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

16th eu-LISA BWG Meeting 2023-06-09

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European Association for Biometrics

ATHENE

European Association for Biometrics eab Human Identity in Europe

NTNU

Agenda

- EES and Biometric Sample Quality
- NFIQ2 development
- Biometric standards developed in SC37
- Open source OFIQ for face samples
- Recommendations to join the efforts

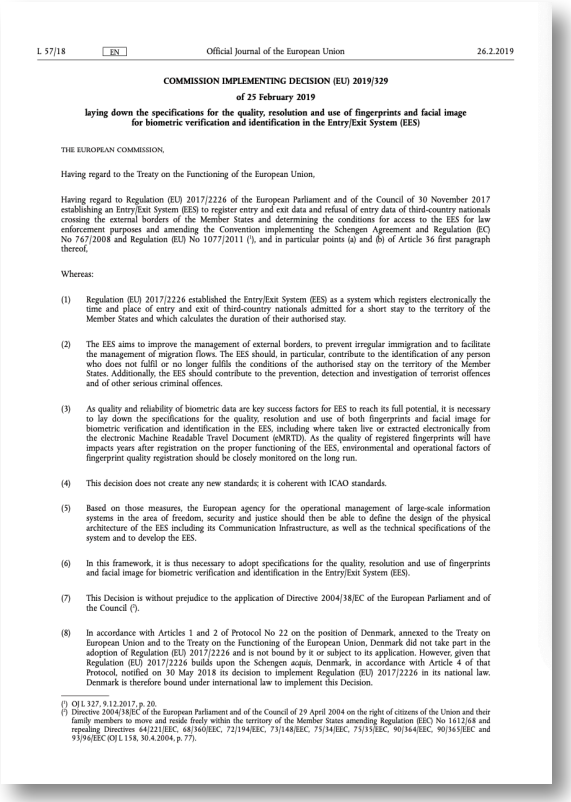
EES and Biometric Sample Quality
NFIQ2.0 Development

Quality Metrics for Fingerprint Images

NFIQ2.0

- The Entry Exit System implementing decision 2019/329 defines the mandatory use:

- „*At the moment of enrolment, the version 2.0 (or newer version) of the Fingerprint Image Quality (NFIQ) metric …. shall be used for verifying that the quality of the captured fingerprint data respects the thresholds …*“



L 57/18 EN Official Journal of the European Union 26.2.2019

COMMISSION IMPLEMENTING DECISION (EU) 2019/329

of 25 February 2019

laying down the specifications for the quality, resolution and use of fingerprints and facial image for biometric verification and identification in the Entry/Exit System (EES)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Regulation (EU) 2017/2226 of the European Parliament and of the Council of 30 November 2017 establishing an Entry/Exit System (EES) to register entry and exit data and refusal of entry data of third-country nationals crossing the external borders of the Member States and determining the conditions for access to the EES for law enforcement purposes and amending the Convention implementing the Schengen Agreement and Regulation (EC) No 767/2008 and Regulation (EU) No 1077/2011 [1], and in particular points (a) and (b) of Article 36 first paragraph thereof,

Whereas:

(1) Regulation (EU) 2017/2226 established the Entry/Exit System (EES) as a system which registers electronically the time and place of entry and exit of third-country nationals admitted for a short stay to the territory of the Member States and which calculates the duration of their authorised stay.

(2) The EES aims to improve the management of external borders, to prevent irregular immigration and to facilitate the management of migration flows. The EES should, in particular, contribute to the identification of any person who does not fulfil or no longer fulfils the conditions of the authorised stay on the territory of the Member States. Additionally, the EES should contribute to the prevention, detection and investigation of terrorist offences and of other serious criminal offences.

(3) As quality and reliability of biometric data are key success factors for EES to reach its full potential, it is necessary to lay down the specifications for the quality, resolution and use of both fingerprints and facial image for biometric verification and identification in the EES, including where taken live or extracted electronically from the electronic Machine Readable Travel Document (eMRTD). As the quality of registered fingerprints will have impacts years after registration on the proper functioning of the EES, environmental and operational factors of fingerprint quality registration should be closely monitored on the long run.

(4) This decision does not create any new standards; it is coherent with ICAO standards.

(5) Based on those measures, the European agency for the operational management of large-scale information systems in the area of freedom, security and justice should then be able to define the design of the physical architecture of the EES including its Communication Infrastructure, as well as the technical specifications of the system and to develop the EES.

