Advances in Face Recognition Research

Second End-User Group Meeting - Feb 21, 2008

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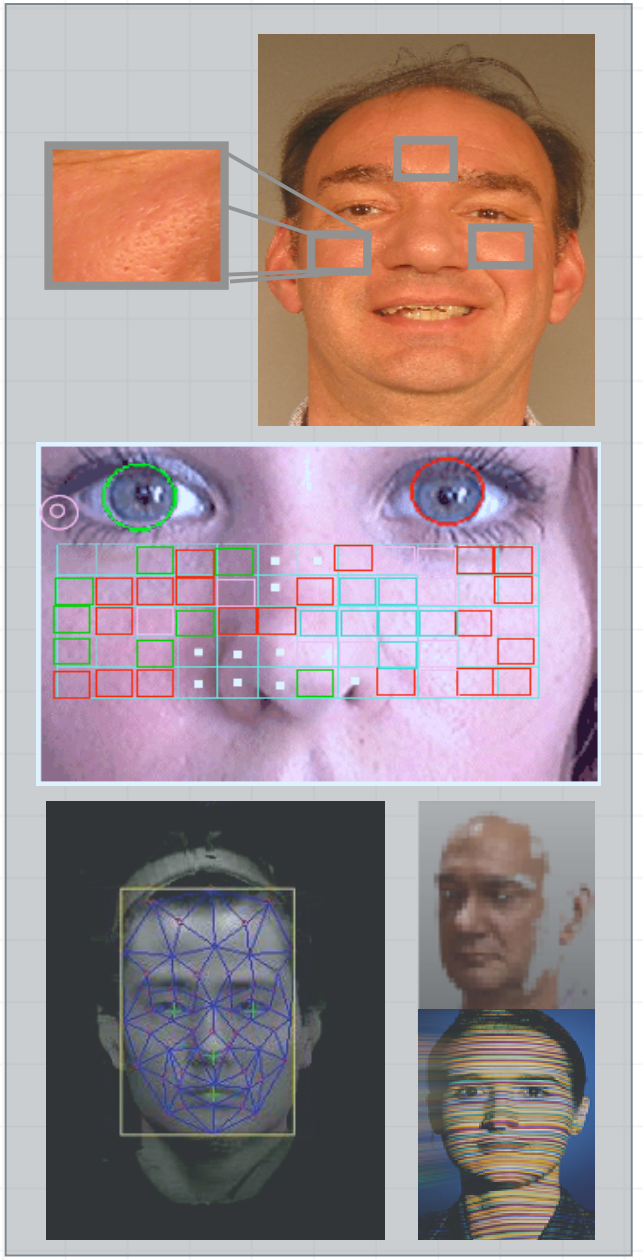
Outline

- Face Recognition Vendor Test 2006
- High Resolution Images and Processing
- Fusion Methods using Multiple Modalities and/or Algorithms
- Conclusions & Outlook
- References



Face Recognition Vendor Test 2006 Overview

- The FRVT 2006 was a facial recognition test open to universities, research institutes, and companies. It was the first independent, third party evaluation of NIST since 2002 (FRVT 2002).
- The FRVT 2006 includes performance evaluations on
  - still frontal images (2D) using different image qualities (very high, high and low resolution, controlled vs. uncontrolled images),
  - three-dimensional facial scans (3D).
- From the 22 participants 9 parties qualified for the large-scale evaluations on 2D facial images, 5 for evaluations using 3D scans.
- FRVT 2006 includes a comparison of human and machine face recognition performance.
- The FRVT 2006 results are summarized in the NIST Report NISTIR 2408, published March 2007 - http://face.nist.gov/frvt/

