

Status Update on ISO/IEC 29794-5 Biometric Sample Quality

19th eu-LISA BWG Meeting 2024-03-26

copy of slides available at:

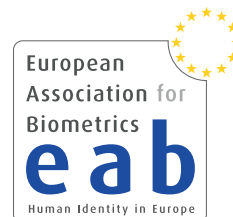
<https://christoph-busch.de/about-talks-slides.html>

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Agenda

- EES and Biometric Sample Quality
- Biometric standards developed in SC37
- ISO/IEC 29794-5
- Open source face image quality (OFIQ) toolkit

Face Image Quality in the EES

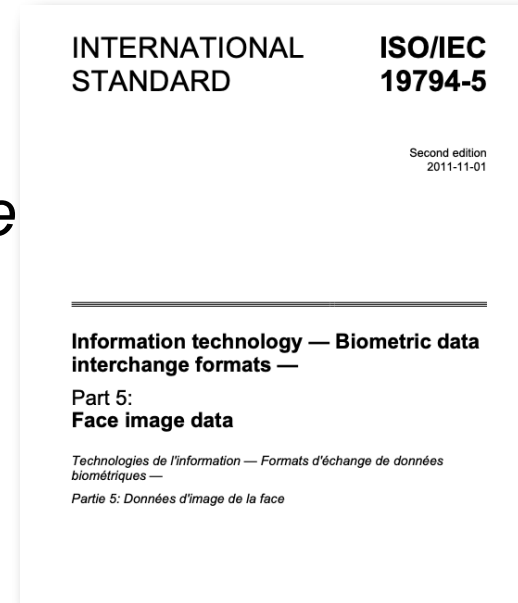
The objective in the EES implementing decision 2019/329

- „The quality of the facial images, ... and with the image requirements of ISO/IEC 19794-5:2011 Frontal image type

What does that mean?

Data subjects need **actionable feedback**

- If quality is poor, then what went wrong?



Compliant image



Pose



Eyes open



Mouth open



Inhomogenous background

Source: ISO/IEC 39794-5

Quality Measures for Facial Images

How to develop face quality measures? (1)

- Strong Interest of the Industry offering proprietary solutions with claimed performance
- Industry solution might well **predict recognition performance** for their **own** face recognition system
- Risk of **vendor lock-in**
- Rather allow **transparency** and exchangeability with a standardised approach

Quality Measures for Facial Images

How to develop face quality measures? (2)

- Strong confusion in the industry regarding what means „**ICAO compliance**“ ?
- In operational environment it is hard to achieve
 - ▶ why and when should we insist on ICAO compliance?
 - ▶ for machine based comparison and human comparison
- As for fingerprint (i.e. NFIQ2.2) - lets a **standardised methodology** decide
 - ▶ **what is** an **ICAO compliant** image
 - ▶ and what is NOT an ICAO compliant image

Quality Measures for Facial Images

How to develop face quality measures? - Roles

- 2021 - 2024



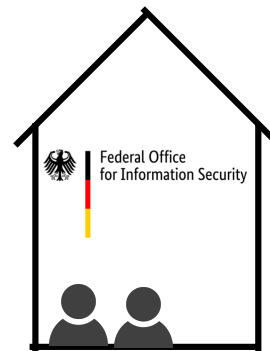
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Maintenance