(6) In this framework, it is thus necessary to adopt specifications for the quality, resolution and use of fingerprints and facial image for biometric verification and identification in the Entry/Exit System (EES).

(7) This Decision is without prejudice to the application of Directive 2004/38/EC of the European Parliament and of the Council [2].

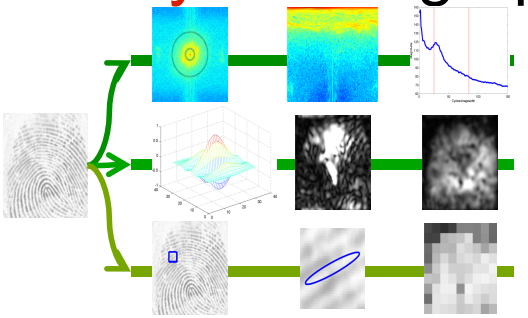
(8) In accordance with Articles 1 and 2 of Protocol No 22 on the position of Denmark, annexed to the Treaty on European Union and to the Treaty on the Functioning of the European Union, Denmark did not take part in the adoption of Regulation (EU) 2017/2226 and is not bound by it or subject to its application. However, given that Regulation (EU) 2017/2226 builds upon the Schengen *acquis*, Denmark, in accordance with Article 4 of that Protocol, notified on 30 May 2018 its decision to implement Regulation (EU) 2017/2226 in its national law. Denmark is therefore bound under international law to implement this Decision.

[1] OJ L 327, 9.12.2017, p. 20.
[2] Directive 2004/38/EC of the European Parliament and of the Council of 29 April 2004 on the right of citizens of the Union and their family members to move and reside freely within the territory of the Member States amending Regulation (EEC) No 1612/68 and repealing Directives 64/221/EEC, 68/360/EEC, 72/194/EEC, 73/148/EEC, 75/34/EEC, 75/35/EEC, 90/364/EEC, 90/365/EEC and 93/96/EEC (OJ L 158, 30.4.2004, p. 77).

Quality Metrics for Fingerprint Images

The NFIQ2.0 approach

- Measure quality by filtering the signal and determine the utility of a fingerprint sample.



- Providing constructive feedback only possible if cause of poor quality is known.

- NFIQ2.0 constitutes the content of ISO/IEC 29794-4

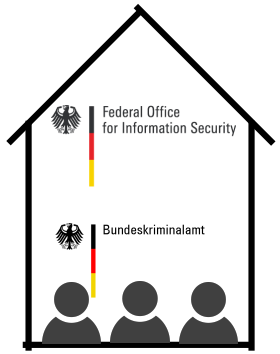
http://www.christoph-busch.de/projects-nfiq2.html

Quality Metrics for Fingerprint Images

How was NFIQ2.0 developed?

- 2010 - 2021

Patrick Grother
Elham Tabassi



Oliver Bausinger
Christopher Schiel

Christoph Busch
Martin Olsen
Ralph Lessmann

Martin Olsen,
Olaf Henniger,
Christoph Busch

Johannes Merkle, Michael Schwaiger

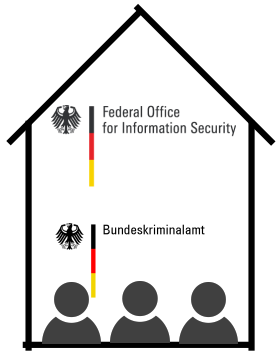
Quality Metrics for Fingerprint Images

How was NFIQ2.0 developed?

- 2010 - 2021

Greg Fiumara

Elham Tabassi
Greg Fiumara



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Martin Olsen
Ralph Lessmann


INTERNATIONAL STANDARD **ISO/IEC 29794-4**

First edition
2017-09

Information technology — Biometric sample quality —
Part 4:
Finger image data

Technologies de l'information — Qualité d'échantillon biométrique — Partie 4: Données d'image de doigt

ISO IEC

Reference number
ISO/IEC 29794-4:2017(E)

© ISO/IEC 2017

Quality Metrics for Fingerprint Images

How was NFIQ2.0 developed?