Participants in FRVT 2006
Large Scale Tests – Fully Automatic

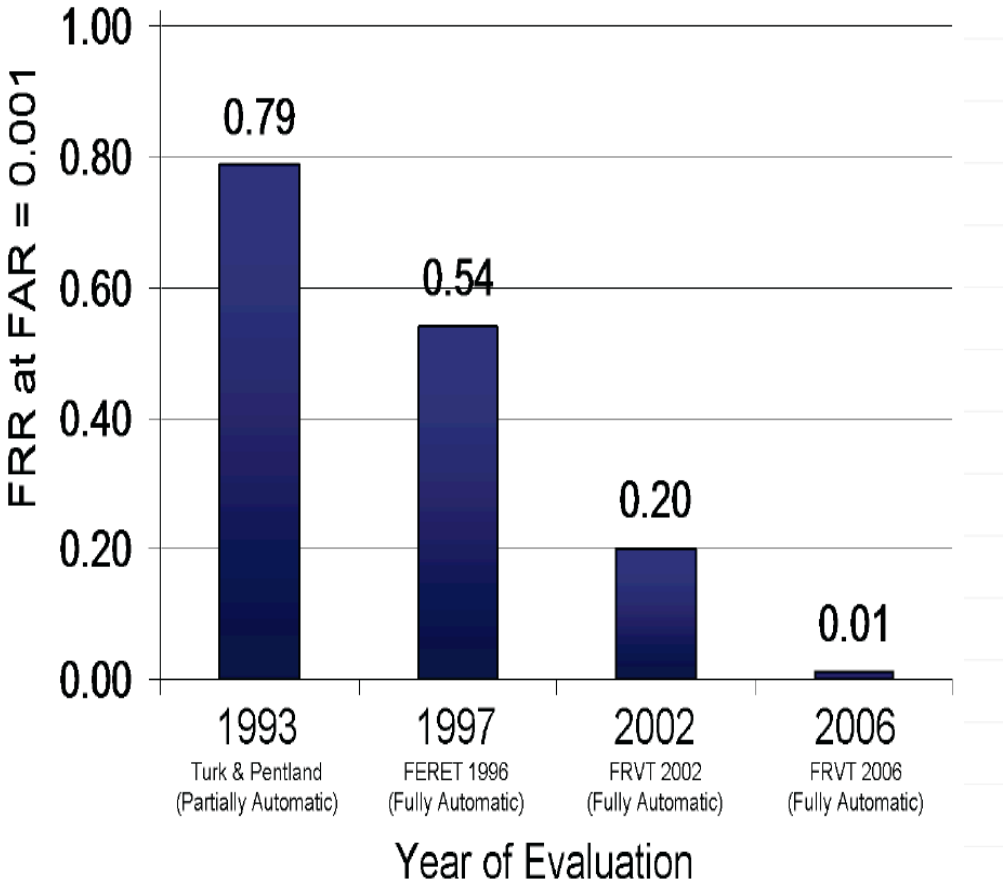
Group	Still 1to1	Still norm	3D 1to1	3D norm	3D shape
Cognitec	X	X	X	X	
Geometrix					X
Univ. Houston					X
Identix (L -1)	X	X			
Neven Vision	X	X			
Rafael	X	X			
Sagem	X	X			
SAIT	X	X			
Toshiba	X	X			
Tsinghua Univ.	X	X	X		
Viisage (L -1)	X	X	X	X	
Total	**9**		**5**		

