Cognitec

The face recognition company

Advances in Face Recognition Research

Presentation for the 2nd End User Group Meeting

Juergen Richter – Cognitec Systems GmbH

For legal reasons some pictures shown on the presentation at the End User meeting had to be removed or replaced for this version.

Outline

- How does Cognitec's 3D Face Recognition work ?
- Resulting research tasks and achievements since start of the EU 3DFace project
- Conclusions for development and user scenarios

Face Recognition: Principal Approach

Input Data — Data as provided by sensor

↓ Feature Extraction

Raw Features — Features with reduced contingency

↓ Classification Transformation

Feature Vector — Features transformed to optimally distinguish individualities

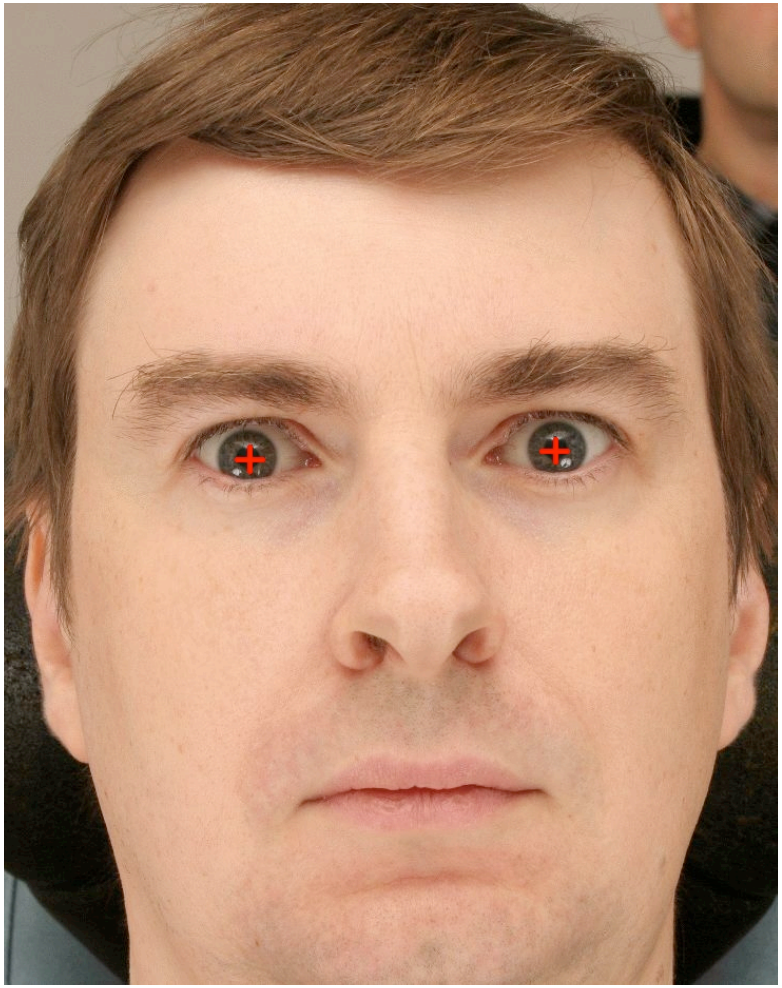
Characterization of Sensor Data

- Typically contains more than just the face
- Varying orientation in space (pose)
- Occasional data corruption
  (gaps, outliers, artefacts like ripples)
- Deformations of facial surface due to glasses, hairdo and beard

3D Face Recognition: Feature Extraction

- Localize facial part of 3D shape
- Align facial region to some defined orientation
- Preprocess shape to eliminate data flaws (Smoothing)
- Apply some feature extraction operator (Reduced dimension input for classification

3D Face Recognition: Localization



- Very accurate 2D feature finders available
- Task of feature localization much more difficult for 3D shapes