Patrick Grother
Joyce Yang

Testing



Anna Stratmann
Marcel Ginzler

Development



Patrick Grother
Christoph Busch, Benjamin Tams, Johannes Merkle

Standardisation



Research Support



OFIQ Prototyping and
OFIQ Productisation

Quality Measures for Facial Images

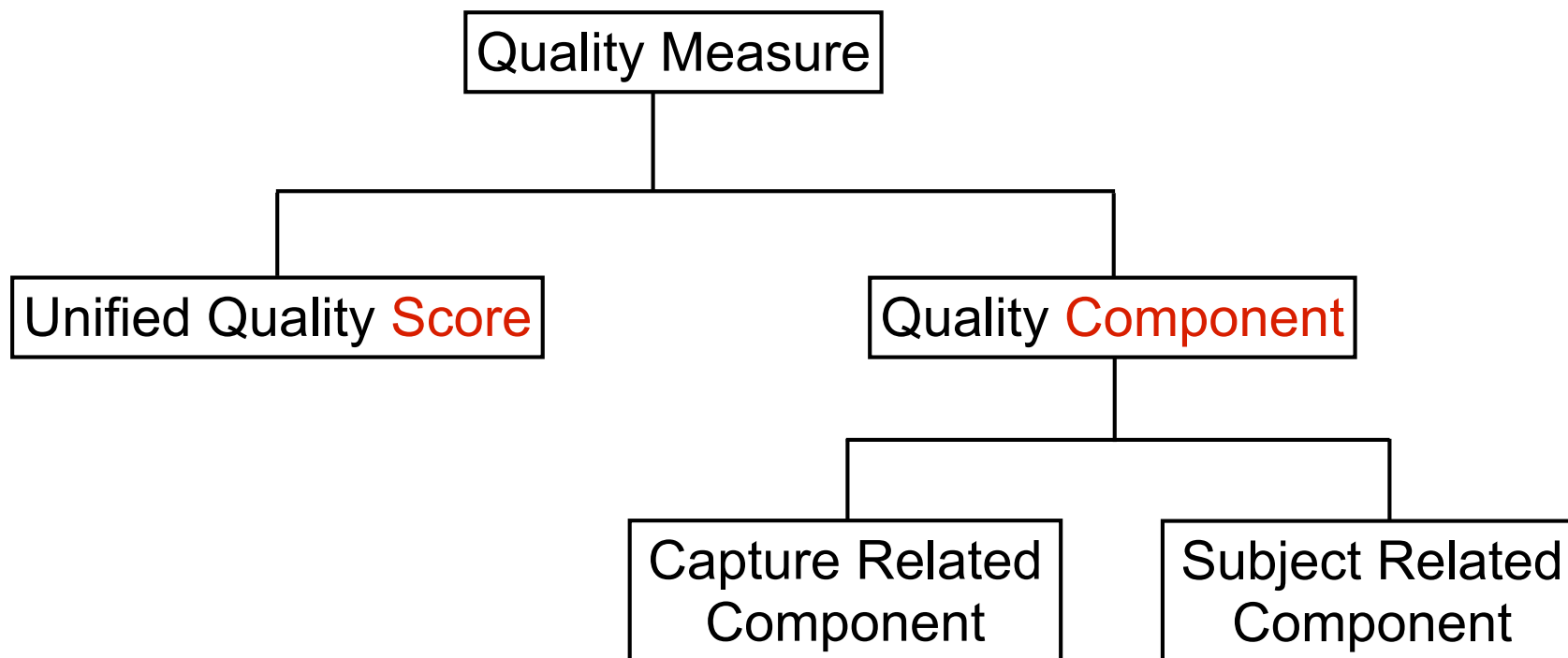
How to develop face quality measures? - Standardisation

- International Organization for Standardization, ISO/IEC 29794-5, Information technology - Biometric sample quality - Part 5: Face image data”, <https://www.iso.org/standard/81005.html>
- Draft International Standard (DIS) available as ISO/IEC JTC 1/Sc 37/WG 3 N 1511
- Providing measures for requirements from ISO/IEC 19794-5:2011 and ISO/IEC 39794-5:2019
 - ▶ Use-1: Reference image for MRTD
 - ▶ Use-2: Reference image for Live-Enrolment at EES Kiosk
 - ▶ Use-3: Probe images (e.g. ABC gate)

