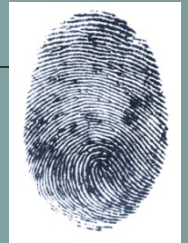


Understanding Biometrics

7. Close up: Face Recognition

Dr. Terence Sim



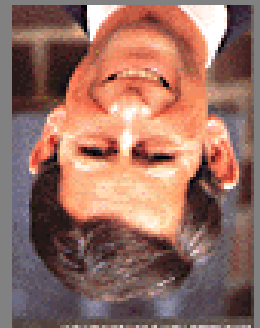
Face Recognition by Humans



- Human face recognition ability is extremely robust, $\approx 100\%$ accurate and very fast.
 - But only for familiar faces
 - Machines do better for unfamiliar faces under illumination variation
- Babies are born “hard-wired” to recognize faces, i.e. this ability is not learned.
- A *grandmother neuron* has been detected in monkeys. This neuron fires when the monkey sees the face of another monkey.

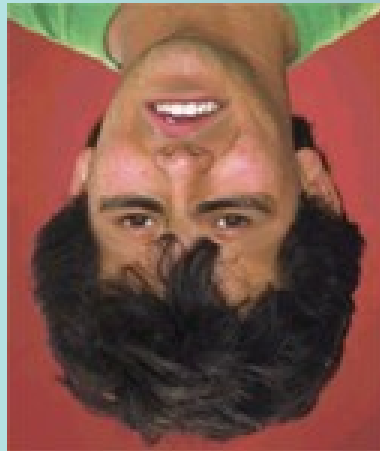
Face Recognition by Humans

- *Prosopagnosia* is a medical condition in which the patient no longer recognizes a face, although he can detect the face (identify the eyes, nose, etc.)
 - Detection and recognition are separate processes in the brain.
- It is hard to recognize from a film negative.
- It is hard to recognize an upside-down face.
- Other-race effect: harder to recognize someone from another race.
- It is easier to recognize distinctive faces than average ones.



Face Recognition by Humans

- Upside down face



Face Recognition

- Who is this?



Face Recognition

- Who is this?