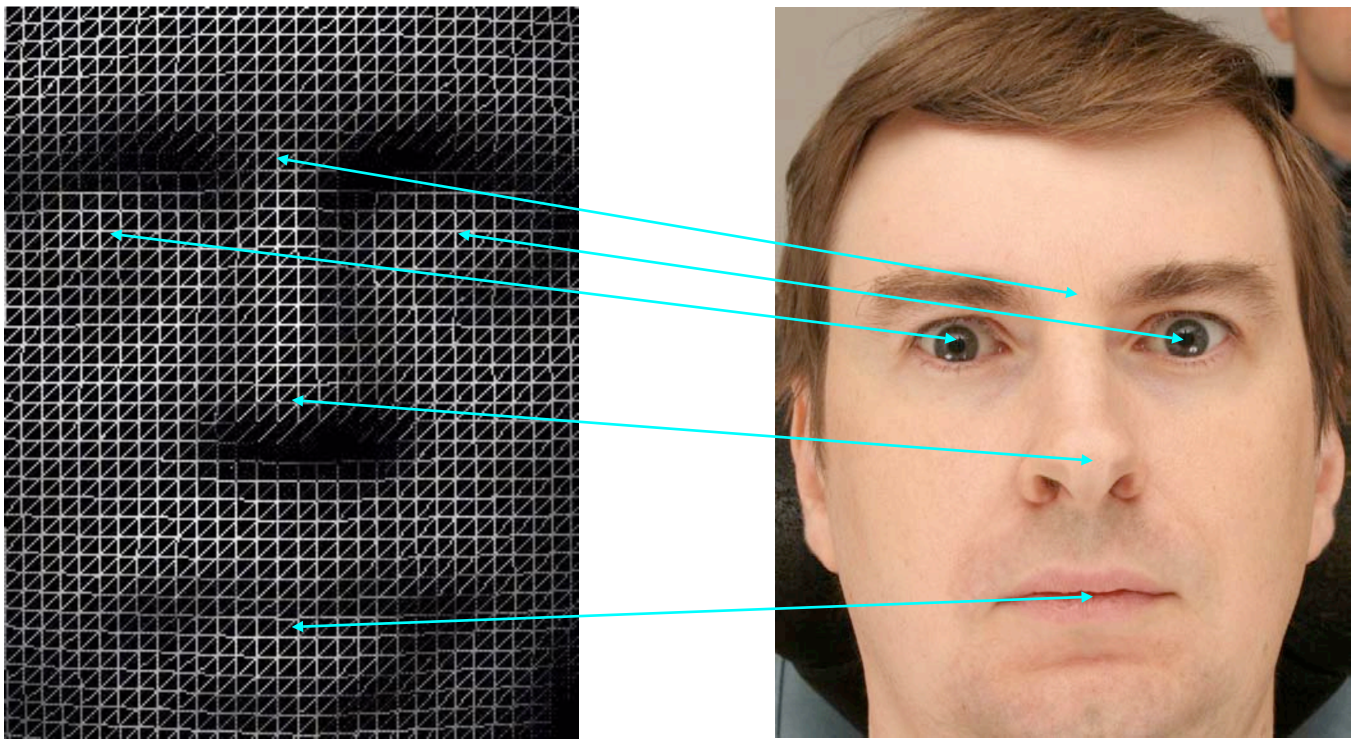
=> Use Power of 2D feature finders for 3D localization, too!

