Towards Contactless Biometric Feature Verification for Mobile Border Control

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Scope & Challenges

- Security and mobility within the EU Border control is a major challenge for member states border control authorities
- Travelers request a minimum delay and a convenient, non-intrusive border crossing
- Border guards must fulfil their obligation to secure the EUs borders

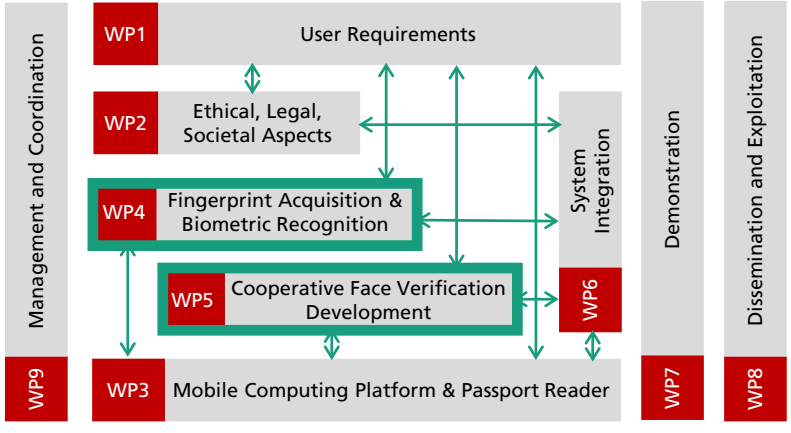

Objectives

- MobilePass development process addresses both requirements:
  - keep security at the highest level
  - increasing the speed and the comfort for all legitimate travellers at land border crossing points.
  - Key aspects:
    - **reliable and convenient capture of biometrics**
    - **modular mobile equipment optimized to border control workflow.**
    - **Improved traveler identification technologies, such as contactless fingerprint capture and advanced mobile facial capture**

Objectives

Objectives:

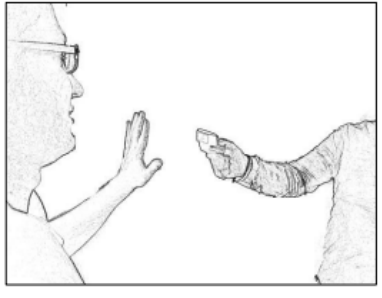
- Investigation and evaluation of algorithms for touch-less fingerprint image capturing
- Investigation and evaluation of algorithms for face detection, recognition or verification
- Both, using mobile sensor systems!