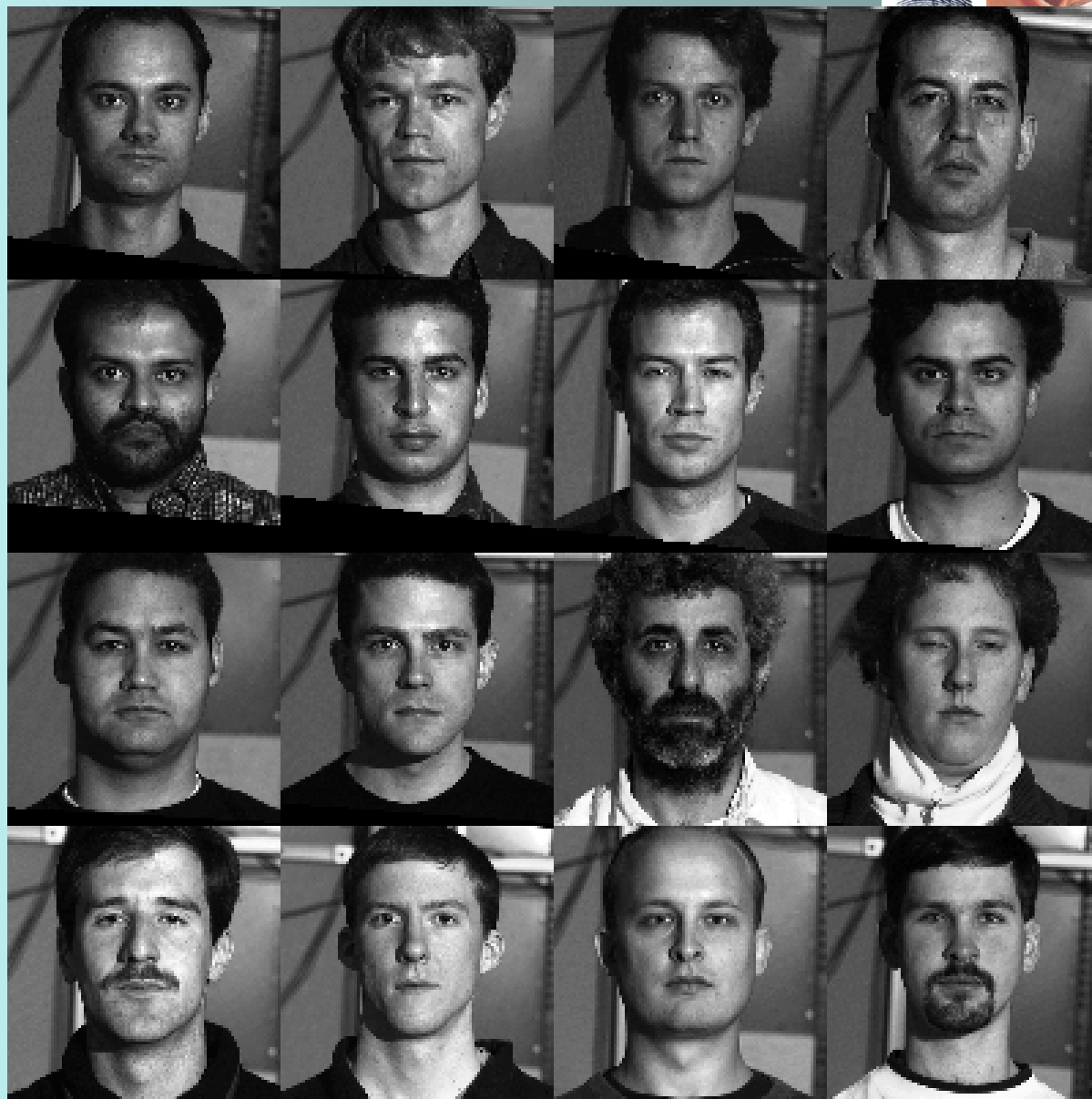


Face Recognition

- Who is this?