Red – 3D-FACE Participants, Grey – Out of Business

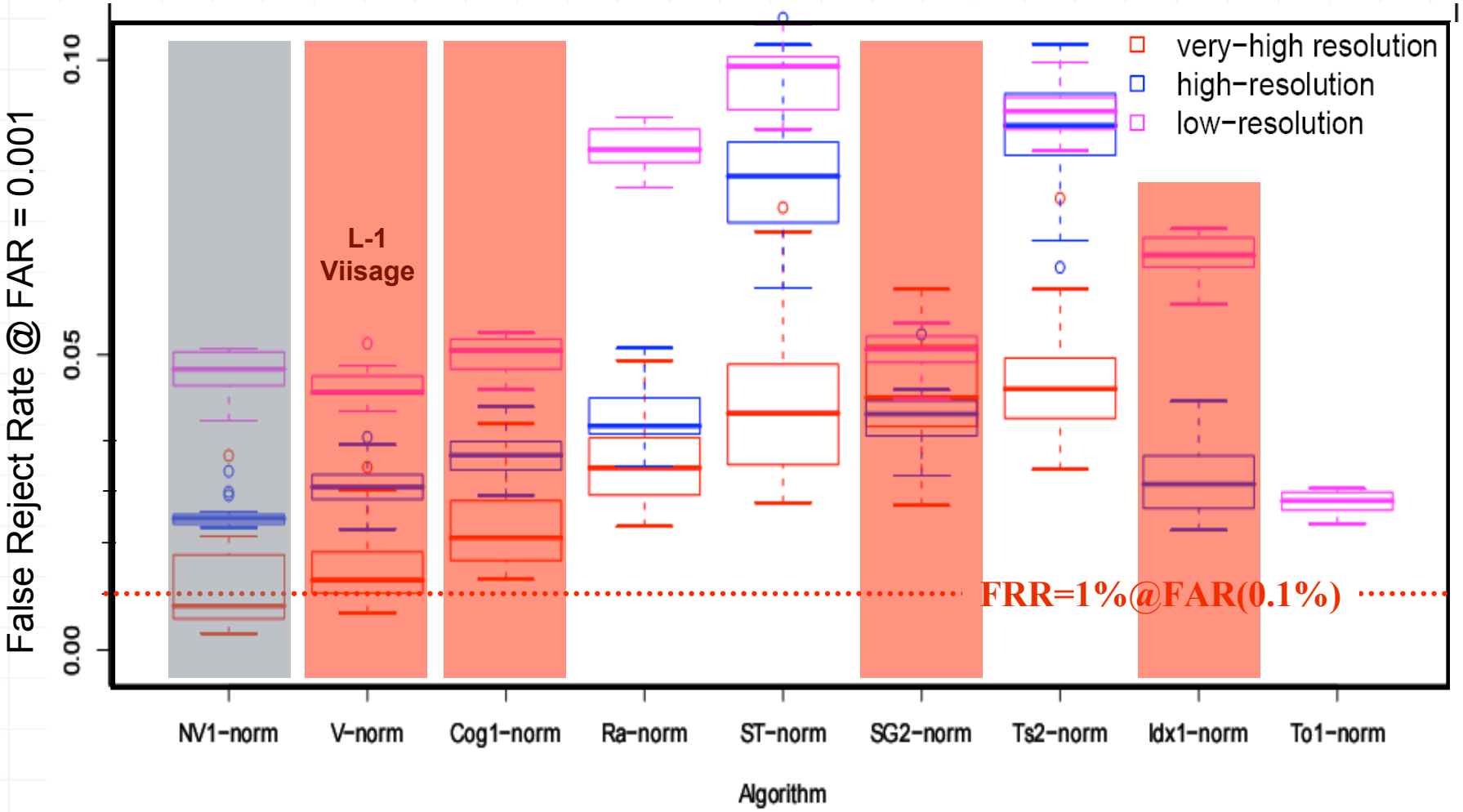
Technology Evolution 1993 – 2006

Results from Face Recognition Vendor Test 2006

- **Performance increase of at least a factor of 10** in comparison to the FRVT 2002, based on algorithmic and image quality improvement
- **Algorithmic improvement** on the FRVT 2002 image sets stated by a **factor of 4-6**, depending on the system
- Significant progress in matching faces across different lighting conditions