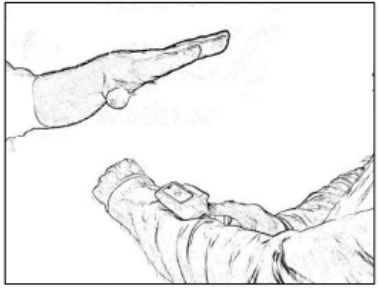


TOWARDS TOUCHLESS FINGERPRINT VERIFICATION

The Concept

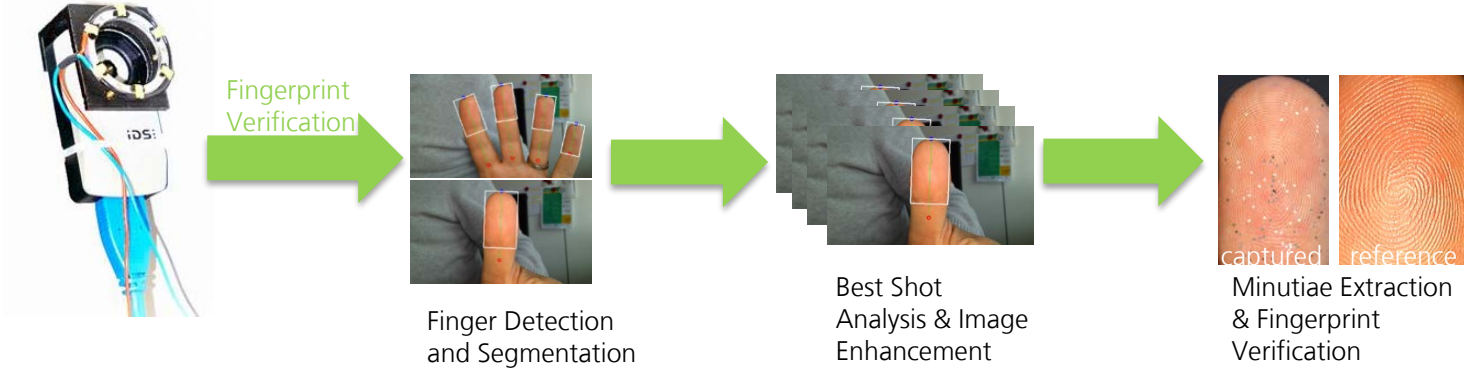
- Elaboration of concepts for fast and efficient fingerprint capturing
- Requirements by end-users
  - Environmental conditions
  - Active lighting
  - Distance to traveller
  - One-hand usage by officer
  - Etc.





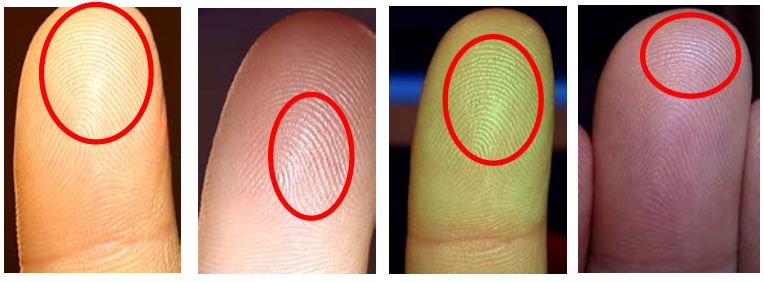
Process Chain for Fingerprint Verification

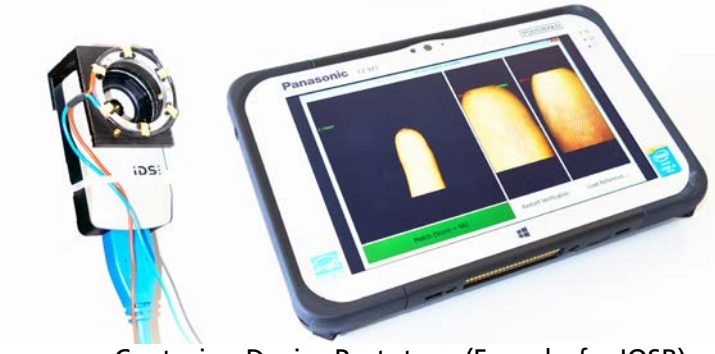
- Touch-less fingerprint acquisition
- Optimized pre-processing of touch-less images
- Interoperable feature extraction and comparison
- Evaluation of the fingerprint recognition subsystem



Extraction of Fingerprint Features

- For best contrast, we found out, that a slight „overexposure“ of fingerprint lines is best for feature extraction
  - Bright field illumination setup!
  - Issue: LEDs have to illuminate the whole area of the finger

