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Rapid Stereo-Vision Enhanced Face Recognition

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Overview

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- Fields of application
- Methods overview

II. Face recognition
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- Face detection
- Training database
- Principal component analysis

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Introduction

- **Face recognition** - is a technology that identifies or verifies a person from a digital image of a video frame.

- **Gender recognition** – face recognition feature, which allows to determine the face gender (*male* / *female*).
- **Mood recognition**– another face recognition feature, which allows to determine the person mood (*angry* / *happy* / *sad* / *surprised*).

- Popular algorithms:
  - Turk & Pentland (1991);
  - Bronstein *et al*. (2005);

Fields of Application

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- Biometrics
  - methods for uniquely recognizing humans based upon one or more intrinsic physical or behavioral traits.
  - RAND: Face recognition for authentication idea (2003)
  - Face Recognition Grand Challenge.
  - (2006)
  - Suprema: D-Station®– authentication system. (2010)

Fields of Application

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- Biometrics
- Surveillance systems
  - methods for monitoring the behavior of people, objects or processes within systems.

  - Fraunhofer IIS: face tracking tec. (2005)
  - Cognitec Systems: face recognition in video surveillance tec. (2009)

Fields of Application

- Biometrics
- Surveillance systems
- Human-machine interaction
  - the study of interaction between people and computers.
  - Fraunhofer HHI: facial animation in video analysis and synthesis tec. (2003)
  - Image metrics: 3D face animation for movies and games industry (2007)

Methods Overview

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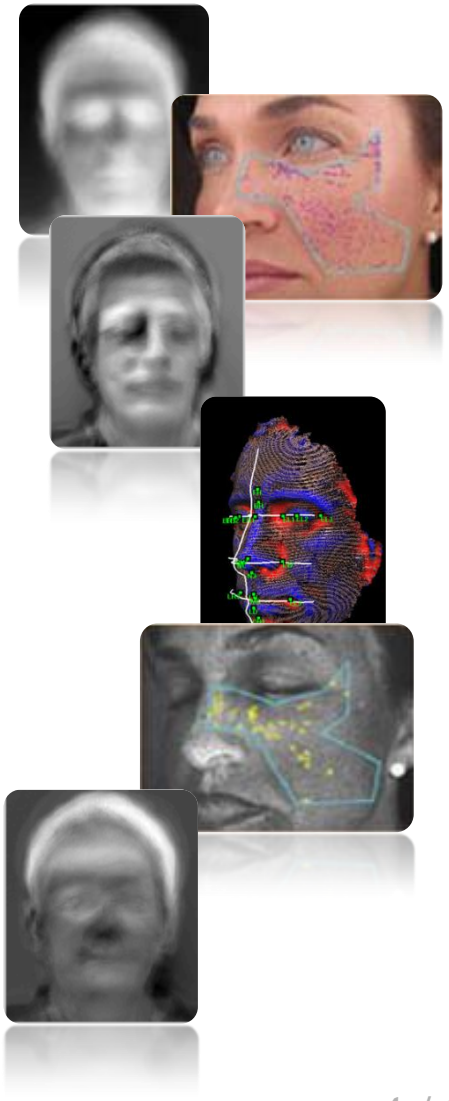
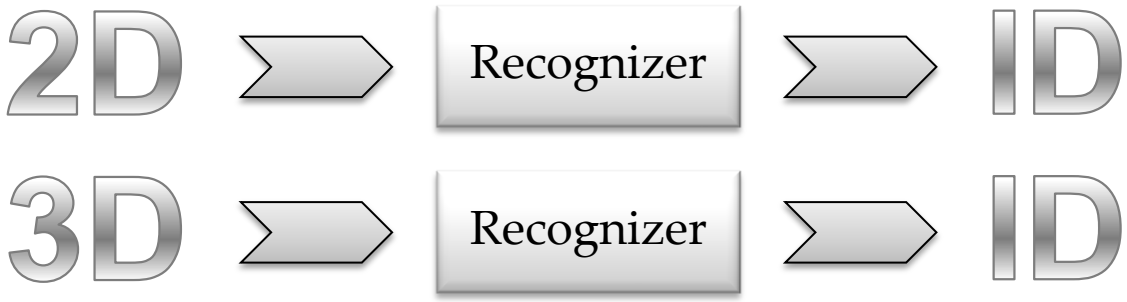
- Requirements
  - Real-time
  - Multiple people recognition
- Combination of 2D and 3D
  - Additional information
  - Lightning invariant
  - We expect better results
- Principal Component Analysis
  - On 3D face modes instead of 2D images