3D Face Recognition: Localization

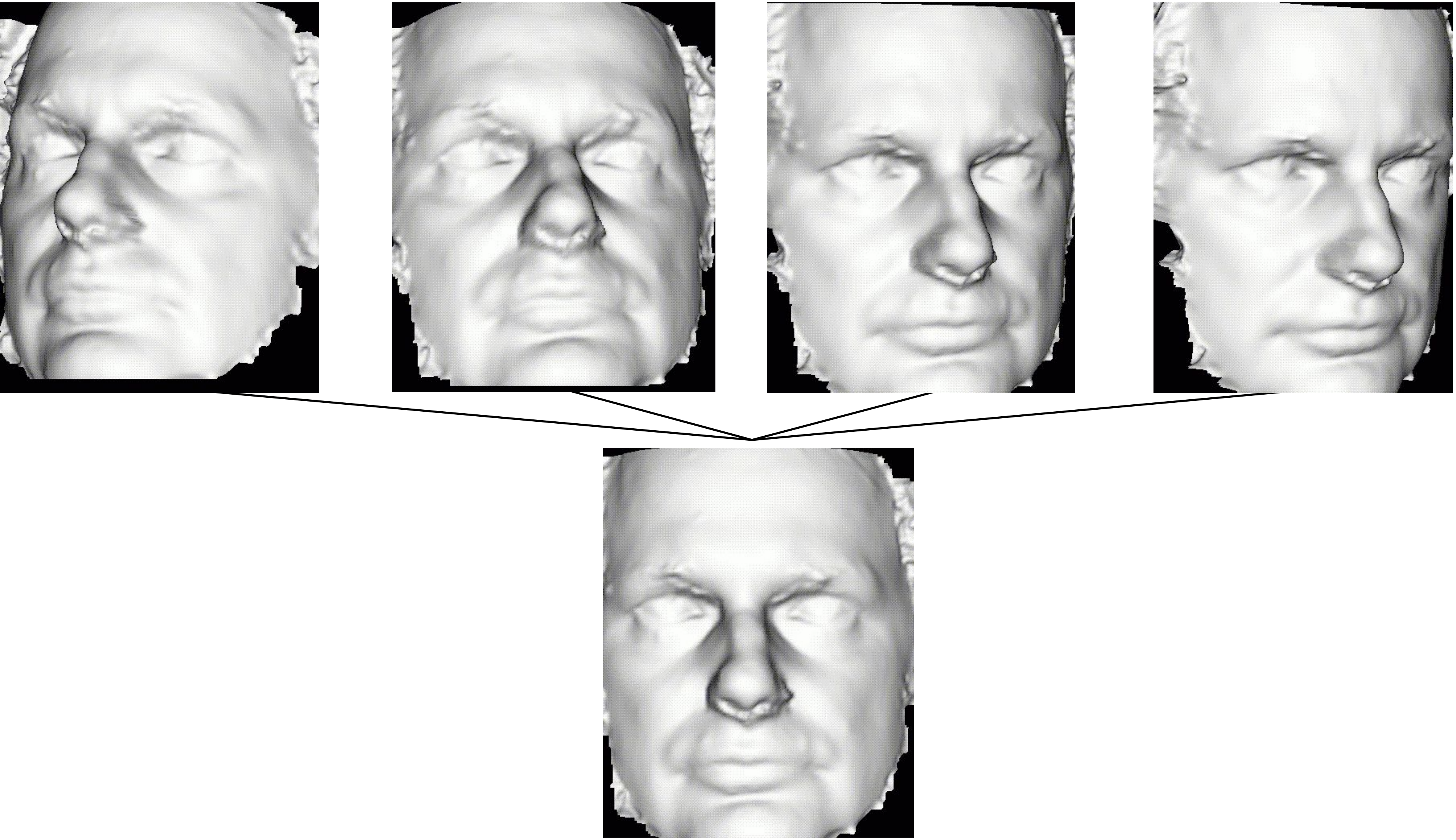
Starting from 2D locations, find 3D locations by pixel – vertex correspondence

i = 1,2,...

k=
1,
2,
.
.
.



3D Face Recognition: Alignment



3D Face Recognition: Shape Preprocessing

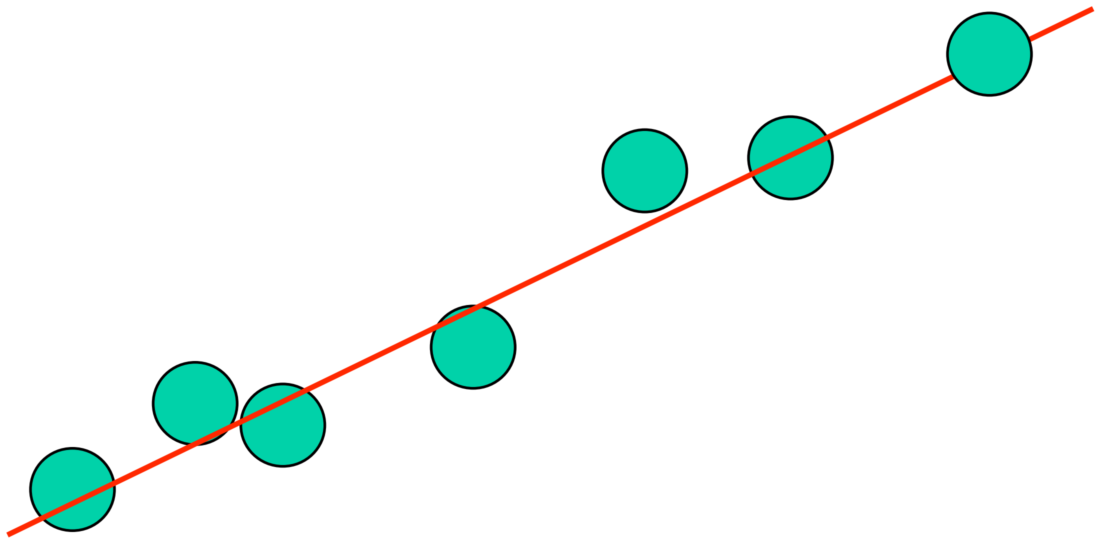
Eliminate data flaws related to:

- Noise: deviations from true positions with some continuous random distribution
- Outliers: isolated points or groups of points with large deviation from true positions
- Gaps: locations where 3D data is missing at all
- Occlusions: particular sort of gaps in regions not available to sensor measurement

One algorithm fits all:
3D surface reconstruction by "Moving Least Squares"

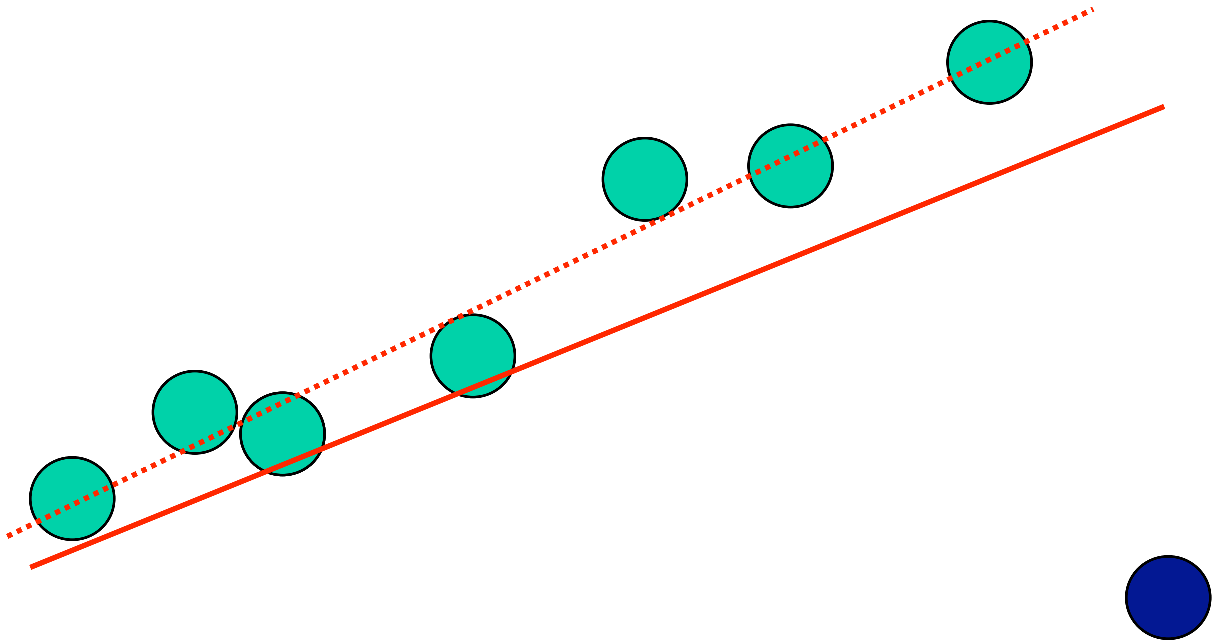
Least Squares Method (1)

Linear Regression:
Find line linearly approximating a set of points
=> minimize sum of squared distances