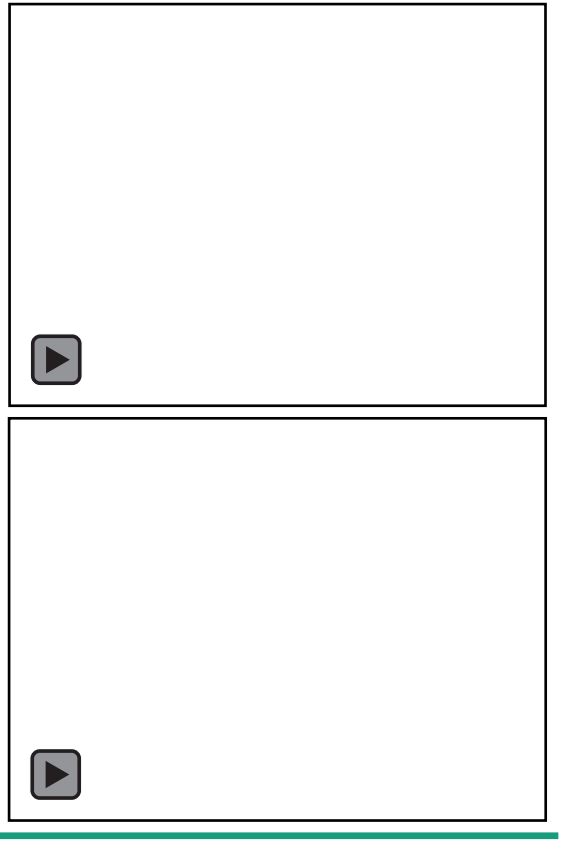




Capturing Device Prototype (Fraunhofer IOSB)

4-Finger Capturing vs. 1-by-1 Capturing

- Conceptual Key Question!
- Work done:
  - Evaluation of algorithms for detection & segmentation of palms and fingers in videos
  - Implementation of several approaches (e.g. ACF hand detector, ACF finger detector, expansion of palm contour to angles, finger extraction by edge pairing of line segments).



4-Finger Capturing vs. 1-by-1 Capturing

- Few approaches turn out to be applicable for robust hand & finger detection
- However, processing with high frame rate seems to be crucial for usability

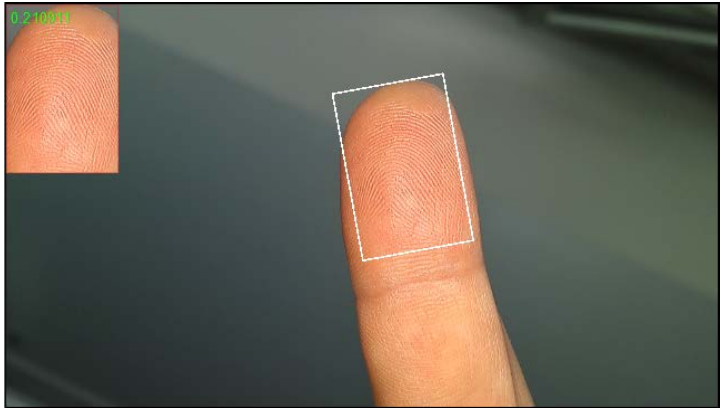
➔ HD-mode needed…

- In HD-Mode limitations are given by sensor field of view & resolution

➔ In Summary: Focus of further R&D activities on 1-by-1 finger capturing

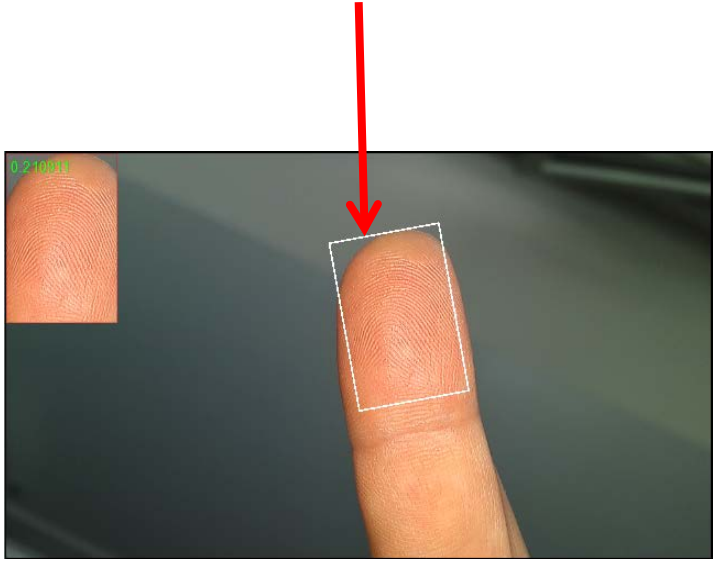
1-by-1 Capturing Concept

- Process Chain:
  1. Pointing camera center (roughly) on a single finger



1-by-1 Capturing Concept

- Process Chain:
  1. Pointing camera center (roughly) on a single finger
  2. Finger Capturing
     1. Automated detection of visible finger in ROI
        (to avoid manual exact pointing / stabilization)