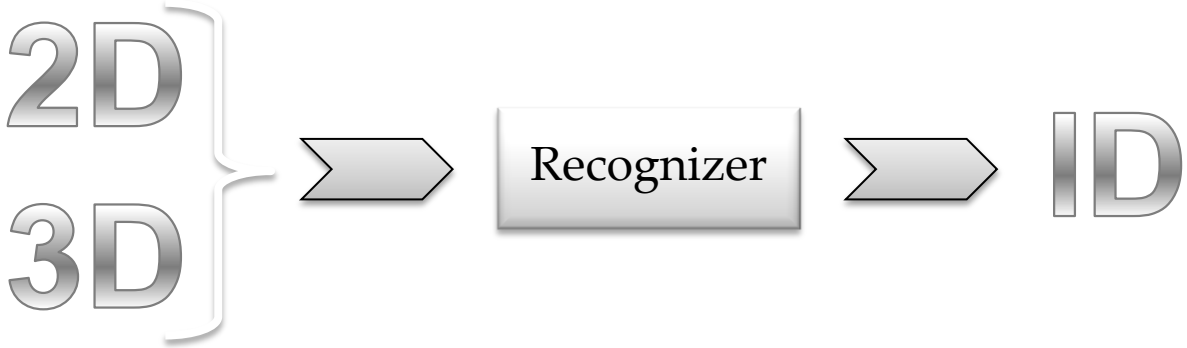


Methods Overview

- Before [1],[2]:



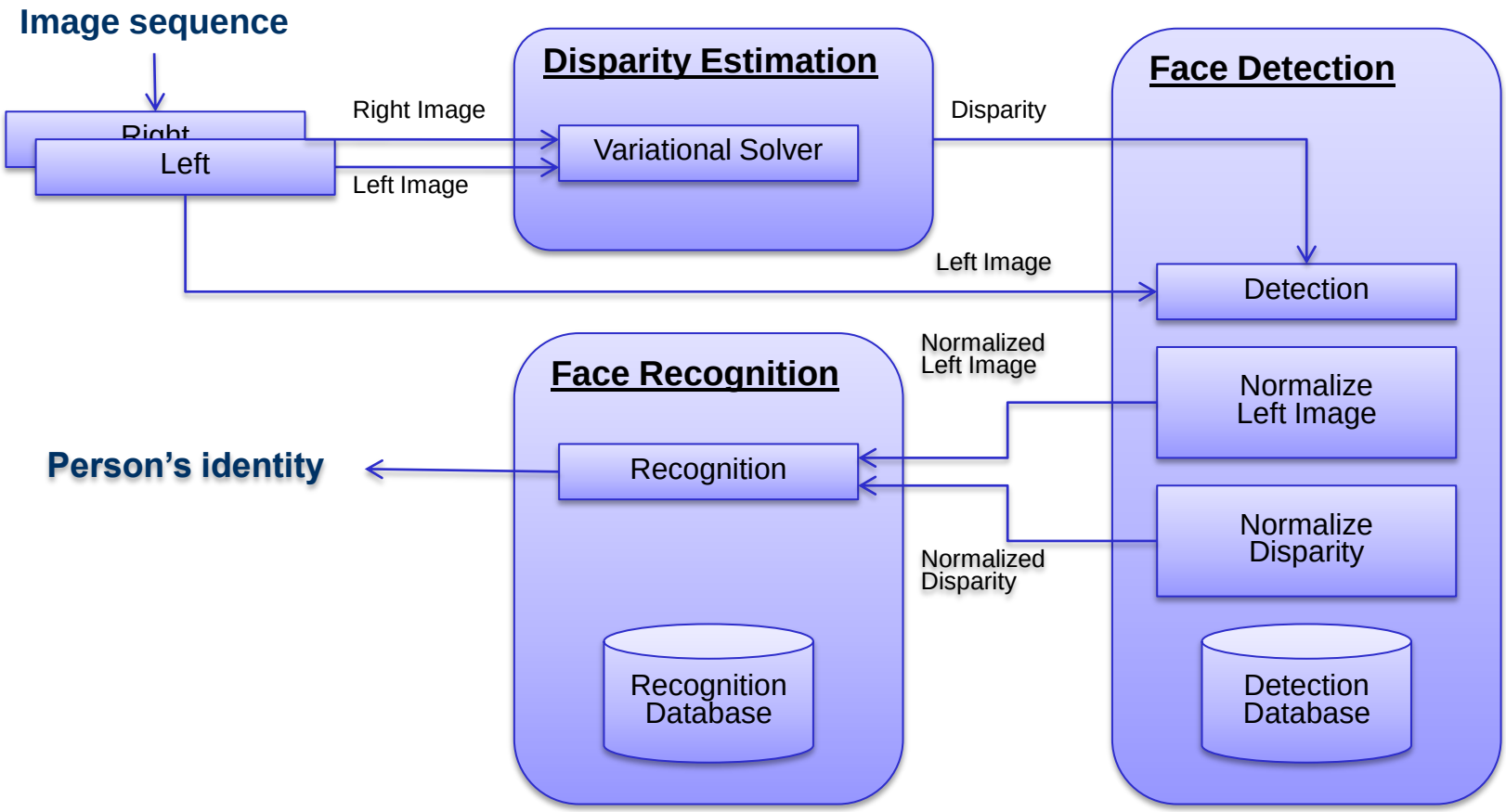
- Now:



[1] M. A. Turk, A. P. Pentland: *Face recognition using eigenfaces*. In Proc. IEEE CVPR 1991

[2] Alexander M. Bronstein, Michael M. Bronstein, and Ron Kimmel: *Three-dimensional face recognition*. Int. J. Comput. Vision, 2005

System structure



Disparity estimation

- Using the *real-time variational method [3]* for disparity reconstruction we get high-accuracy dense disparity maps.
  - Precise face surface reconstruction
  - Additional information for face detection and recognition
  - Robust under different illumination conditions

Left (base) image

Right image

Disparity map

[3] S. Kosov, T. Thormählen, H.-P. Seidel: *Accurate Real-Time Disparity Estimation with Variational Methods.* In Proc. ISVC 2009

Face Detection

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- **Face detection** – is a technology that determines the locations and sizes of human faces in arbitrary images.

Detecting false positives with the stereo enhanced classifier: (a) input image, (b) two detected faces of the monocular classifier (true positive and one false positive, (c) calculated optical flow, (d) the stereo-enhanced classifier dismisses the false positive [4].

[4] S. Kosov, K. Scherbaum, K. Faber, T. Thormählen, H.-P. Seidel: Rapid stereo-vision enhanced face detection. In Proc. IEEE ICIP 2009.