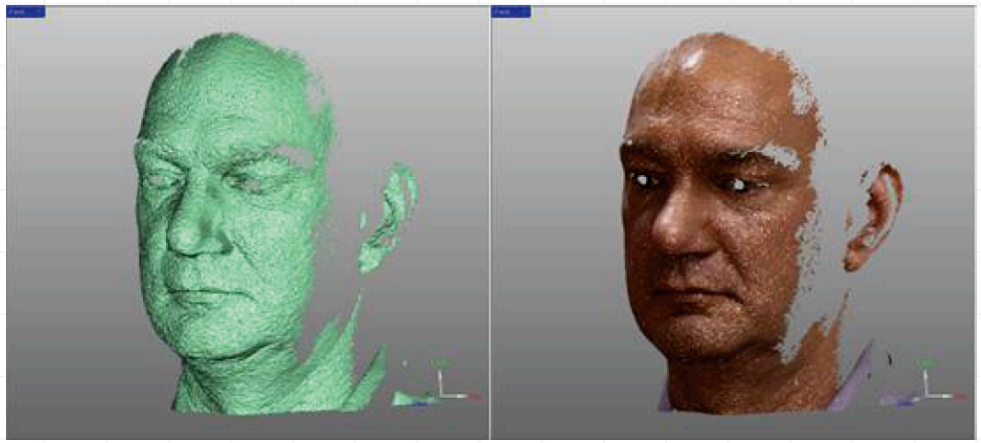


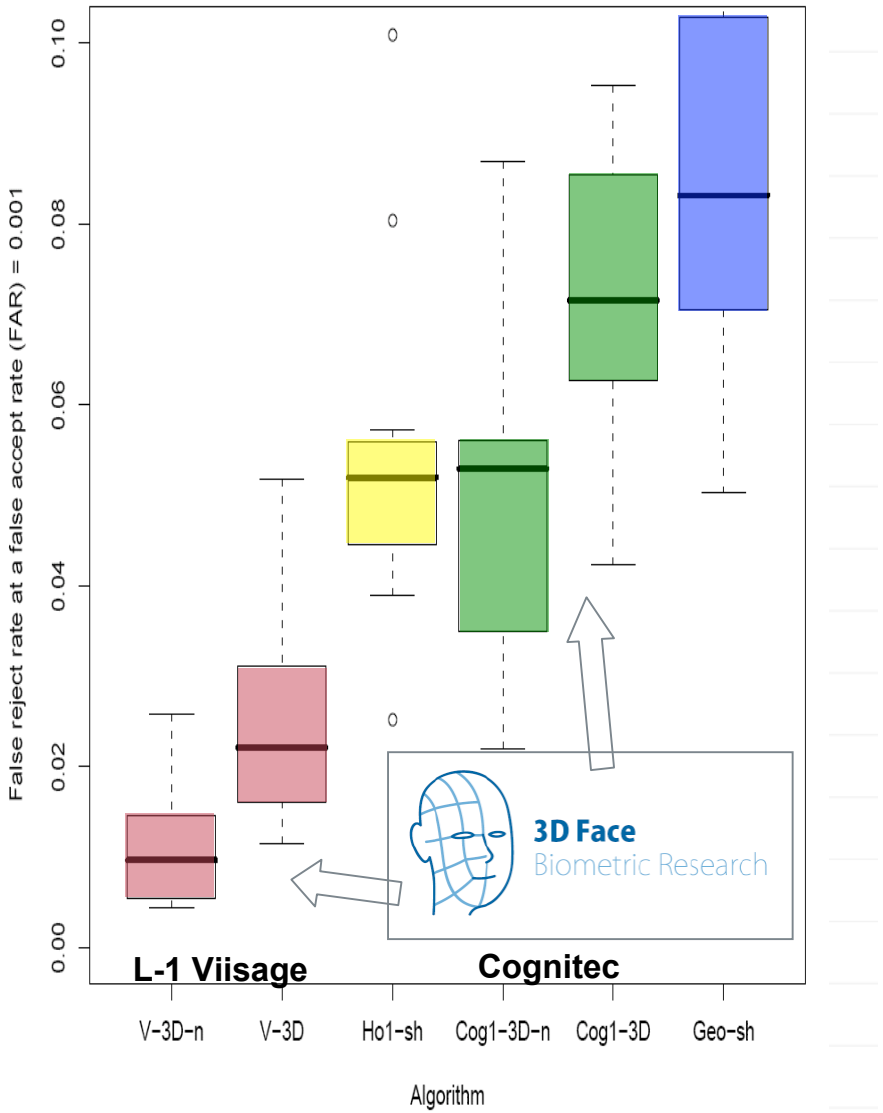
FRVT 2006 Results Summary (2D)



FRVT 2006 Large-Scale Tests
Three Dimensional Facial Scans

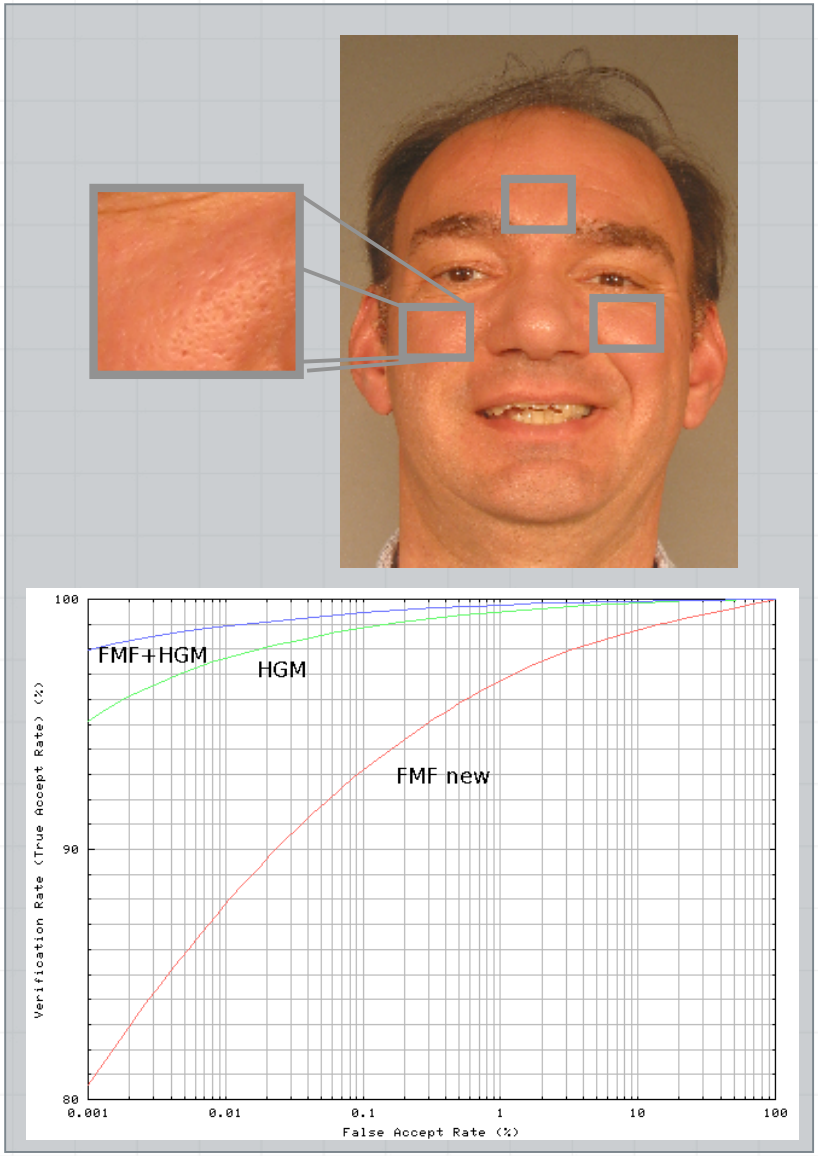
- 3D images were acquired with a Minolta Vivid 900/910 sensor and includes both shape and texture data