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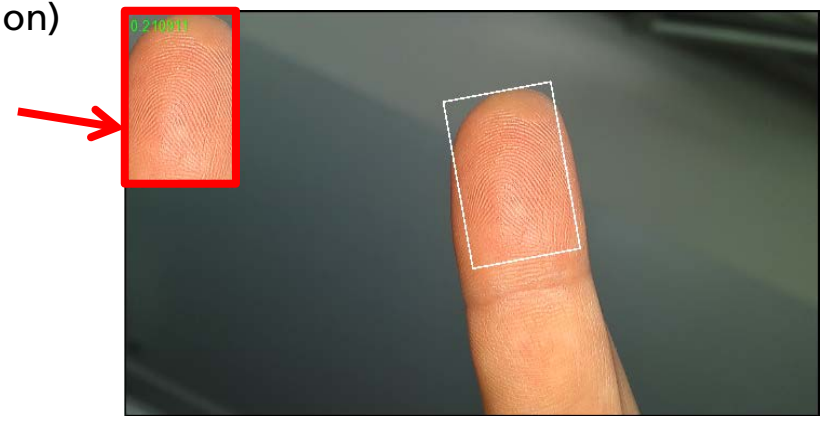
        (detection of fingertip)



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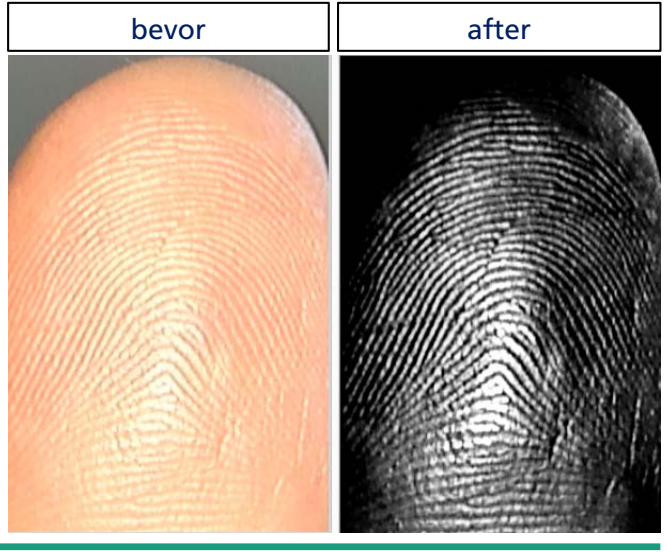
     3. Image enhancement
        (Normalization & contrast enhancement)



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     4. Fingerprint Quality Assessment
        (Sharpness-Measurement & NFIQ)

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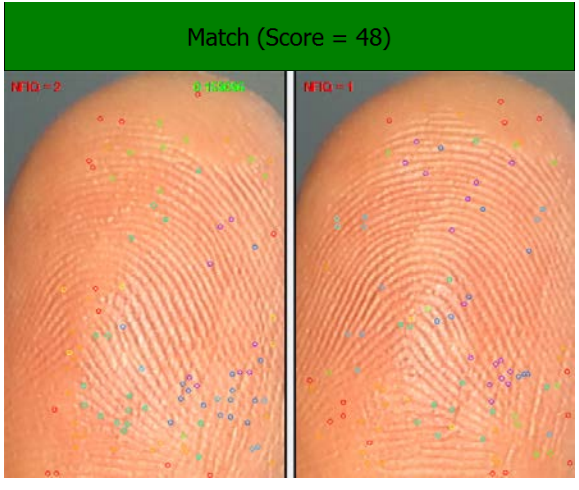
  3. Minutia Extraction and Matching (NBIS-Library)