Face Detection

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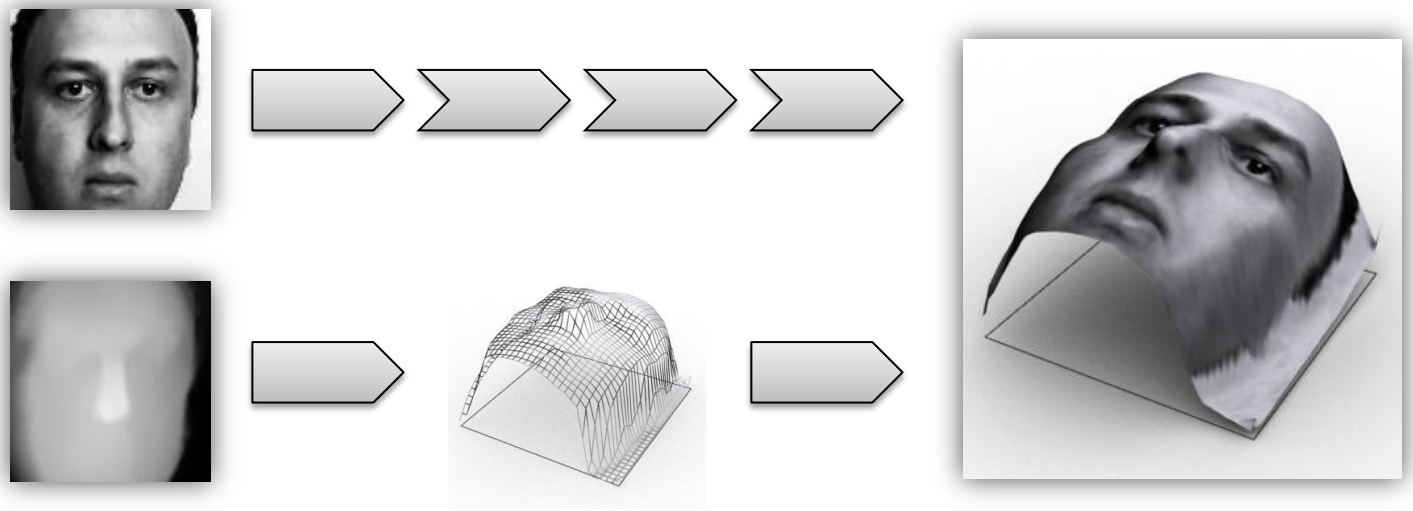
- **Face detection** – is a technology that determines the locations and sizes of human faces in arbitrary images.

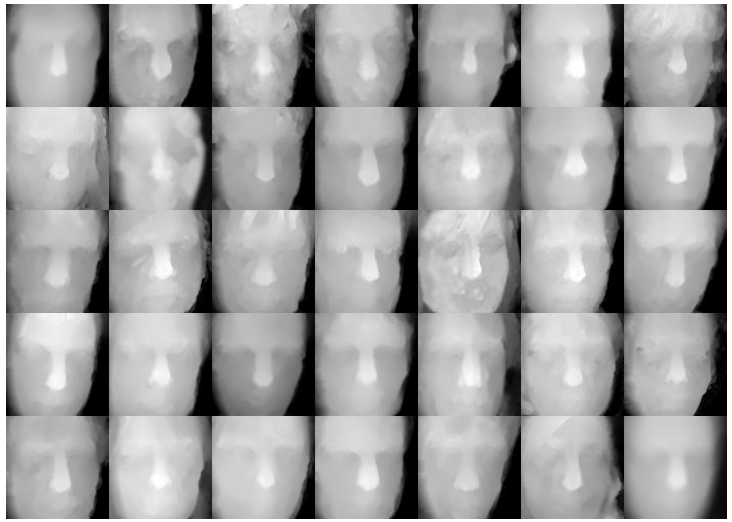


Converting the disparity map to the depth map and combining it with the base intensity image, we achieve the three-dimensional face model.

Training Database

- Training set of $K = 34$ normalized faces with corresponding normalized disparity maps.
- Each image has a resolution of N x N pixels. ($N = 100$)