The Benefit of High Resolution Data

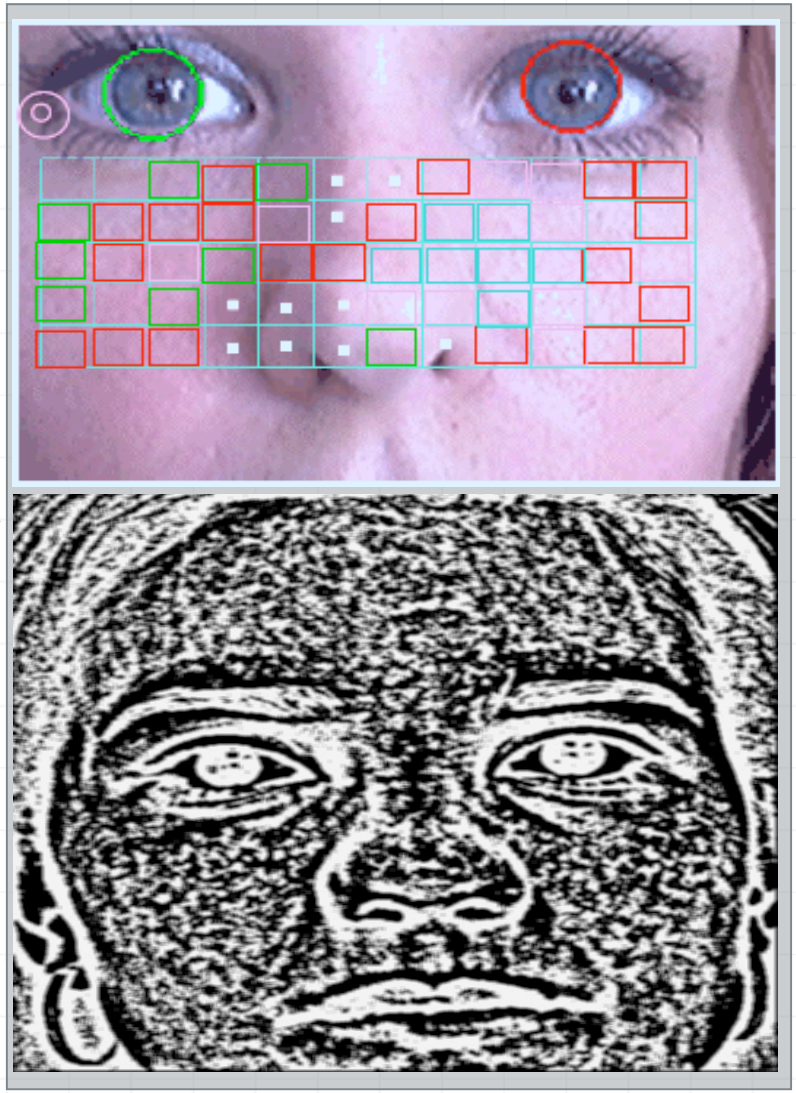
- Some newer high-performance algorithms available that operate on high resolution data
  - Viisage (L-1) FaceTexture Analysis
  - Identix (L-1) Surface Texture Analysis
  - Sagem Face Texture
- These methods shows significant improvement on controlled data
- Requires high resolution data
  - Min. 90 – 120 pixels eye-to-eye
- Sensitive to pose and compression artefacts
- Currently matching speed lower than “standard” methods, but no problem for verification tasks



The Benefit of High Resolution Data
Surface Texture Analysis (STA)