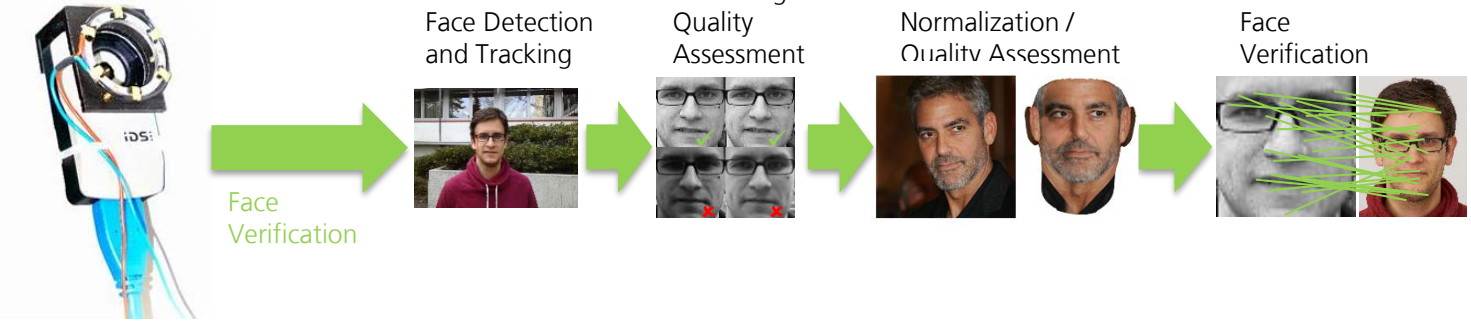
DEMO

TOWARDS FACE VERIFICATION WITH MOBILE SYSTEMS

MobilePass
Fraunhofer IOSB
VIDEMO Intelligent Video Analysis
Universidad Carlos III de Madrid

Process Chain for Face Verification

- Reference Implementations and Evaluation Dataset
- Illumination Compensation and Face Image Enhancement/Reconstruction
- Advanced Embedded Face Verification Algorithms
- Evaluation of Face Verification Algorithms



Face Image Quality Assessment

- Face image quality
  - Image-specific qualities
    - Sharpness, contrast, artifacts, etc.
  - Face-specific qualities
    - Pose, expression, shadow, etc.
- Target
  - Select best face images for verification