Quality Score Algorithms - Standards

Quality assessment algorithms

- according ISO/IEC 29794-1



ISO/IEC 29794-5: Face Image Quality

ISO/IEC 29794-5 will be **aligned** with both

- ISO/IEC 19794-5:2011
- ISO/IEC 39794-5:2019

Definitions

- 7.2 **Unified** quality **score**
- 7.3 **Capture-related** quality elements
- 7.4. **Subject-related** quality elements



a) Compliant image

b) Low contrast

source: ISO/IEC 39794-5:2019, Annex D
<https://www.iso.org/standard/72156.html>



images with +8 degrees (left) and -8 degrees (right) rotation in roll

Image Source: ISO/IEC 19794-5:2011

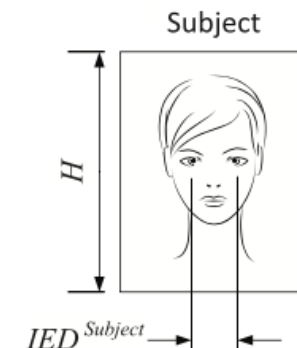


Image Source: ISO/IEC 39794-5

ISO/IEC 29794-5: Face Image Quality

ISO/IEC DIS 29794-5 quality measures in detail

#	Face image quality measure
1.	Quality score (unified)
2.	Background uniformity
3.	Illumination uniformity
4.	Luminance mean
5.	Luminance variance
6.	Under-exposure prevention
7.	Over-exposure prevention
8.	Dynamic range
9.	Sharpness
10.	No compression artifacts
11.	Natural colour
12.	Single face present
13.	Eyes open
14.	Mouth closed
15.	Eyes visible
16.	Mouth occlusion prevention
17.	Face occlusion prevention
18.	Inter-eye distance
19.	Head size
20.	Leftward crop of face in image
21.	Rightward crop of face in image
22.	Downward crop of face in image
23.	Upward crop of face in image
24.	Pose angle yaw frontal alignment
25.	Pose angle pitch frontal alignment
26.	Pose angle roll frontal alignment
27.	Expression neutrality
28.	No head covering
29.	Radial distortion
30.	Pixel aspect ratio
31.	Gaze
32.	Shoulder presentation
33.	Camera subject distance
34.	Motion blur prevention

Capture device related

Subject related

Open Source Face Image Quality (OFIQ)

Approach

- Library with quality assessment algorithms
- Open source with liberal license (MIT)
 - ▶ enables commercial use
- Support for major OS platforms (including mobile OS)
 - ▶ C/C++
- Aligned with ISO/IEC 29794-5
 - ▶ serves as reference implementation
 - ▶ providing target values for conformance tests
- Selection criteria for integrated algorithms
 - ▶ accuracy (OFIQ-evaluation or NIST FATE SIDD evaluation)
 - ▶ low computational complexity
 - ▶ liberal license (MIT or alike)

Quality Measures for Facial Images



How to find the best face quality measures?

- Testing



Patrick Grother
Mei Ngan
Joyce Yang

Category	ISO/IEC 29794-5 Quality Check	SIDD Quality Component
Capture device-related	6.3.2 Background uniformity	Background uniformity
	6.3.3 Illumination uniformity	-
	6.3.4 Moments of the luminance distribution	-
	6.3.5 Under-exposure	Under-exposure
	6.3.6 Over-exposure	Over-exposure
	6.3.7 Dynamic range	-
	6.3.8 De-focus	Resolution
	6.3.9 Motion blur	Motion blur
	6.3.10 Compression ratio	Compression artifacts
	6.3.11 Unnatural color	-
	6.3.12 Radial distortion	-
	6.3.13 Pixel aspect ratio	-
	6.3.14 Camera to subject distance	-
	Subject-related	6.4.2 Single face present
6.4.3 Eyes visible		Sunglasses + eyeglasses
6.4.4 Eyes open		Eyes open
6.4.5 Mouth occlusion		Face occlusion
6.4.6 Mouth closed		Mouth open
6.4.7 Nose occlusion		Face occlusion
6.4.8 Inter-eye distance		Spatial sampling rate
6.4.9 Horizontal position of the face		Face cropping and margin
6.4.10 Vertical position of the face		Face cropping and margin
6.4.11 Pose		Pose
6.4.12 Shoulder presentation		-
6.4.13 Expression neutrality		-