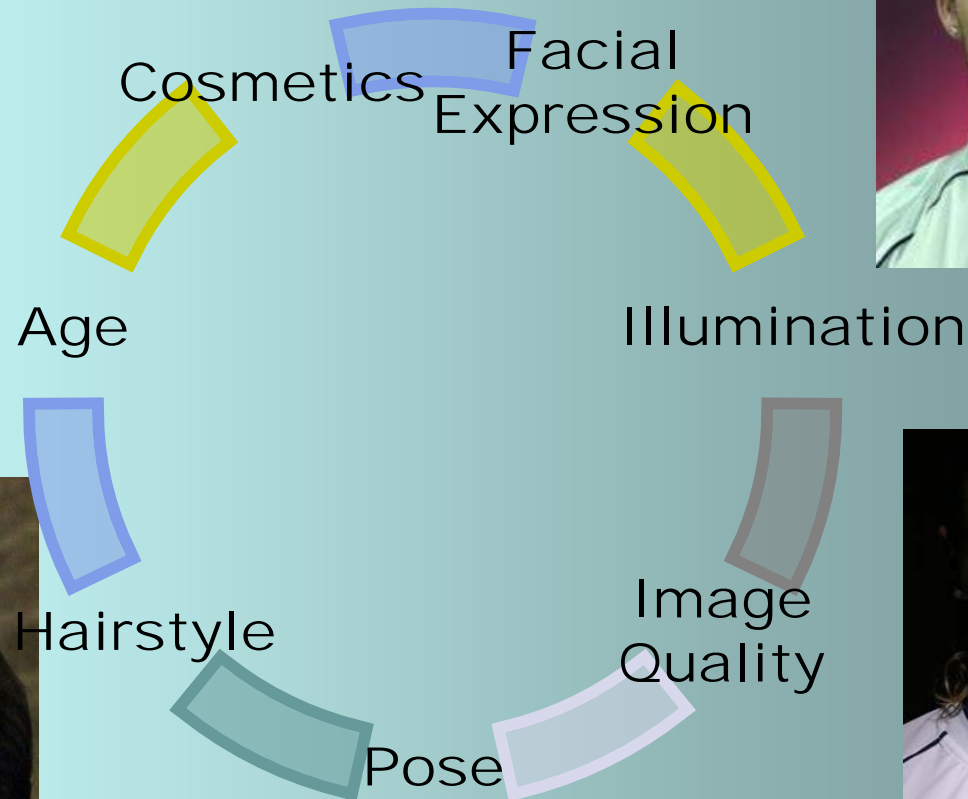
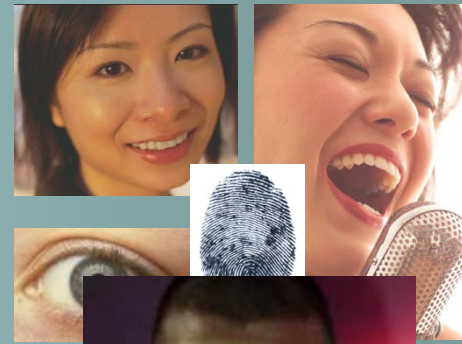
Look for him