Face Image Quality Assessment

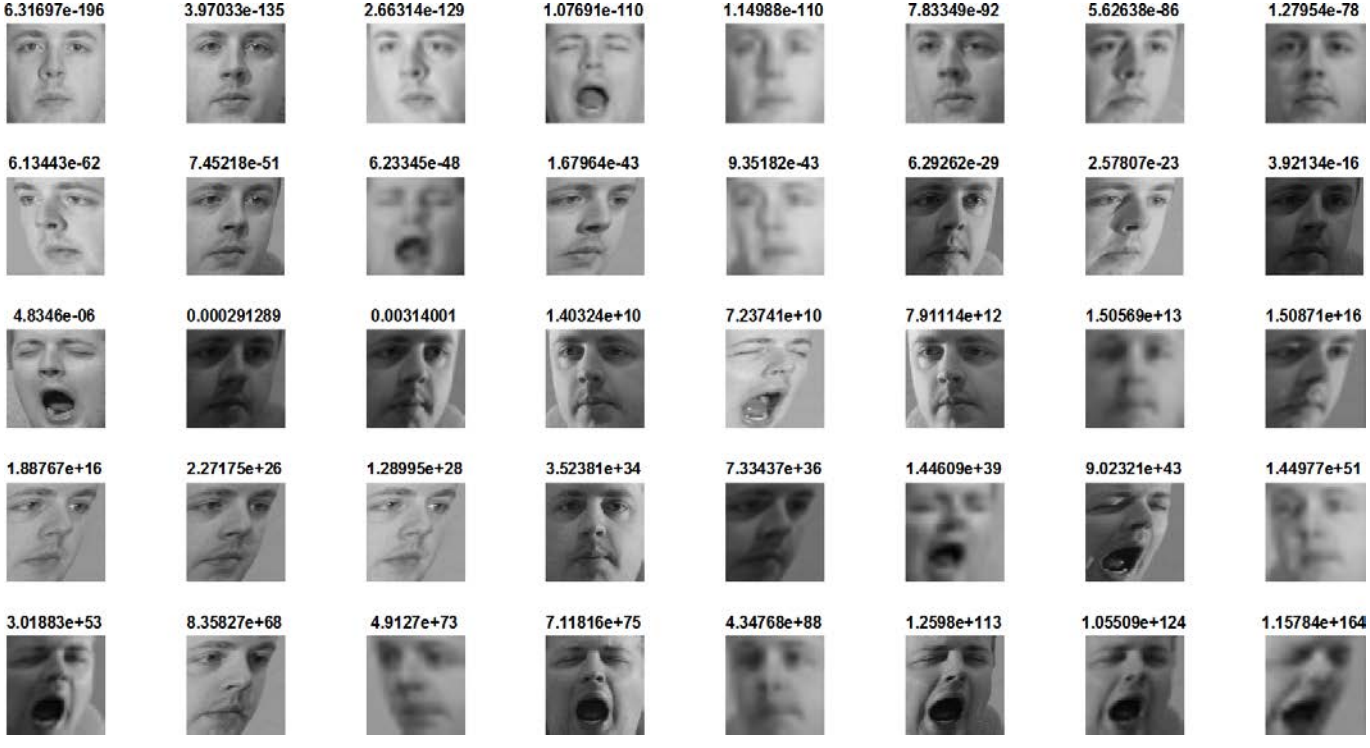
- A probabilistic framework
  - Similarity of the face image w.r.t. the probabilistic face model
  - Single score for all nuisance factors
  - No fusion of multiple assessments needed
  - Efficient

Y. Wong et al., Patch-based probabilistic image quality assessment for face selection and improved video-based face recognition, CVPRW'14

Face Image Quality Assessment

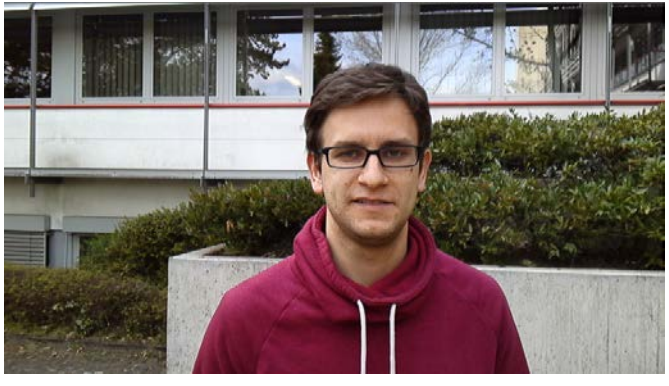
- Training images from Multi-PIE with
  - Frontal pose
  - Frontal illumination
  - Neutral expression
- Test sequence with variations in
  - Pose
  - Illumination
  - Expression
  - Blurring

