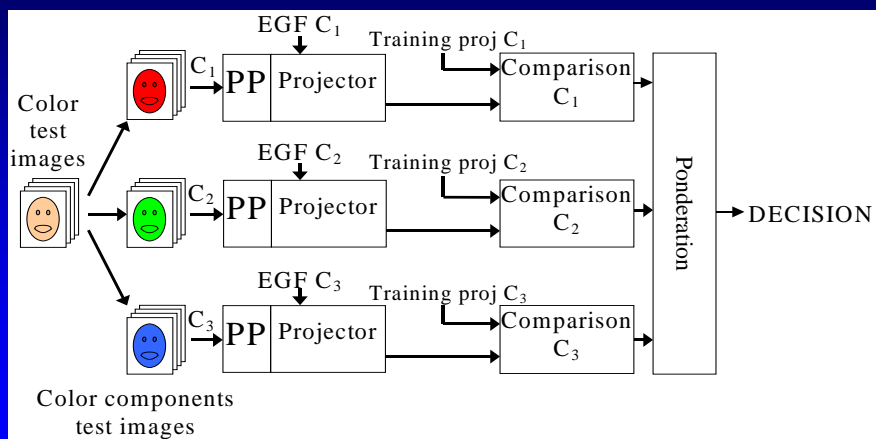


V

Use of color - training stage



Use of color - test stage



Importance of color: Results



Test

With luminance

With color

4% of improvement

Any other help for face recognition?

YES!

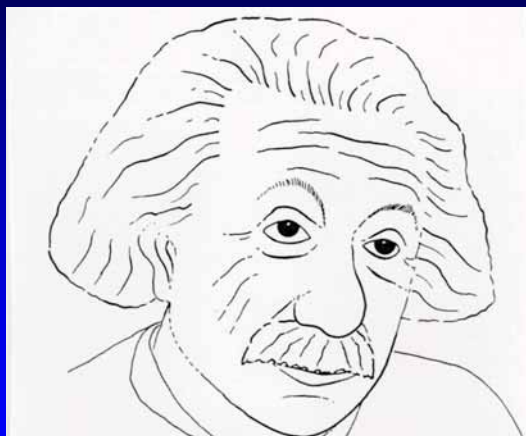
The human visual system

The human visual system - 1



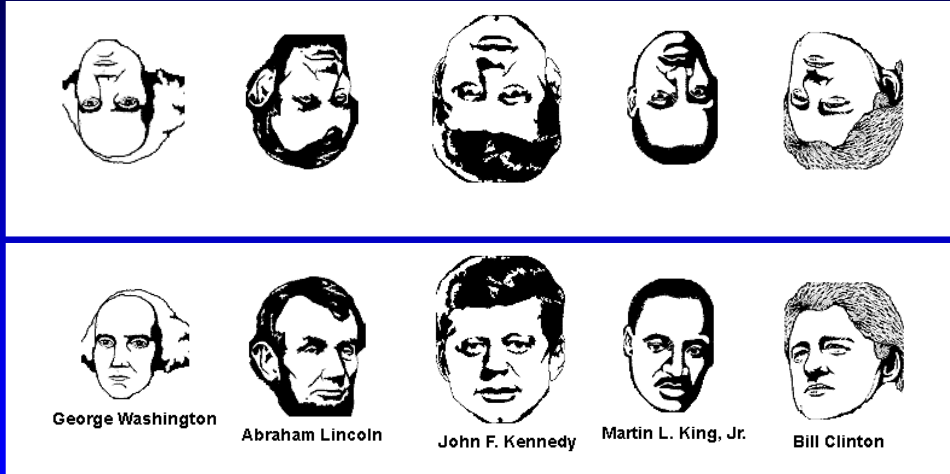
If the HVS can do it, a computer can do it

The human visual system - 2



If the HVS can do it, a computer can do it

The human visual system - 3



Prof. Eric H. Chudler, Dept. of Anesthesiology
University of Washington

The human visual system - 4



Is there any hope for face recognition?

Strong need of cooperative research between

- Computer vision
- Signal Processing
- Psychophysics
- Neurosciences

Conclusions

- Yes there is hope for face recognition
 - Human Visual System
 - Need cooperative work
 - Computer vision, signal processing
 - Psychophysics, Neurosciences
- Multimodal information
- Face detection + face recognition
- Video-based FR
- Use of color information

Many thanks for your attention !!!

Hvala na pažnji!!!