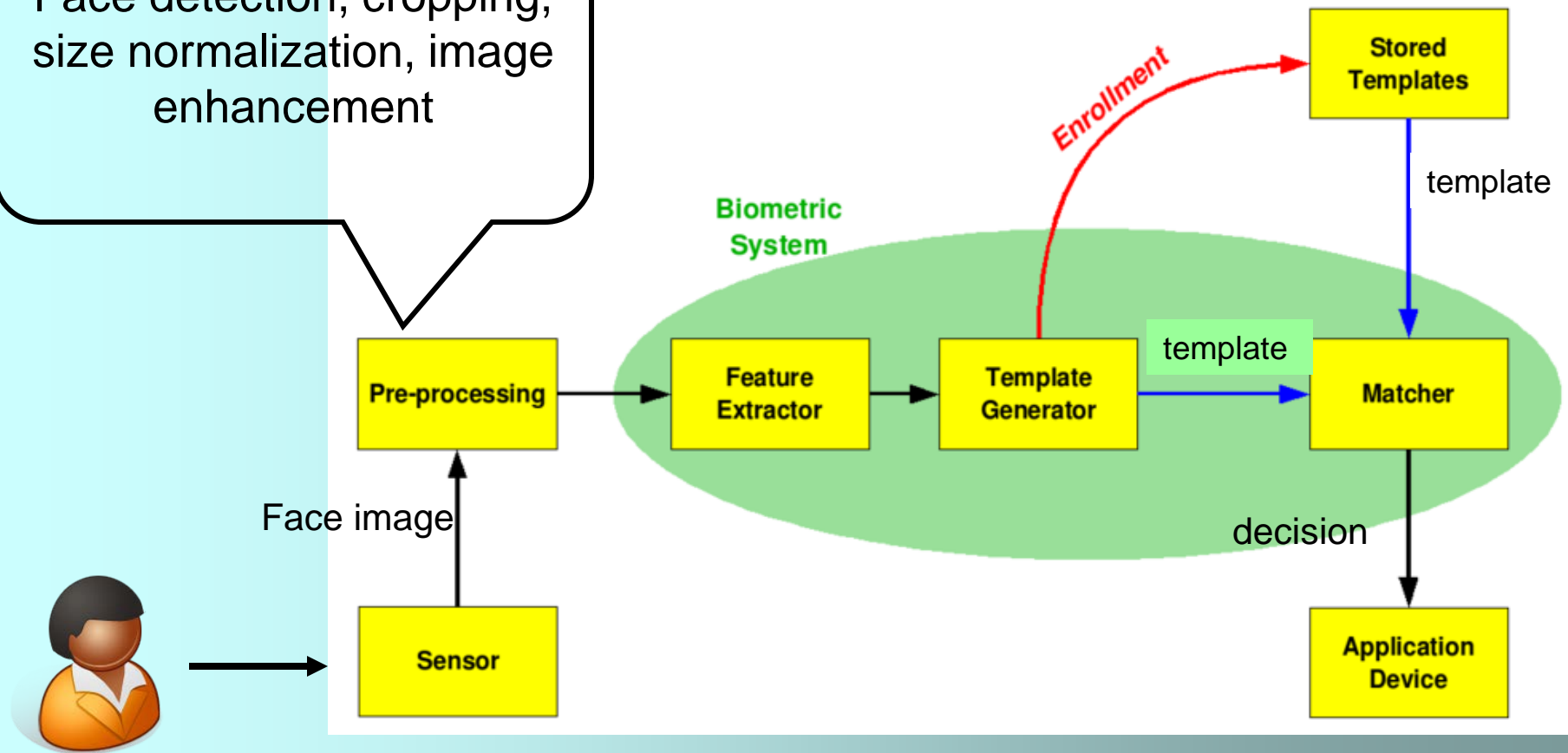
Face Recognition Game

Appearance depends on



Typical architecture

Face detection, cropping,
size normalization, image
enhancement



Adapted from: http://en.wikipedia.org/wiki/Image:Biometric_system_diagram.png

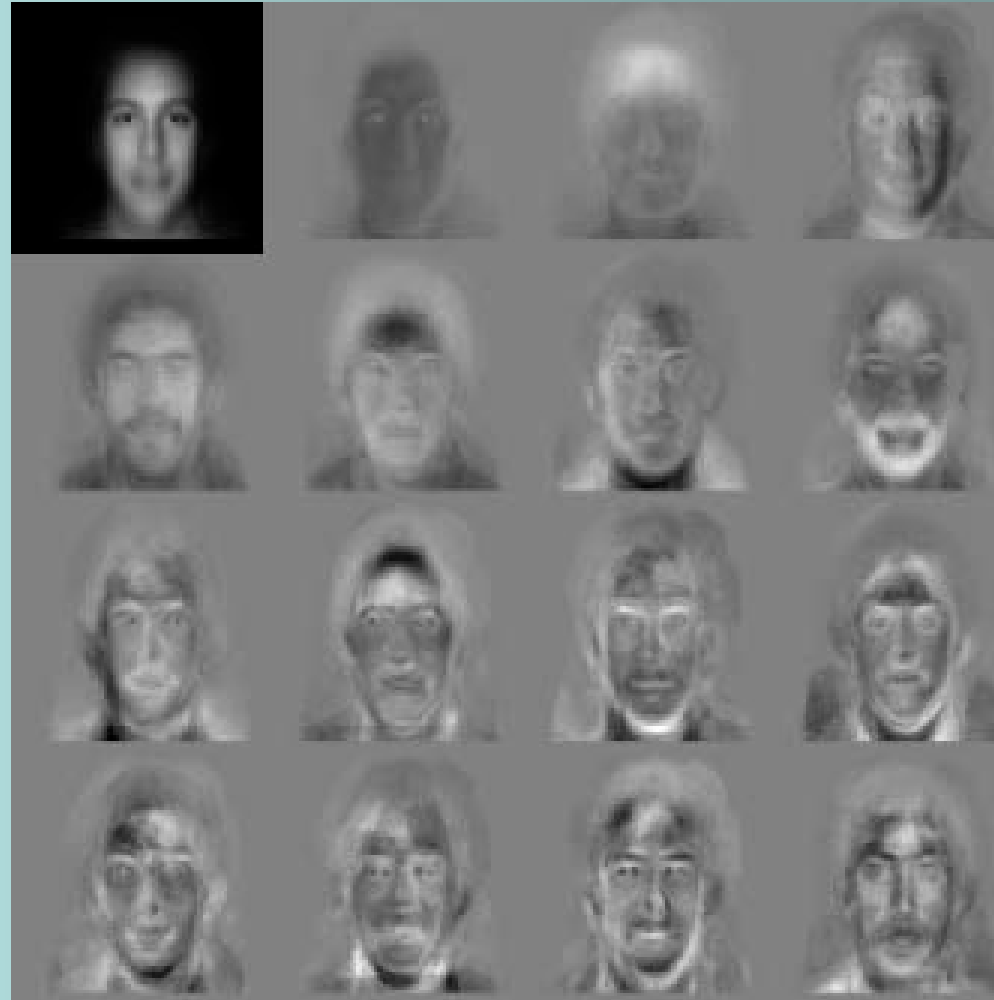
Face Recognition Features



- There is no consensus on what features are best.
 - Each vendor has proprietary algorithm.
- No features found to be invariant against all types of appearance variation.
- 3D not better than 2D