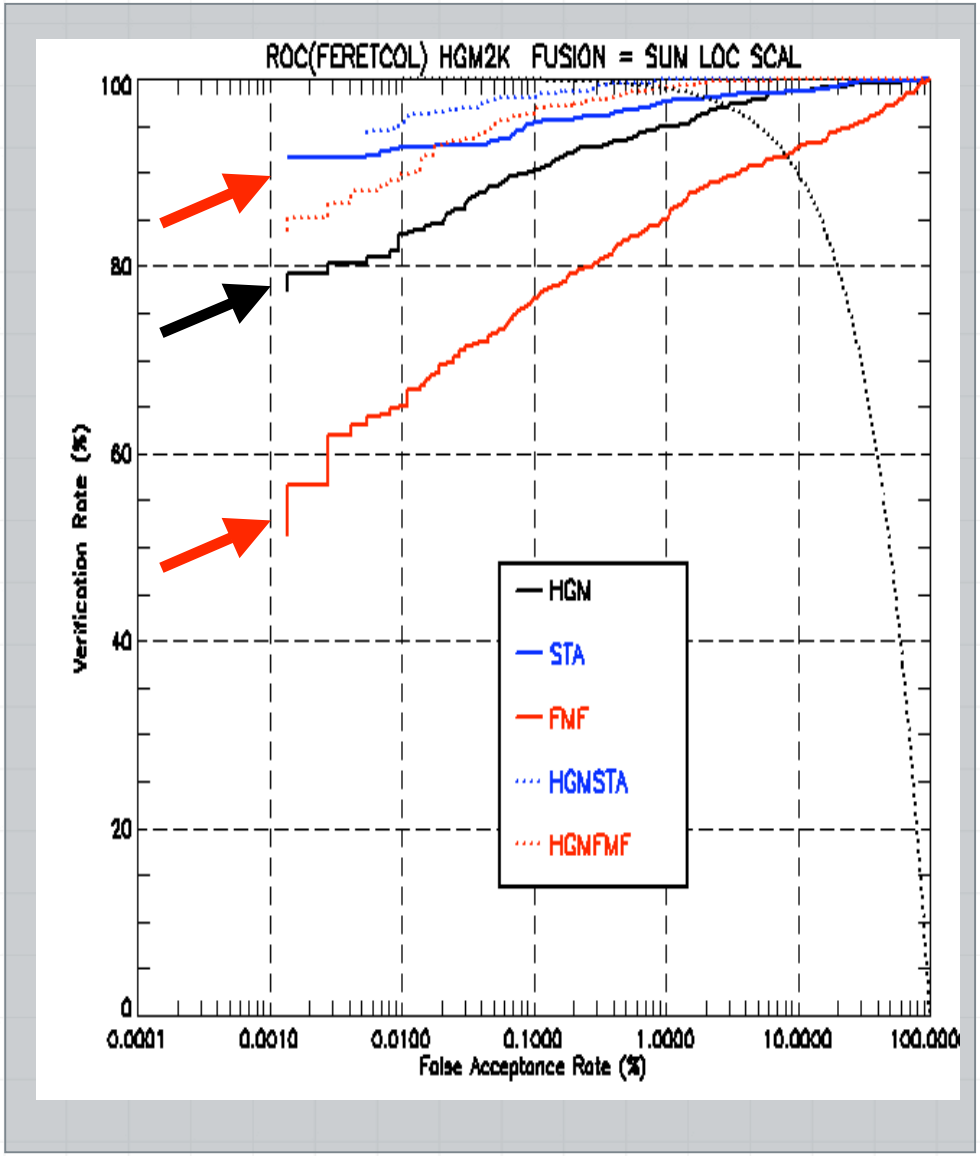
- STA analyzes skin as a random surface
- The algorithm compares small blocks of random skin surface.
- Local correlation is used to indicate identity

  (if neighboring blocks have matches that are also neighbors, then that is a match event)
- Evaluations proof, that a very small number of “adjacent matches” guarantees identity
- Good robustness to aging and expression
- Sensitive against pose/ compression
- For identification tasks typically used in a multi-pass architecture



The Benefit of High Resolution Data

Results on FERET-Color dataset (high quality, controlled)