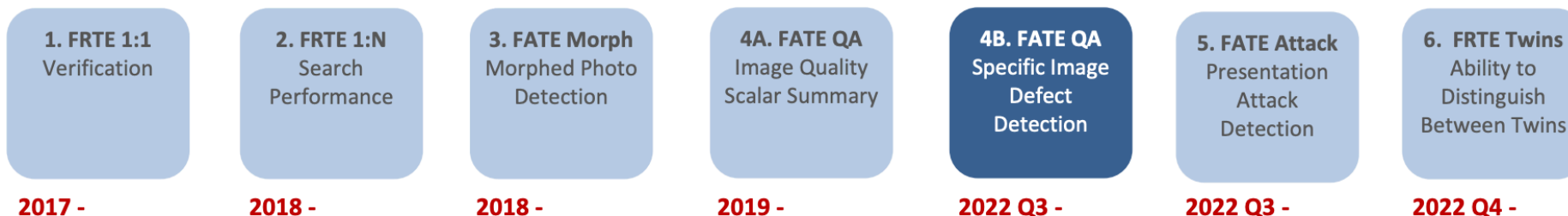
Patrick Grother
Benjamin Tams
Johannes Merkle
Christoph Busch

- FATE Quality - Unified Quality Score

https://pages.nist.gov/frvt/html/frvt_quality.html

- FATE Quality - Specific Image Defect Detection (SIDD)

https://pages.nist.gov/frvt/reports/quality_sidd/frvt_quality_sidd_report.pdf



Open Source Face Image Quality (OFIQ)

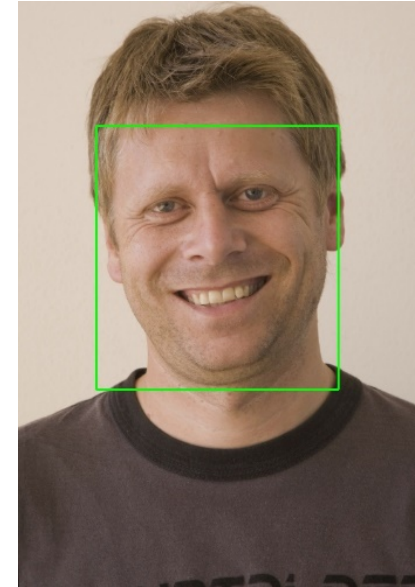
Algorithms for pre-processing

- Face Detection
- Face Landmark Estimation
- Alignment
- Face Occlusion Segmentation
- Face Parsing

Open Source Face Image Quality (OFIQ)

Face Detection

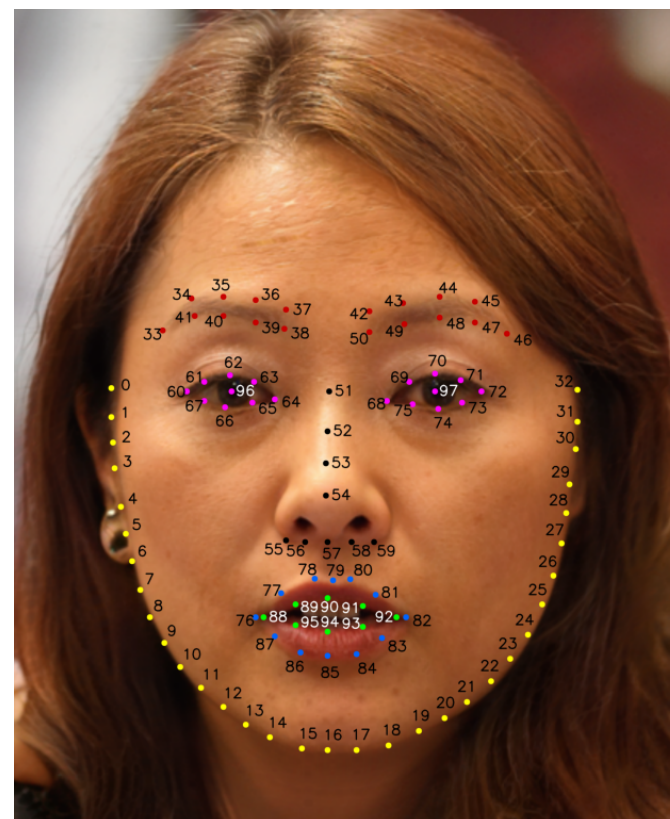
- Bounding box of all detected faces
- SSD face detection CNN
<https://github.com/sr6033/face-detection-with-OpenCV-and-DNN>
- Largest face is assessed further