Face Image Quality Assessment



Capturing Concept

- Process Chain:
  1. Pointing camera center (roughly) towards traveller's face



Capturing Concept

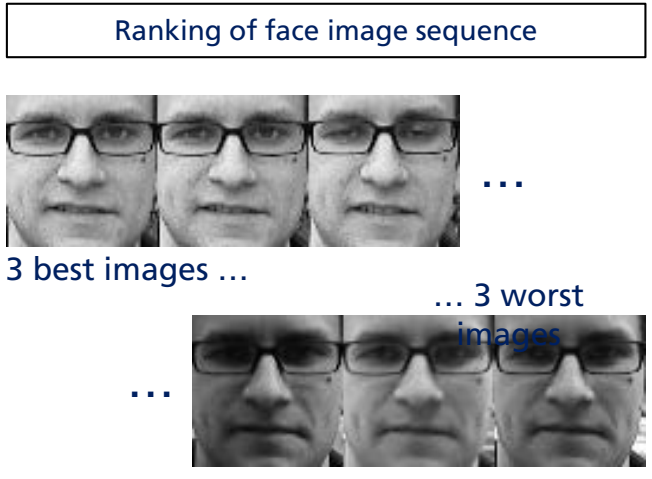
- Process Chain:
  1. Pointing camera center (roughly) towards traveller's face
  2. Face Capturing
     1. Automated detection of the face

Capturing Concept

- Process Chain:
  1. Pointing camera center (roughly) towards traveller's face
  2. Face Capturing
     1. Automated detection of the face
     2. Pose Estimation (pan, tilt, roll)

Capturing Concept

- Process Chain:
  1. Pointing camera center (roughly) towards traveller's face
  2. Face Capturing
     1. Automated detection of the face
     2. Pose Estimation (pan, tilt, roll)
     3. Face Image Quality Assessment



Capturing Concept

- Process Chain:
  1. Pointing camera center (roughly) towards traveller's face
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     1. Automated detection of the face
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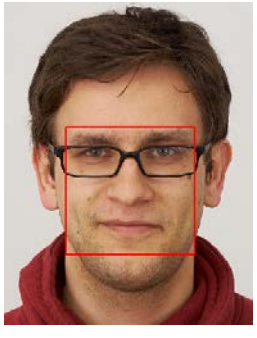
     3. Face Image Quality Assessment
  3. Face Feature Extraction and Matching (Videmo-Library)