Dataset Statistics

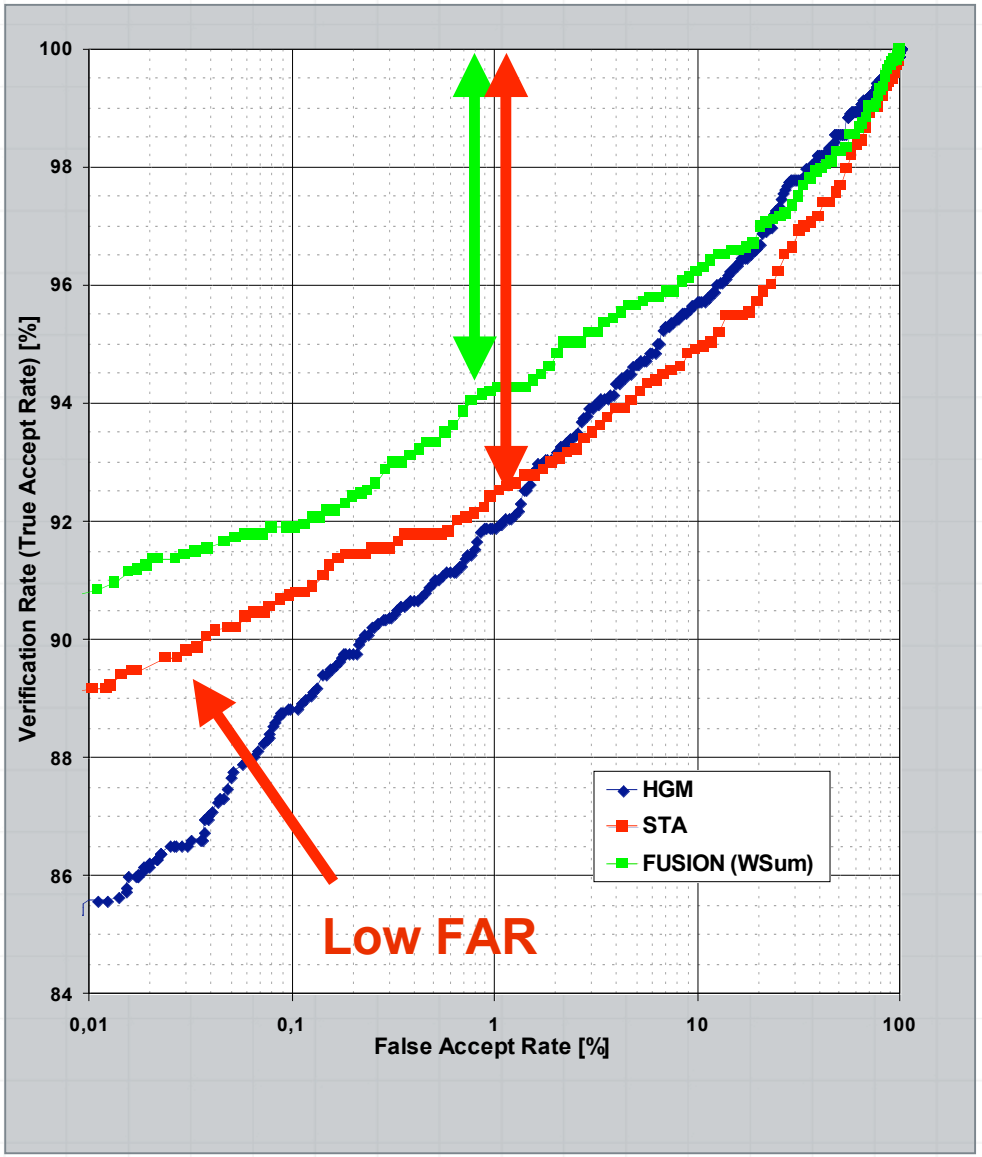
- Image resolution: 512 x 768 pixels
- Eye distance: 80-160 pixels
- Gallery: 994 frontal faces with one image per person
- Probe set: 1728 frontal images of 992 individuals
- Male 46% - Female 54%, multiple ethnical groups

The Benefit of High Resolution Data

Results on “robustness” dataset (3DFACE, w/o caps, Phase2 images)

Dataset Statistics

- Image resolution: 491 x 656 pixels
- Eye distance: 120 - 160 pixels
- Gallery: 101 individuals and images, frontal, neutral expression, no glasses
- Probe: 101 individuals, 1727 images, frontal/non frontal, with/without glasses, neutral/talking/smiling, no caps