- Best performing algorithms use appearance (not geometry).

Eigenfaces

- Commonly used.
- Captures dominant variations across different faces.
- Original image = weighted sum of eigenfaces.
- Feature = set of weights.



Eigenfaces



Original
image

With
1 eigenface

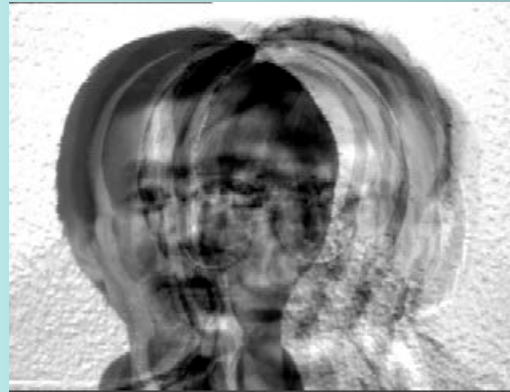
With
13 eigenfaces

With
25 eigenfaces

Eigenfaces



Original
image



Reconstruction
Using unaligned
images

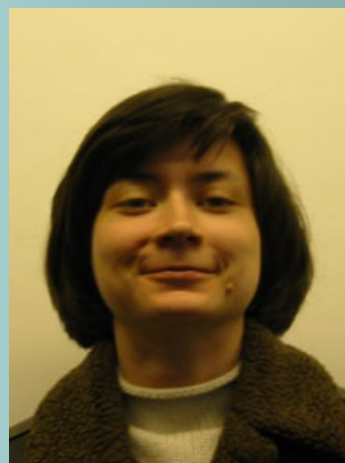
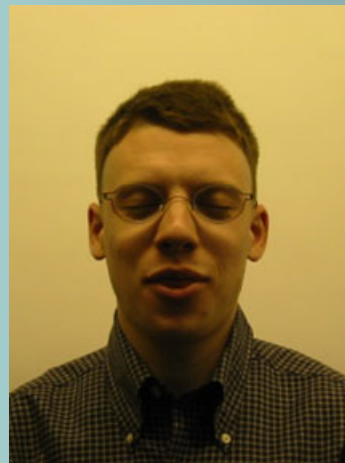
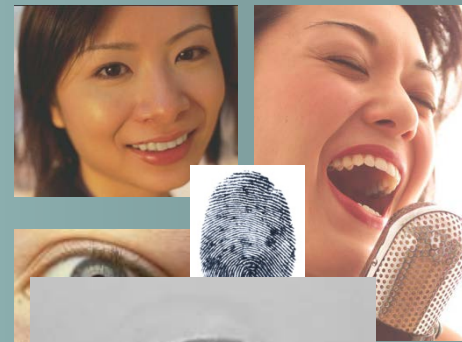