Open Source Face Image Quality (OFIQ)

Face Landmark Estimation

- Localization of key points of facial traits
- CNN from repository ADNet
<https://github.com/huangyangyu/ADNet>
 - ▶ 98 Landmarks
- Most time consuming algorithm



Open Source Face Image Quality (OFIQ)

Alignment

- Unified positioning of face within image
 - ▶ Eyes on same height
- Based on landmarks of eyes, nose & mouth



Open Source Face Image Quality (OFIQ)

Face Occlusion Segmentation

- Identify un-occluded region of face (incl. forehead)
- Occlusions:
 - ▶ Hair (not facial hair)
 - ▶ Objects (e.g. face masks, sunglasses)
 - ▶ Body parts (hand, tongue) except face
 - ▶ Frames of and reflections on eyeglasses
- CNN from repository FaceExtraction

<https://github.com/face3d0725/FaceExtraction>



Open Source Face Image Quality (OFIQ)

Face Parsing

- Identify different parts of subject in image
 - ▶ Face parts (eyes, eye brows, nose, lips, skin)
 - ▶ Neck, ears, hair
 - ▶ Glasses, clothes, hats, earrings, necklaces
 - ▶ Background
- CNN from repository `face-parsing.PyTorch`

<https://github.com/VisionSystemsInc/face-parsing.PyTorch>



OFIQ - Unified Quality Score

General, holistic quality score

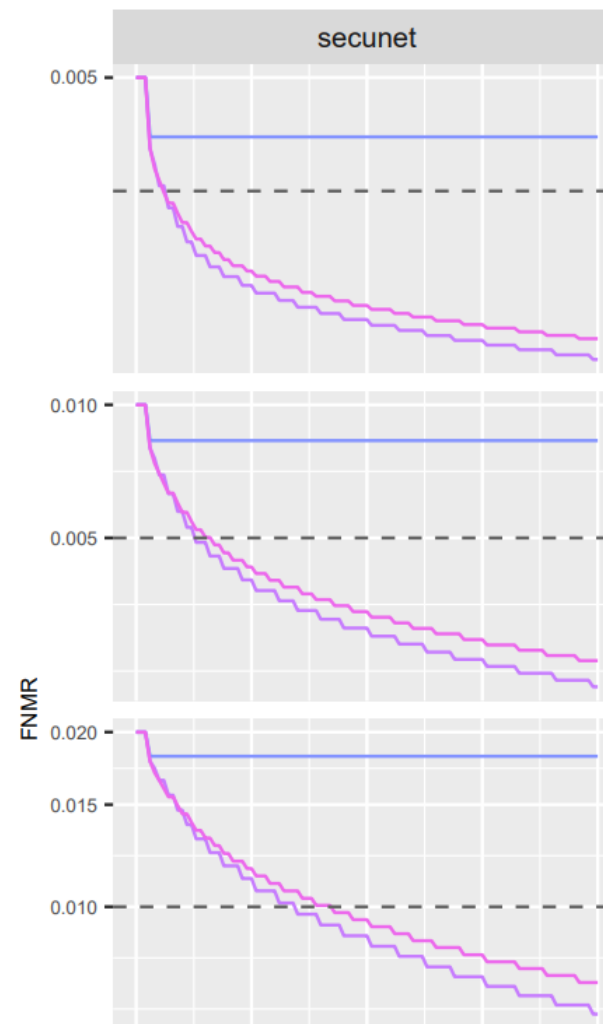
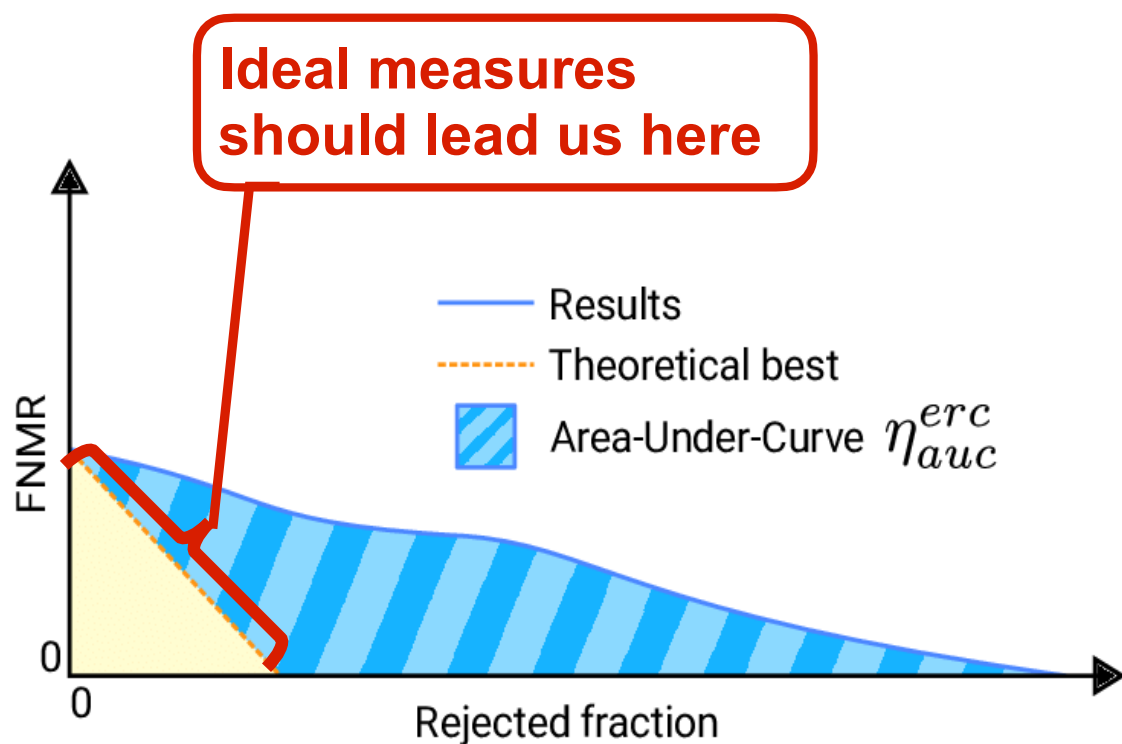
- Not limited to certain quality criteria / defects
- CNN MagFace (iResNet 50 model)
- Shows good prediction of face recognition scores



OFIQ - Unified Quality Score

Excellent results in FATE SIDD (1st of 16)

- Very good prediction of low face recognition scores
- Best performing algorithm



OFIQ - Quality Components

Sharpness

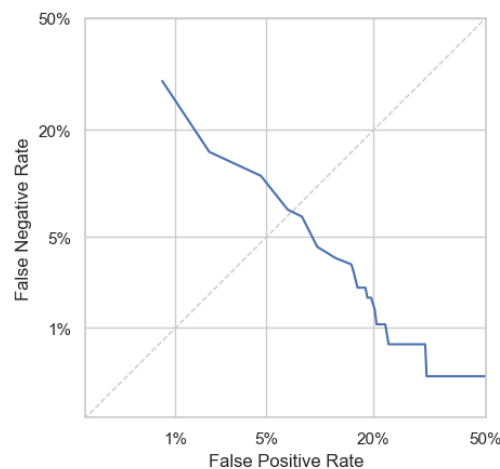
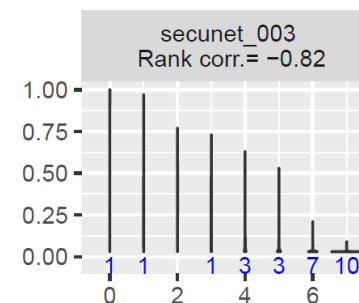
- Random Forest classifier
- Several features:
 - ▶ Sobel-Filter
 - ▶ Laplace filter
 - ▶ Difference of image from mean-filtered image
- Trained on synthetic and real blur
- Restricted to landmarked region