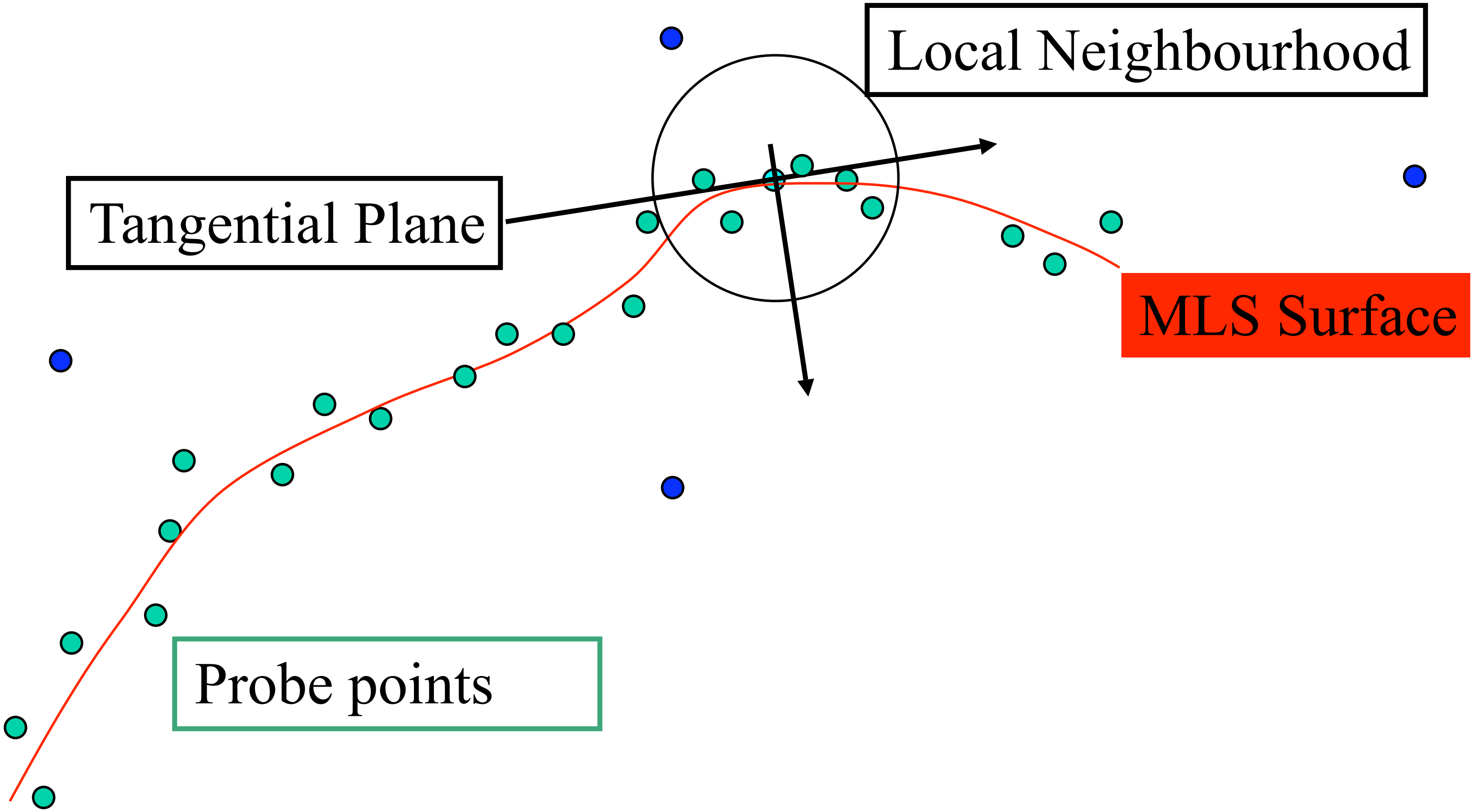


Least Squares Method (2)

Disadvantage: Sensitive to outliers!



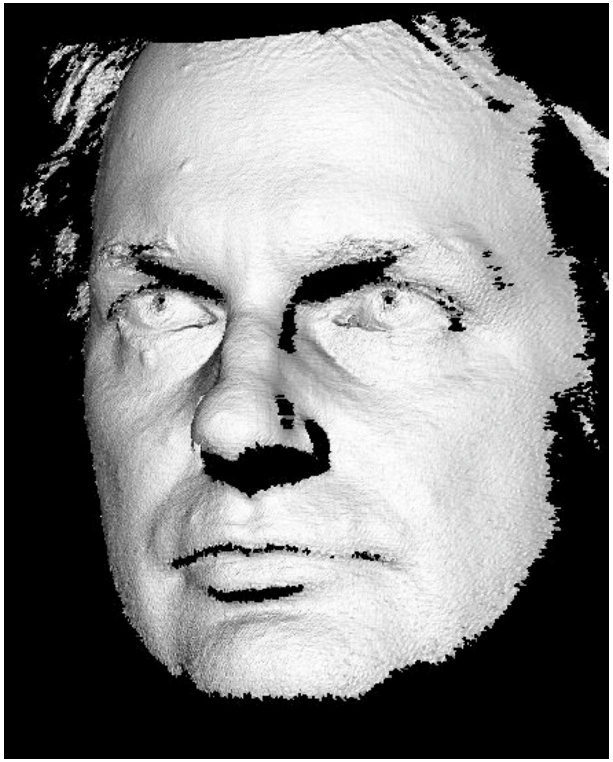
3D Face Recognition: Moving Least Squares (MLS)