Fusion of Face Modalities and Algorithms

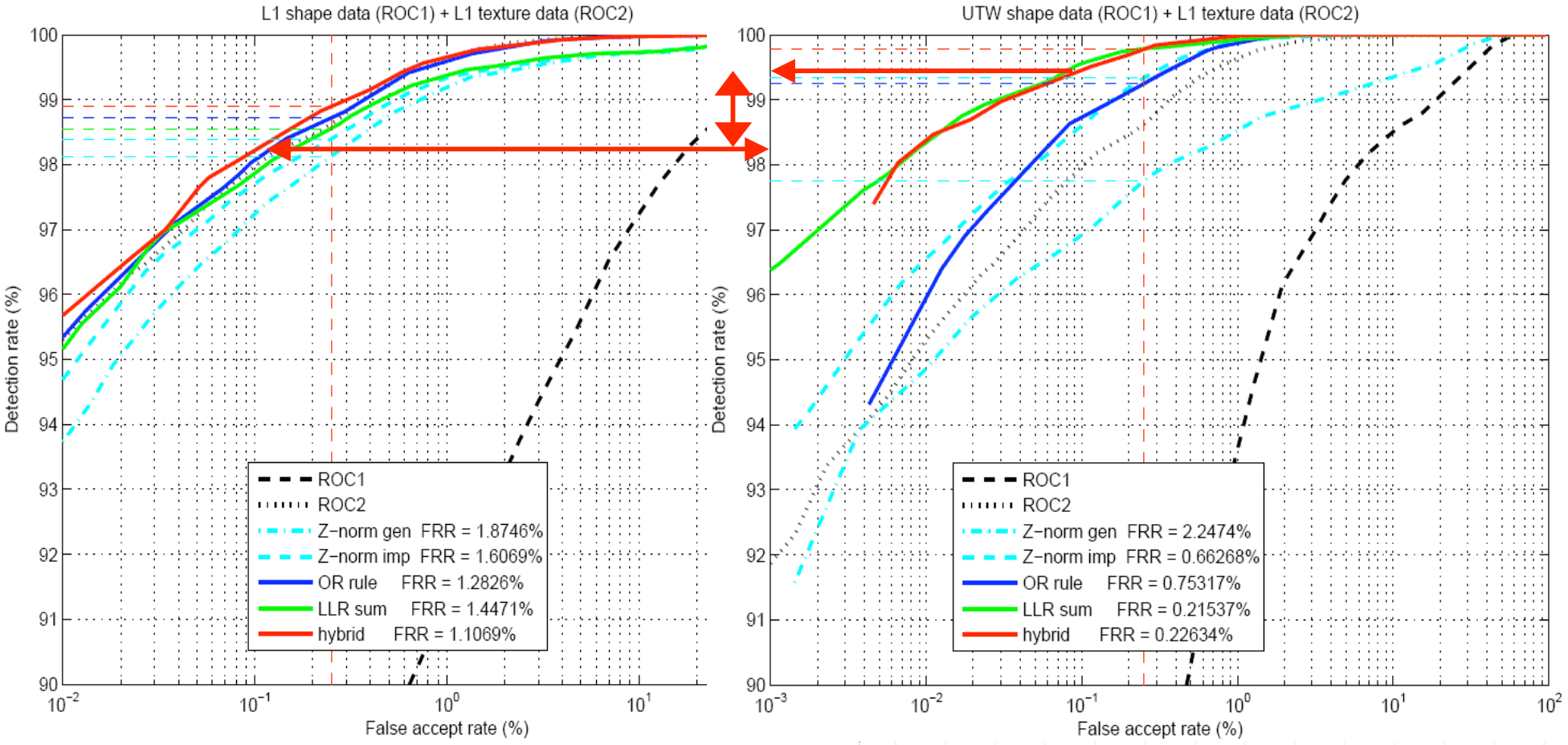
- One important goal of the 3D-Face project is the selection and appropriate combination (fusion) of the best algorithms available for 2D and 3D processing
- Investigations have shown, that at least three factors are important to consider:
  - Accuracy of the individual methods
  - Appropriate fusion algorithm
  - 'Independency' of methods and algorithms
- Advantage: Single acquisition for 2D/3D
- Typical real-life limitations to be considered (template size, computing resources)

Modalities
- 2D texture
- 2D high resolution
- 3D shape

Algorithms/Partners
- University of Twente
- Fraunhofer IGD
- Sagem
- Cognitec
- L-1 Identity Solutions

Fusion Methods
- Accuracy, robustness
- Computing time
- Computing resources
- Template size

Algorithmic Fusion
L-1 (2D/3D) vs. L-1 (2D)+Uni Twente (3D)



A significant error reduction can be achieved by fusion of multiple algorithms

Results obtained using 3D data from the Face Recognition Grand Challenge dataset

Conclusions and Outlook

- Huge progress in Face Recognition R&D and supportive technologies over last 10 years with an increase of accuracy of approx. 2 orders of magnitude.
- FRGC 2004/2005 and FRVT 2006 pushed development of high-resolution and 3D technologies. Comparable accuracy to iris recognition in controlled scenarios.
- 3D-FACE consortium combines a majority of the top face recognition research groups worldwide.
- High resolution texture methods significantly improves facial verification, especially at very low FAR rates.
- Multi-biometric fusion is an effective method to increase the accuracy and overall security of biometric solutions.
- 3D-FACE project explores methods that are applicable to other biometric modalities, e.g. iris and fingerprint multi-biometrics, too.

References

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[3] L. Wiskott, J.-M. Fellous, N. Krüger, and C. von der Malsburg. **Face recognition by elastic bunch graph matching.** *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 19(7):775–779, 1997.

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[6] 3D FACE CONSORTIUM. **3D Face - Integrated Project**, www.3dface.org, 2006.

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Thank you!

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