OFIQ - Quality Components

Sharpness

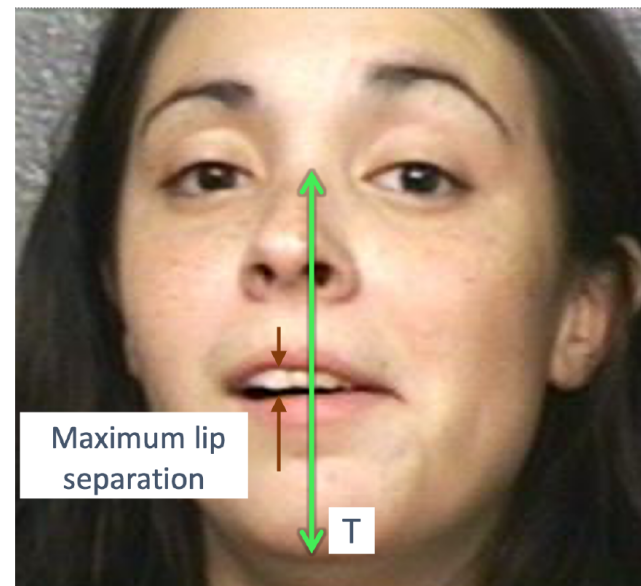
- Very good results in FATE Quality (3rd of 18)
 - ▶ Only synthetic blur
- Internal evaluation on FRGCv2 (real blur)
 - ▶ Accuracy high but not very high
 - ▶ Challenging



OFIQ - Quality Components

Eyes Open and Mouth Closed

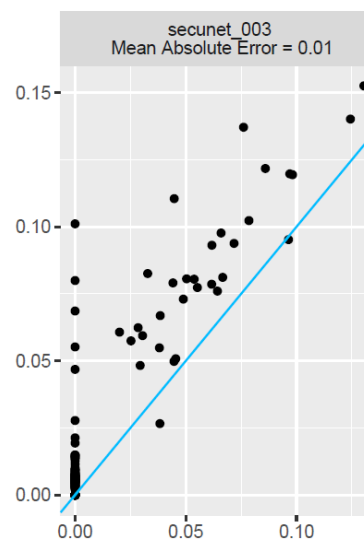
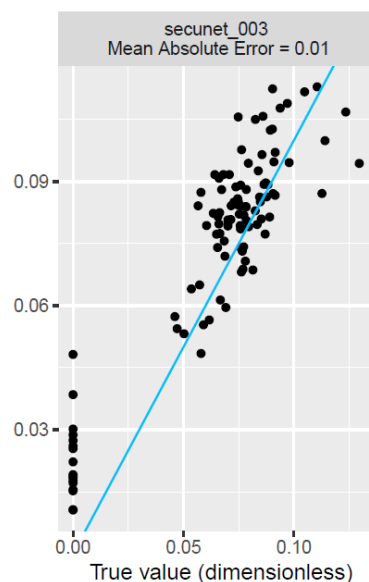
- Algorithms based on landmarks
- Maximum distance between lids / lips
- Normalized by distance T between eye's midpoint and chin



OFIQ - Quality Components

Eyes Open and Mouth Closed

- Excellent results in FATE Quality
- 1st of 6 and 1st of 5
- No ethnic bias found for Eyes Open



Outlook for OFIQ

Perspective

- OFIQ will become the **reference implementation** of ISO/IEC 29794-5:2024
- OFIQ 2.0 project will start later this year

Take home information

- OFIQ open source code:
<https://github.com/BSI-OFIQ/OFIQ-Project>
- NIST test report:
https://pages.nist.gov/frvt/reports/quality_sidd/frvt_quality_sidd_report.pdf

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