Training database of intensity images



Training database of disparity maps

Principal Component Analysis

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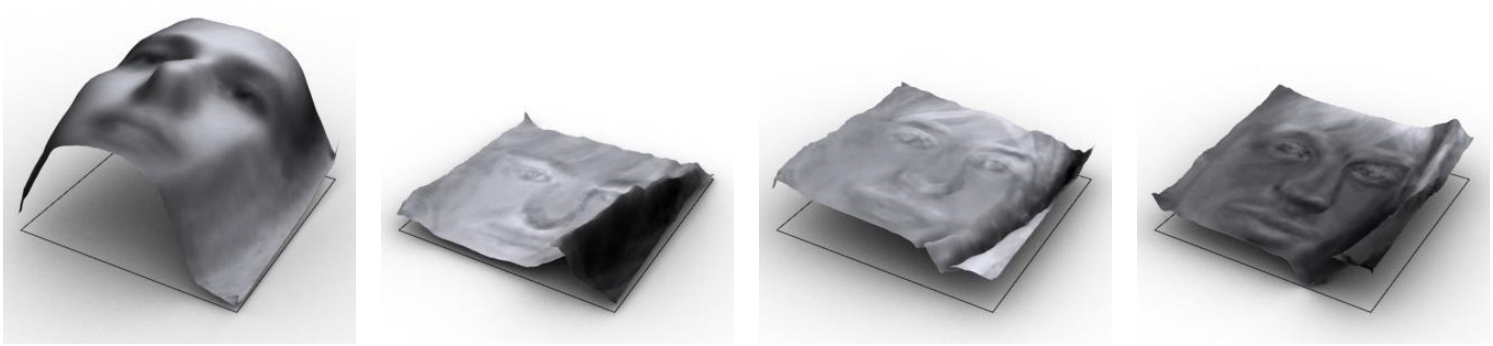
- Transforms a number of possibly correlated variables into a smaller number of uncorrelated variables – principal components
- Mathematically – orthogonal linear transformation to a new coordinate system
- Similarities are searched within the new coordinate system



Results of the PCA on the training dataset: The average face and the first three principal components.

Implementation Details

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- Face Detection-Recognition-Tracking (DRT) system
  - C++ GPL application for UNIX / Windows
  - Based on OpenCV library from Intel
- The application uses:
  - OpenCV haar cascades for detection
  - OpenCV optic flow for tracking
  - Variational dense optic flow for 3D reconstruction
  - OpenCV PCA for recognition
- Input data:
  - Image
  - Image sequence
  - Recorded video
  - Real-time webcam stream

Performance discussion

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- Speed performance:

Step	Mono [msec]	Stereo [msec]
Estimate disparity map	-	91
Face detection	86	152
Face recognition	1	2
Total	**87**	**245**

Timings for an Intel® Core™ 2 Quad CPU Q9550 with 2,83GHz

Performance discussion

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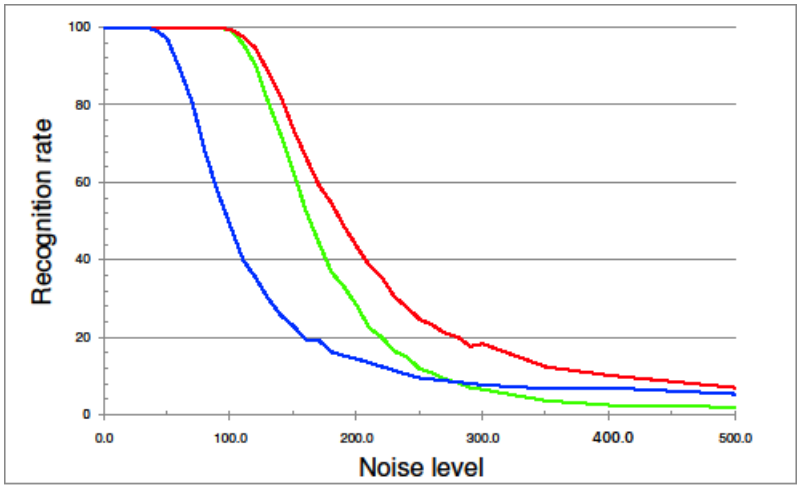
- Video

Performance discussion

- Accuracy:



- monocular recognition
- disparity – based method
- our stereo – enhanced method

Recognition rates (in percent) over noise level σ

- Average accuracy gain is 7,7%

The end

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- Thank you for your attention

Ready to answer your questions ☺