Reconstruction
Using aligned
images



Eigenfaces

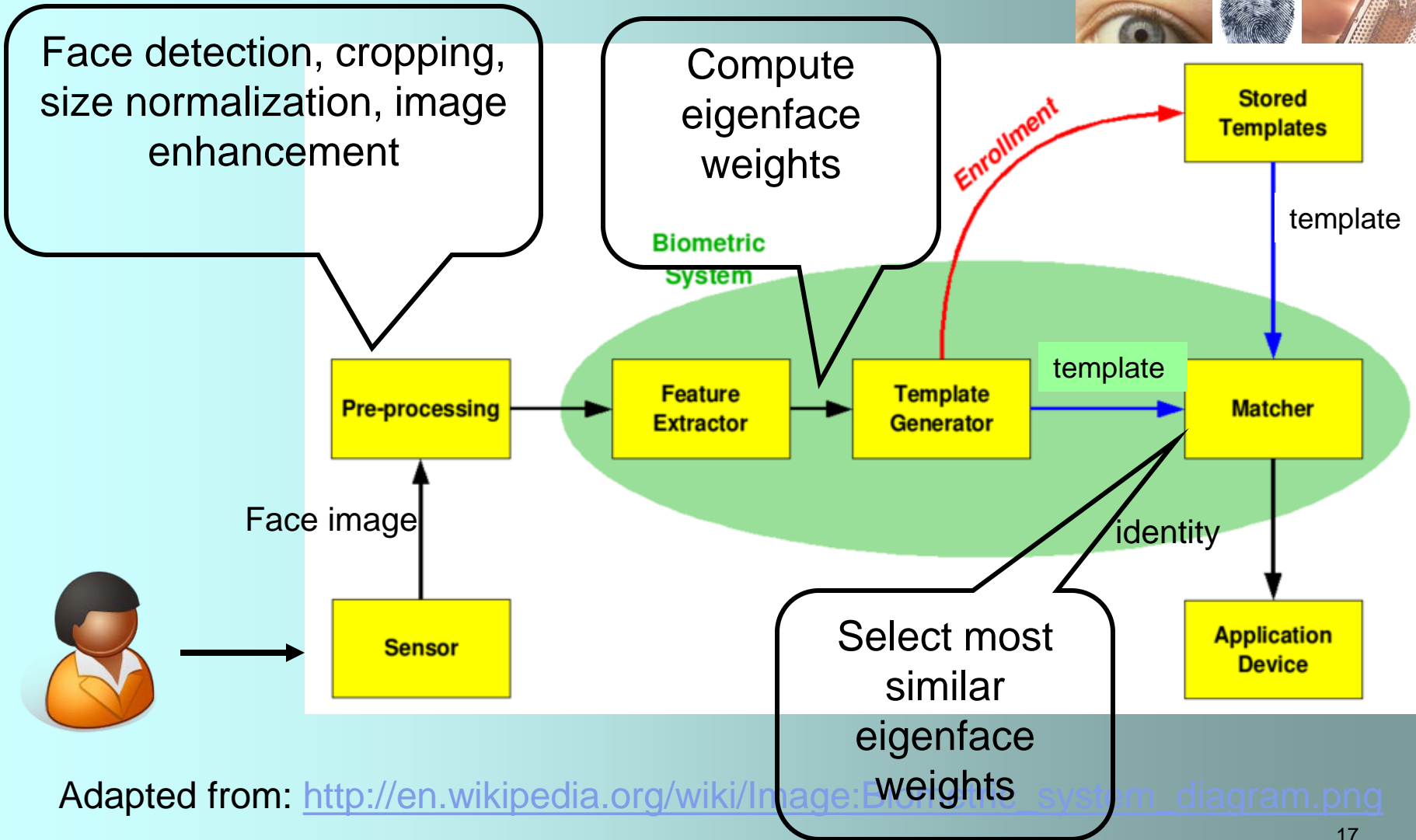
- Eigenfaces sensitive to alignment.
- Example shows the effect of aligning the eyes.