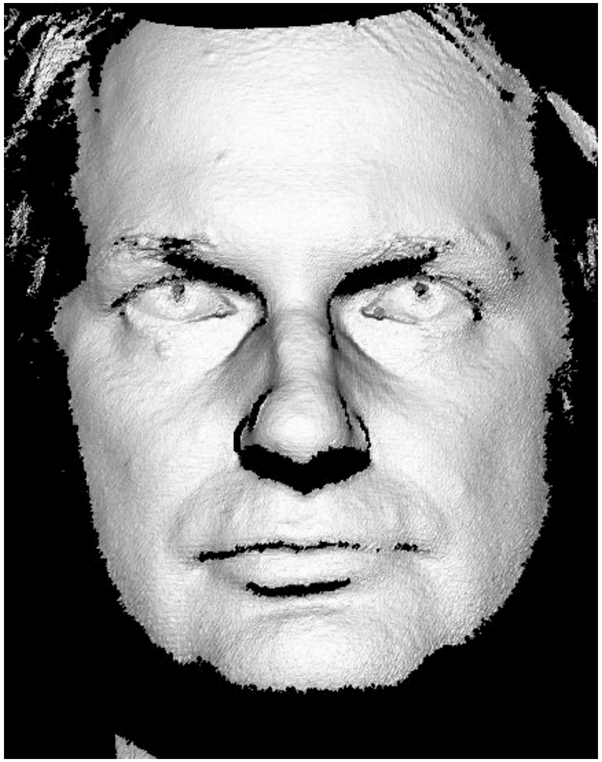
Local Least Squares Approximation

3D Face Recognition: Processing Steps

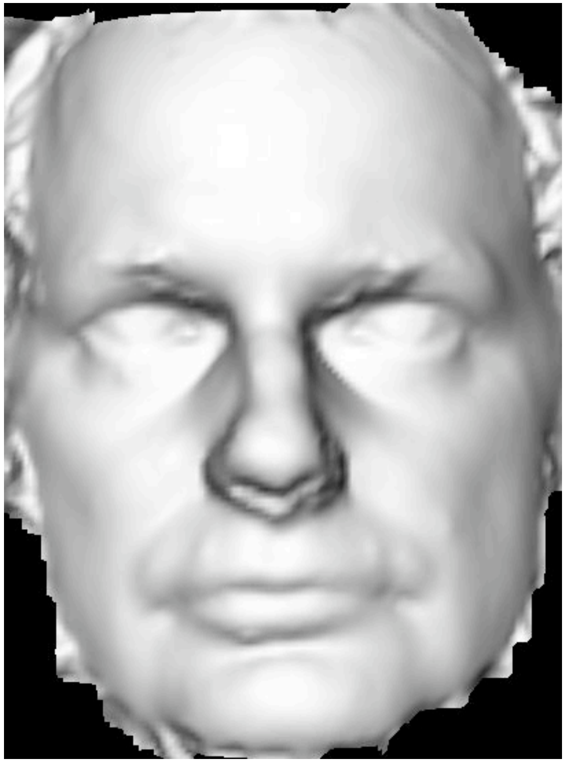
Sensor Data



Aligned



MLS smoothed



3D Face Recognition: Major Research Tasks

- Improvement of 2D Feature Finders
  (face finder, eyes finder)