- 2010 - 2021

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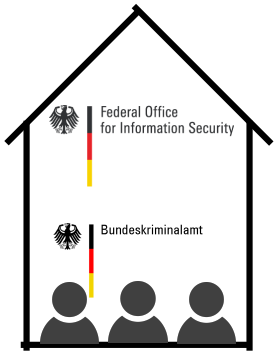
Elham Tabassi
Greg Fiumara



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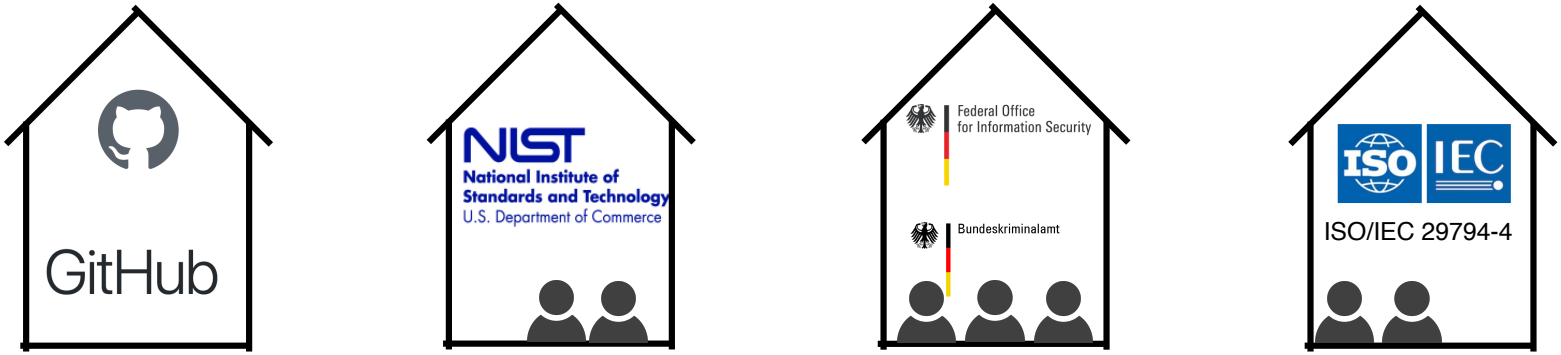
Ralph Lessmann

- NFIQ2.2 in 2023
  - Verified quality feature stability over >2 million fingerprints
  - Adopted to latest OpenCV
  - Pre-compiled binaries for various OS
- Continuation of the maintenance can be expected

Quality Metrics for Fingerprint Images

How was NFIQ2.0 developed?

- 2010 - 2021



Maintenance | Testing | Development | Standardisation

- Status 2023
  - NFIQ2.2 in GitHub: https://github.com/usnistgov/NFIQ2
  - ISO/IEC 29794-4: https://www.iso.org/standard/62791.html

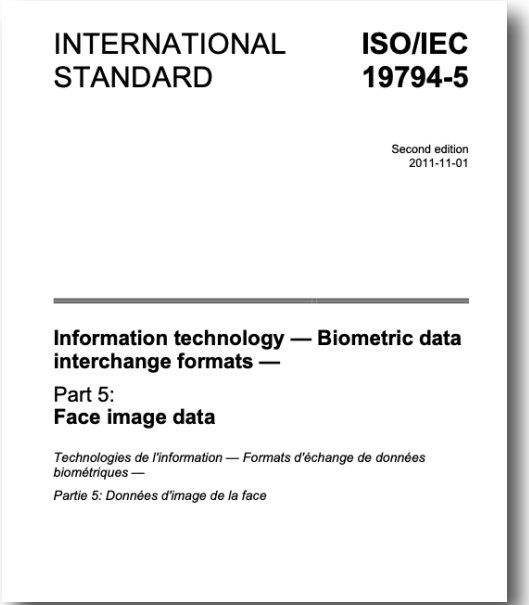
EES and Biometric Sample Quality
Face Image Data

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?


INTERNATIONAL STANDARD

ISO/IEC 19794-5

Second edition
2011-11-01

Information technology — Biometric data interchange formats —

Part 5:
Face image data

Technologies de l'information — Formats d'échange de données biométriques —

Partie 5: Données d'image de la face

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: Let 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? - Standardisation