Original
image

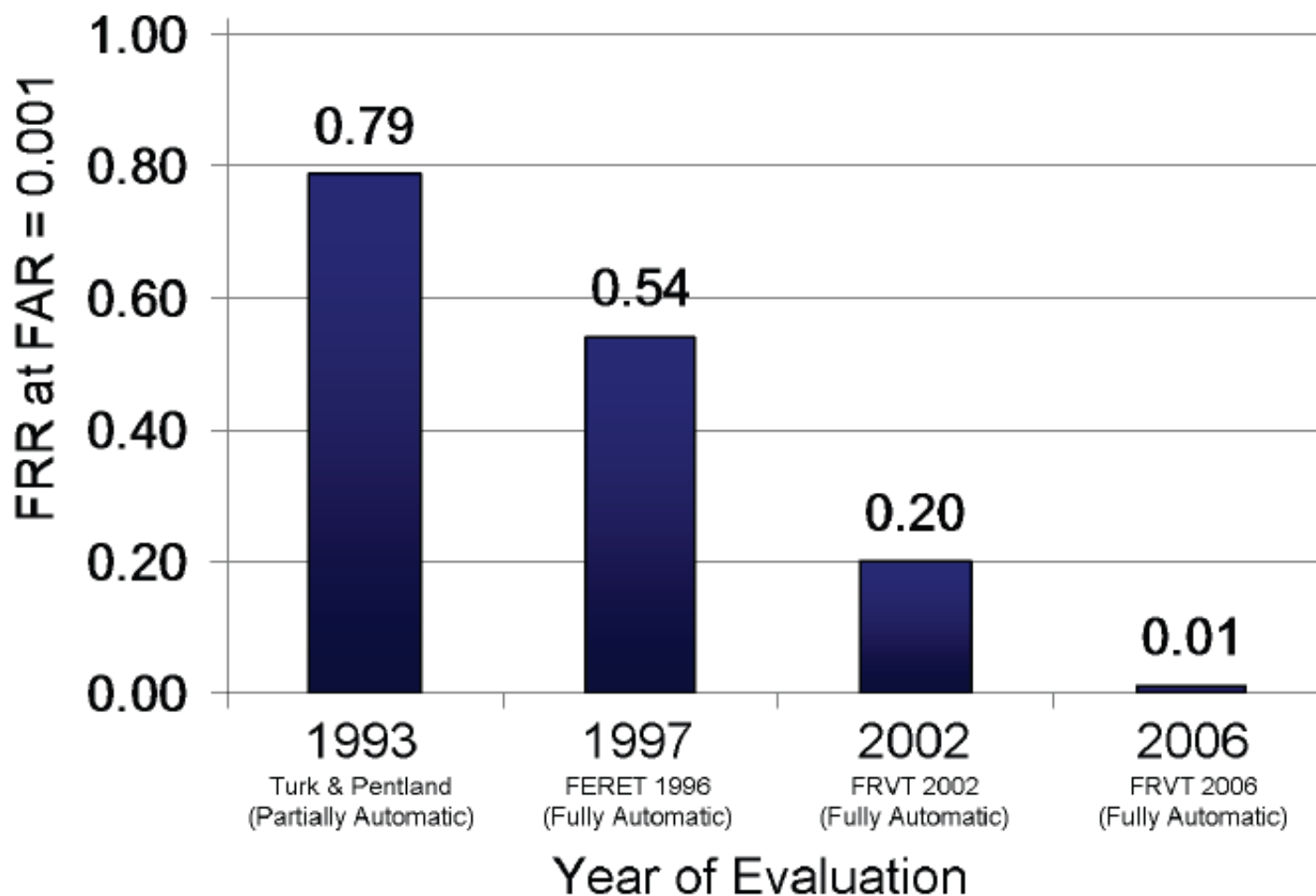
With
11 EFs

Typical architecture



FRVT 2006

- <http://www.frvt.org/>



FRVT 2006



- Organized by US NIST.
- 14 teams (from universities and vendors) took part.
- Face recognition performance on still frontal images taken under controlled illumination has improved by an order of magnitude since the FRVT 2002, due to:
 - Improvements in algorithms,
 - Higher resolution imagery (6M pixels)
 - Greater consistency of lighting.
- This experiment (on unfamiliar faces) found that algorithms are capable of human performance levels, and that at false accept rates in the range of 0.05, machines can out-perform humans.

Many challenges remain



- Uncontrolled lighting is still a problem.
- So is head pose variation.
- Also: facial expression
- Also: elapsed time
 - Time between enrollment and verification
- Also: low image quality