- Implementation and optimization of MLS algorithm

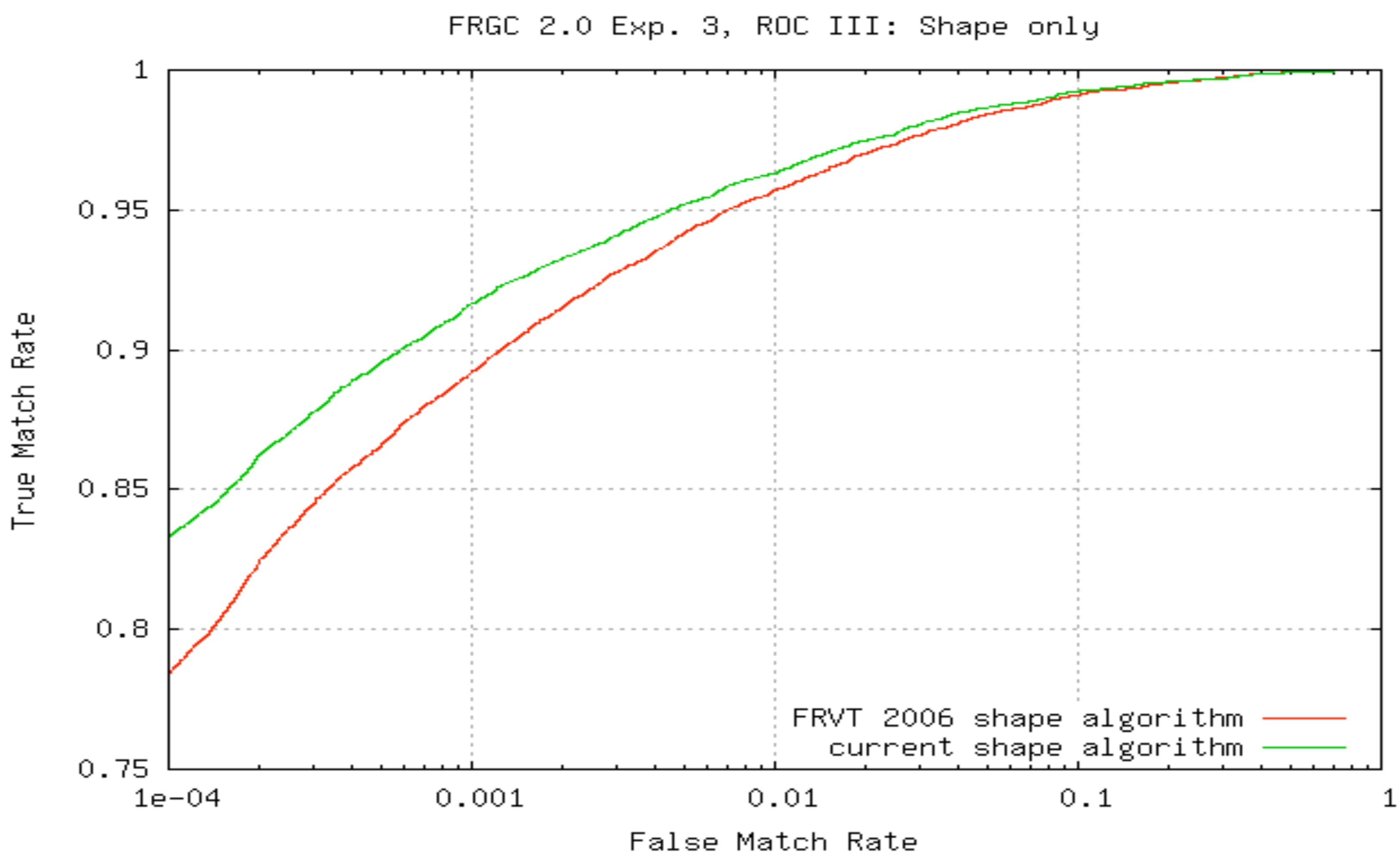
- Optimization of classification algorithm

"Improvement" and "Optimization" both in terms of biometric performance, robustness and computing speed!

Selected Achievements: Face Finding

Face Finder Performance: % of faces not/incorrectly found		
Face Database	T6 (2006)	T8 (2008)
Mainly frontal images, low variation in lighting:		
Cferet-frontal	0.1	0.04
Internal 1	0.2	0.05
Internal 2	0.3	0.2
Strong variations in both pose and lighting:		
Weizmann	1.7	0.1
Internal 3	0.3	0.1

Selected Achievements: Recognition Performance



Selected Achievements: Computing Speed

MLS Surface (200x200) Computation Timings (sec) on Xeon 3220 (QuadCore, 2.4 GHz)		
	1 Thread	4 Threads
1st MLS version May 2006	20	n/a
MLS version in TDF Modules Dec 2007	6.8	1.8
Most recent MLS version Feb 2008	0.9	0.4

Avoidable Data Flaws

- Nonfrontal pose resulting in data gaps
- Occlusions caused by caps, dark glasses, strands of hair
- Data artefacts (ripples, gaps, outliers) caused by head motion during capture

Conclusions

For Sensor and Application Developers:

- Keep exposure time low
- Provide clear feedback on start and end of exposure phase
- Reduce processing times as far as possible

For user scenario: “Educate” cooperative user

- Look straight into sensor camera
- Keep neutral expression
- For time of exposure, try to freeze head movements
- Avoid occlusion of face (caps, dark sunglasses, hair)