- 2021 - 2024

Patrick Grother
Joyce Yang

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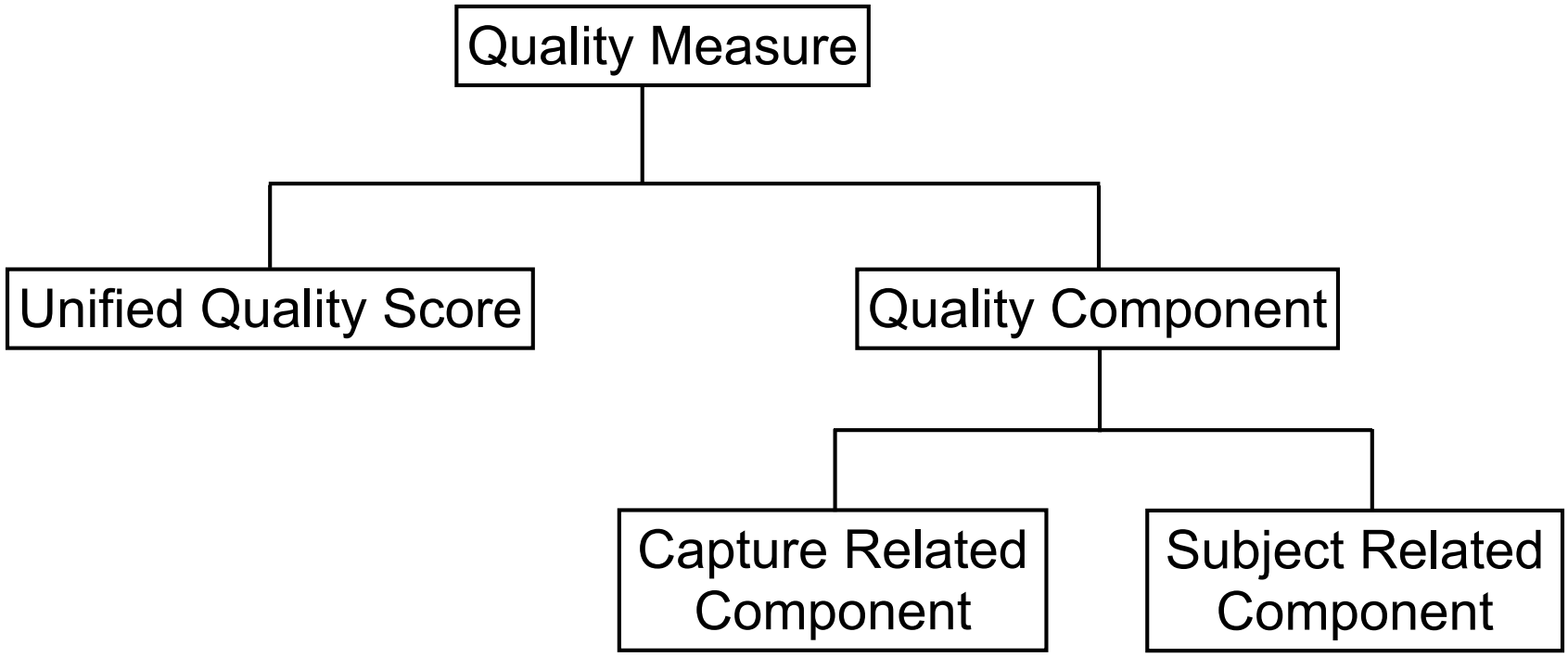
Christoph Busch, Benjamin Tams, Johannes Merkle

- 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
- Committee Draft (CD) available at:
  https://www.iso.org/home.isoDocumentsDownload.do?t=6SGyH5oqfHN_g4rhcubyOKS8k92pBa-zlVRiyvuIg3XNLdCFVp-GrxGiR-E4OCME&CSRFTOKEN=3V4D-MXKO-U9KD-1ONV-NVMX-BET5-SYKF-686T