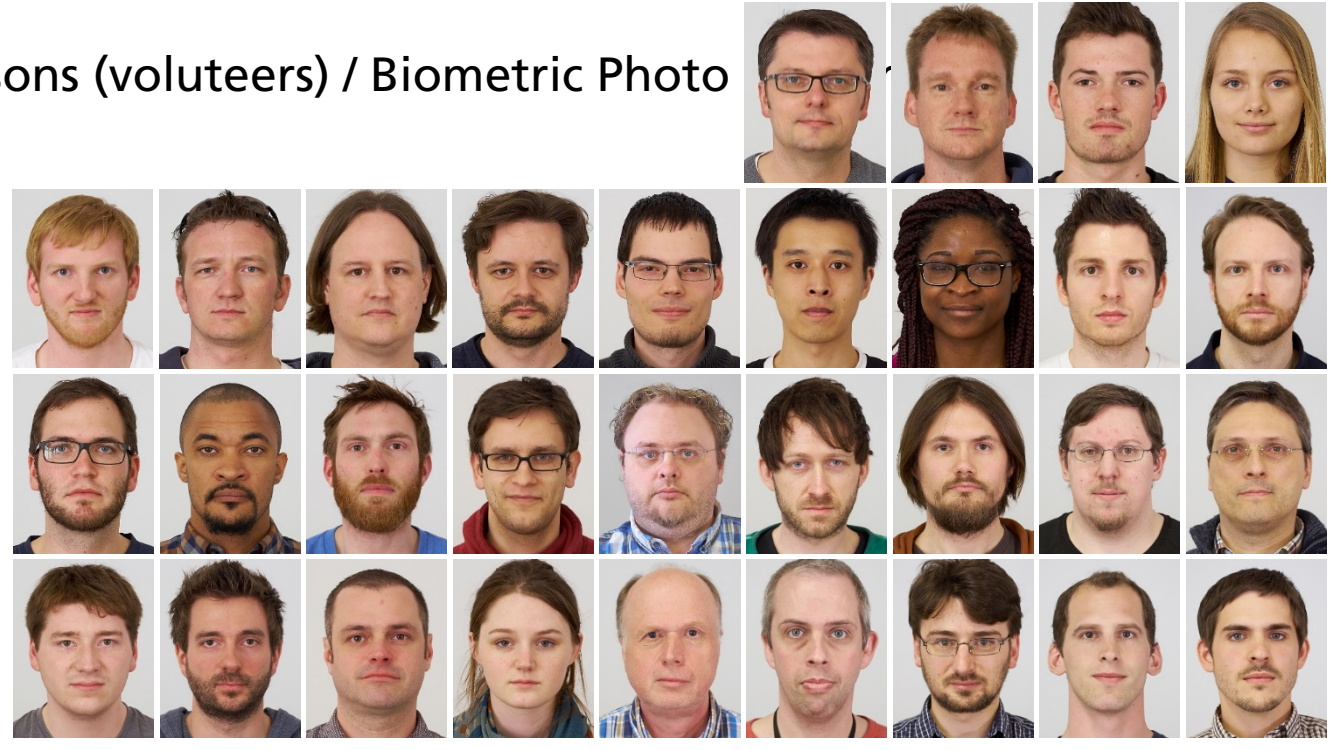
Query Image

Reference Image



MobilePass Face Dataset

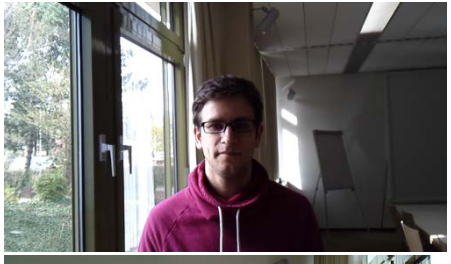
- 31 Persons (voluteers) / Biometric Photo



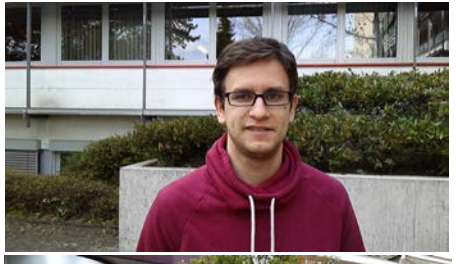
MobilePass Face Dataset

Reference Video
(homogenous background)

Indoor
(hard illumination conditions)



Outdoor
(hard illumination conditions / variing background)



Dataset Size

- Images and Videos from 31 volunteers
- Video recorded with IDS XC camera (sony MA130 integrated)
  - HD Resolution
  - Approx. 8-10fps
- >25.000 frames recorded, >60 GB (png format)

Next Steps…

- Evaluation of 3D face reconstruction and pose normalization algorithms (IOSB)
- Evaluation of Videmo Face Verification Library (Videmo)

DEMO

Scientific Dissemination / Planned Publications

- C. Qu, H. Gao, E. Monari, J. Beyerer and J.-P. Thiran, J.-P., “Towards Robust Cascaded Regression for Face Alignment in the Wild”, to appear in Proc. CVPRW, 2015
- C. Qu, C. Herrmann, E. Monari, T. Schuchert and J. Beyerer , “3D vs. 2D: On the Importance of Registration for Hallucinating Faces under Unconstrained Poses”, to appear in Proceedings of CRV, 2015
- C. Jonietz, C. Qu, H. Widak, E. Monari, „Towards Touchless Fingerprint Verification with Mobile Devices“, to appear in 1st International Workshop on Identication and Surveillance for Border Control (ISBC 2015), 2015
- C. Jonietz, C. Qu, H. Widak, E. Monari, “Towards Touchless Palm and Finger Detection for Fingerprint Extraction with Mobile Devices”, to appear in Proc. of BIOSIG, 2015

THANK YOU FOR YOUR ATTENTION!