Quality Score Algorithms - Standards

Quality assessment algorithms

- according ISO/IEC 29794-1



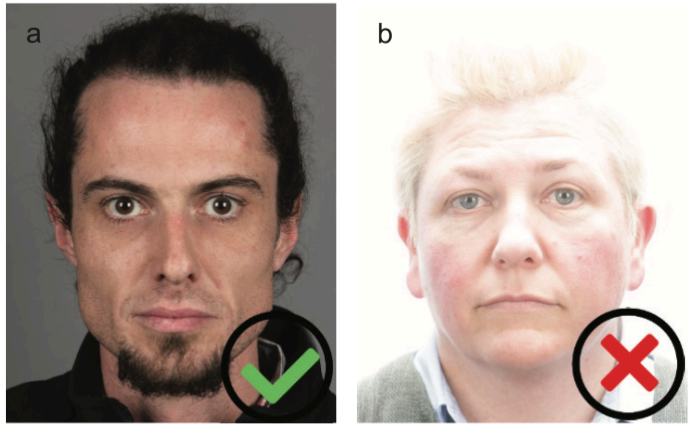
Quality-Related Standards

ISO/IEC 29794-5 will be aligned with both

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

Definitions

- 6.2 Unified quality score



a) Compliant image **b) Low contrast**

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

- 6.3 Capture-related quality elements
- 6.4. Subject-related quality elements

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

Image Source: ISO/IEC 19794-5:2011

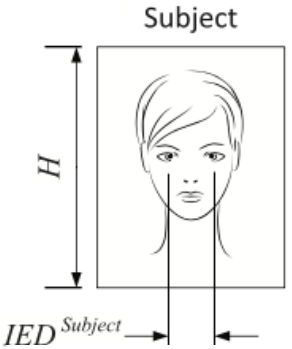


Image Source: ISO/IEC 39794-5

ISO/IEC IS 29794-5: Face Image Quality

ISO/IEC CD1 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.	Skewed illumination prevention
7.	Kurtotic illumination prevention
8.	Under-exposure prevention
9.	Over-exposure prevention
10.	Dynamic range
11.	Focus
12.	Motion blur prevention
13.	Sharpness
14.	Compression ratio
15.	Natural colour
16.	Single face present
17.	Eyes visible
18.	Eyes open
19.	Mouth occlusion prevention
20.	Mouth closed
21.	Face occlusion prevention
22.	Inter-eye distance
23.	Head size
24.	Leftward crop of face in image
25.	Rightward crop of face in image
26.	Downward crop of face in image
27.	Upward crop of face in image
28.	Pose angle yaw frontal alignment
29.	Pose angle pitch frontal alignment
30.	Pose angle roll frontal alignment
31.	Shoulder presentation
32.	Expression neutrality
33.	No head covering
34.	Radial distortion
35.	Pixel aspect ratio
36.	Camera subject distance

This is a draft table

Capture device related

Subject related

Quality Measures for Facial Images

How to develop face quality measures? - Specification

- 2021 - 2024

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Christoph Busch, Benjamin Tams, Johannes Merkle

- Joint events of NIST and EAB
  - to develop the specification for the OFIQ under participation of the stakeholders (i.e. the end users)
  - 2021: https://eab.org/events/program/261
  - 2022: https://www.nist.gov/news-events/events/2022/11/international-face-performance-conference-ifpc-2022

European Association for Biometrics
eab
Human Identity in Europe

Quality Measures for Facial Images

How to develop face quality measures? - Development

- Open source approach!
- Open source Face Image Quality (OFIQ)
  - reference implementation to ISO/IEC 29794-5
  - kindly supported by the German BSI
  - developed by secunet
  - quality measures will be tested with the NIST FRVT SIDD evaluation before they are integrated in OFIQ
- OFIQ was introduced at the 2022 International Face Performance Conference (IFPC).
  - See: https://pages.nist.gov/ifpc/2022/videos/02.mp4
  - see also: https://github.com/BSI-OFIQ/OFIQ-Project

Quality Measures for Facial Images

How to develop face quality measures? - Productisation

- 2021 - 2024

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Anna Stratmann
Marcel Ginzler

Patrick Grother
Christoph Busch, Benjamin Tams, Johannes Merkle

- Academic research

Christoph Busch, Christian Rathgeb, Kiran Raja,
Olaf Henniger, Juan Tapia, Praveen Chandaliya,
Torsten Schlett, Haoyu Zhang, Marcel Grimmer, Wassim Kabaai.

- OFIQ-Development
  (i.e. „Productisation“)

Benjamin Tams, Johannes Merkle, Maxim Schaubert

Quality Measures for Facial Images

How to develop standardised face quality measures?

- 2021 - 2024

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	Face count
	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	-

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- NIST FRVT Quality Assessment

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

- FRVT Quality Assessment - Specific Image Defect Detection

  https://pages.nist.gov/frvt/api/FRVT_ongoing_quality_sidd_api.pdf

1. FRVT 1:1 Verification	2. FRVT 1:N Search Performance	3. FRVT Morph Morphed Photo Detection	4A. FRVT QA Image Quality Scalar Summary	**4B. FRVT QA Specific Image Defect Detection**	5. FRVT Attack Presentation Attack Detection	6. FRVT Twins Ability to Distinguish Between Twins
2017 -	2018 -	2018 -	2019 -	2022 Q3 -	2022 Q3 -	2022 Q4 -

Quality Measures for Facial Images

How to develop face quality measures? - Roles

- 2021 - 2024

TBD

Maintenance

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Testing

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Development

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Christoph Busch, Benjamin Tams, Johannes Merkle

Standardisation

Research Support

OFIQ Prototyping and
OFIQ Productisation

Summary and Recommendations

Progress for OFIQ

Standardisation - why enforcing algorithms in ISO/IEC 29794-5 is important:

- ISO/IEC 29794-5 should be consistent with ISO/IEC 29794-4, which enforced quality measures
- Quality measures shall consider the diversity of face recognition algorithms (and not only predict one vendor)
  - Only an enforced implementation of quality measures, can prevent a vendor-lock-in situation for the operator
- We can not break with ISO/IEC 29794-1, which requires in Clause 7.1.2: *"Different versions of a quality assessment algorithm that yield different results shall be assigned different QAIDs to allow for unique identification."*
- Conformance testing as in 29794-4 would be impossible without explicit algorithms and tables in the standard, which define for a given input image the expected score

Recommendation

Support ISO/IEC 29794-5 and the

reference implementation OFIQ

- It can be foreseen that conformance with ISO/IEC 29794-5 will be required in upcoming call for tenders.
- For interoperability of operational systems, it is crucial to require explicit algorithms and ensure strict alignment of ISO/IEC 29794-5 and OFIQ
- Join the ISO/IEC JTC1 SC37 WG3 for the meeting on June 27 and 29 (in Tallinn) on ISO/IEC 29794-5
- Register now as representative of your institution
  - https://www.iso.org/members.html
  - https://sd.iso.org/meetings/126252

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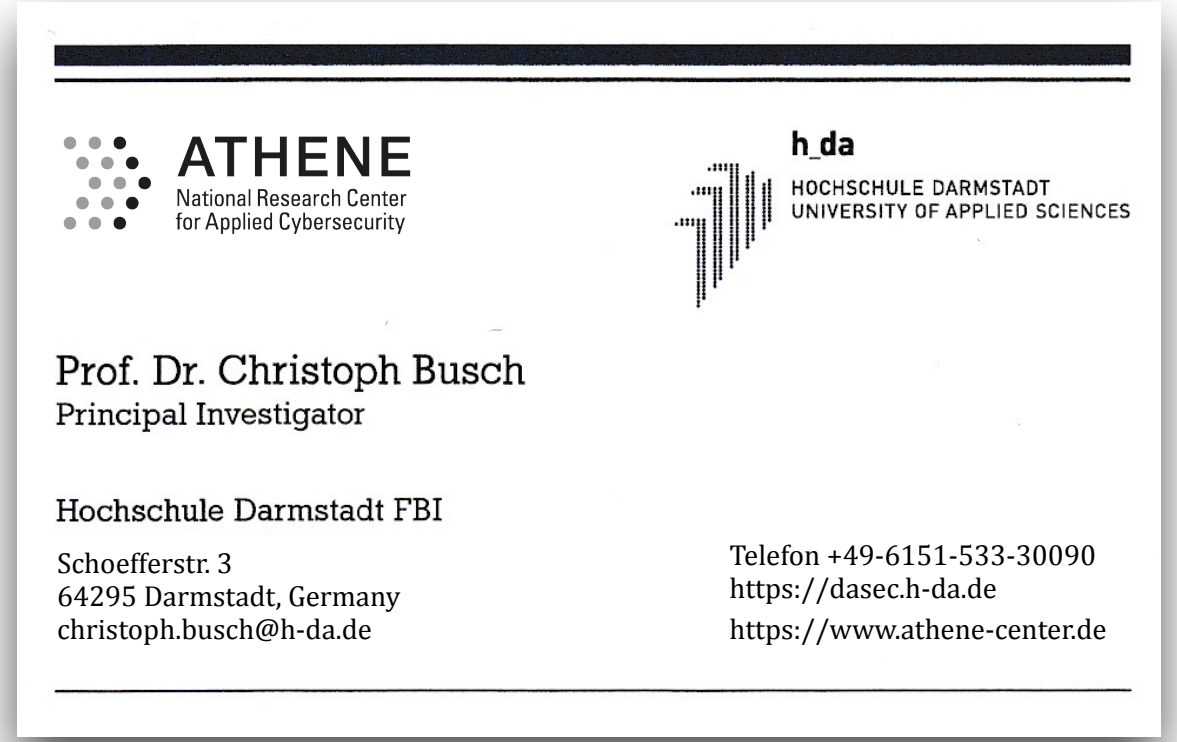
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