Face Image Quality Measures in OFIQ

Benjamin Tams

https://de.wikipedia.org/wiki/StyleGAN

Agenda

Goal

- Open Face Image Quality (OFIQ) implementation
- C/C++
- Open source
- Allows commercial use
- Portable (mobile devices, too)
- Reference implementation of ISO/IEC 29794-5 standard

Project

- BSI / Federal Office for Information Security (Germany)
- Outcome OFIQ 1.0
- Implemented by secunet

Composition of algorithms

Quality component / Pre-Processing
Face Detection
Landmark Extraction
Face Segmentation
Face Alignment
Unified Quality Score
Background Uniformity
Sharpness
Mouth Closed
Eyes Open
Head Pose Frontalness
…

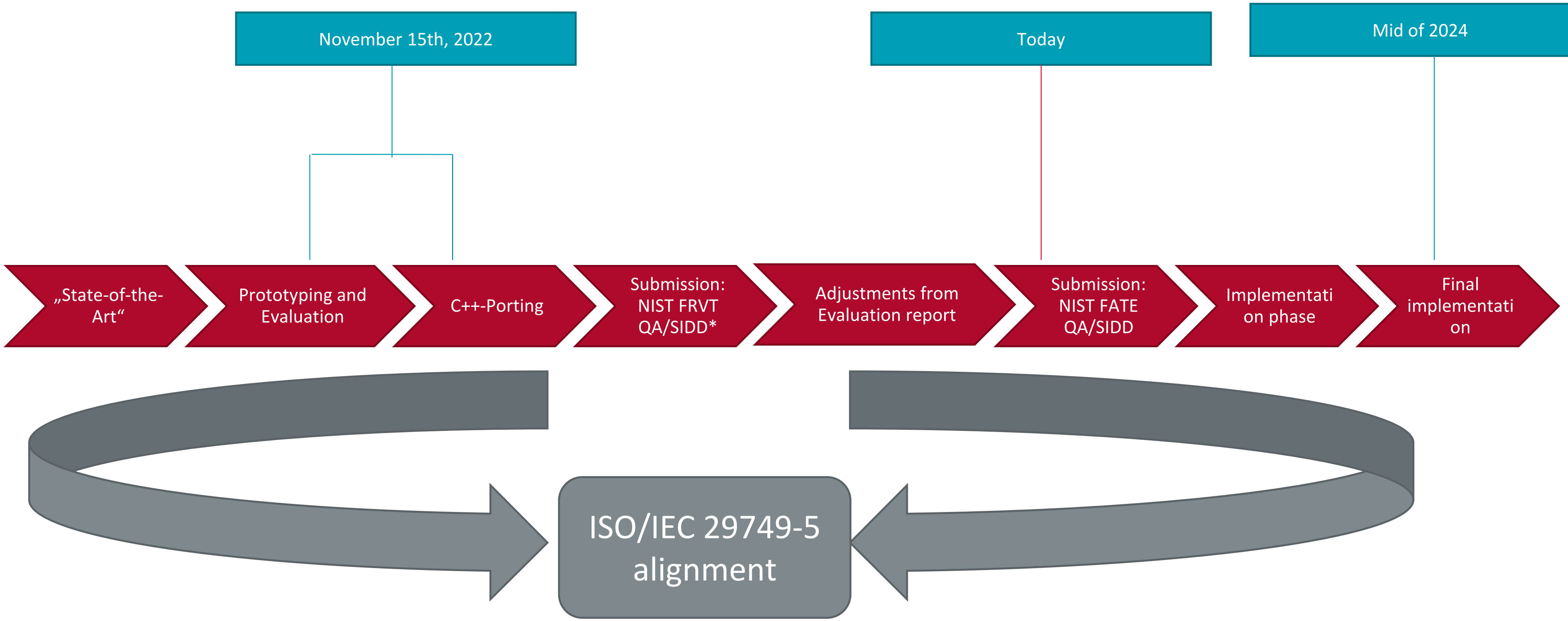
Algorithms are selected based on …

- detection accuracy as provided by the NIST FATE QA/SIDD, or internal evaluations
- Computational complexity
- Appropriate license conditions

Preview of OFIQ

https://github.com/BSI-OFIQ/OFIQ-Project

Review of last status talk at IFPC

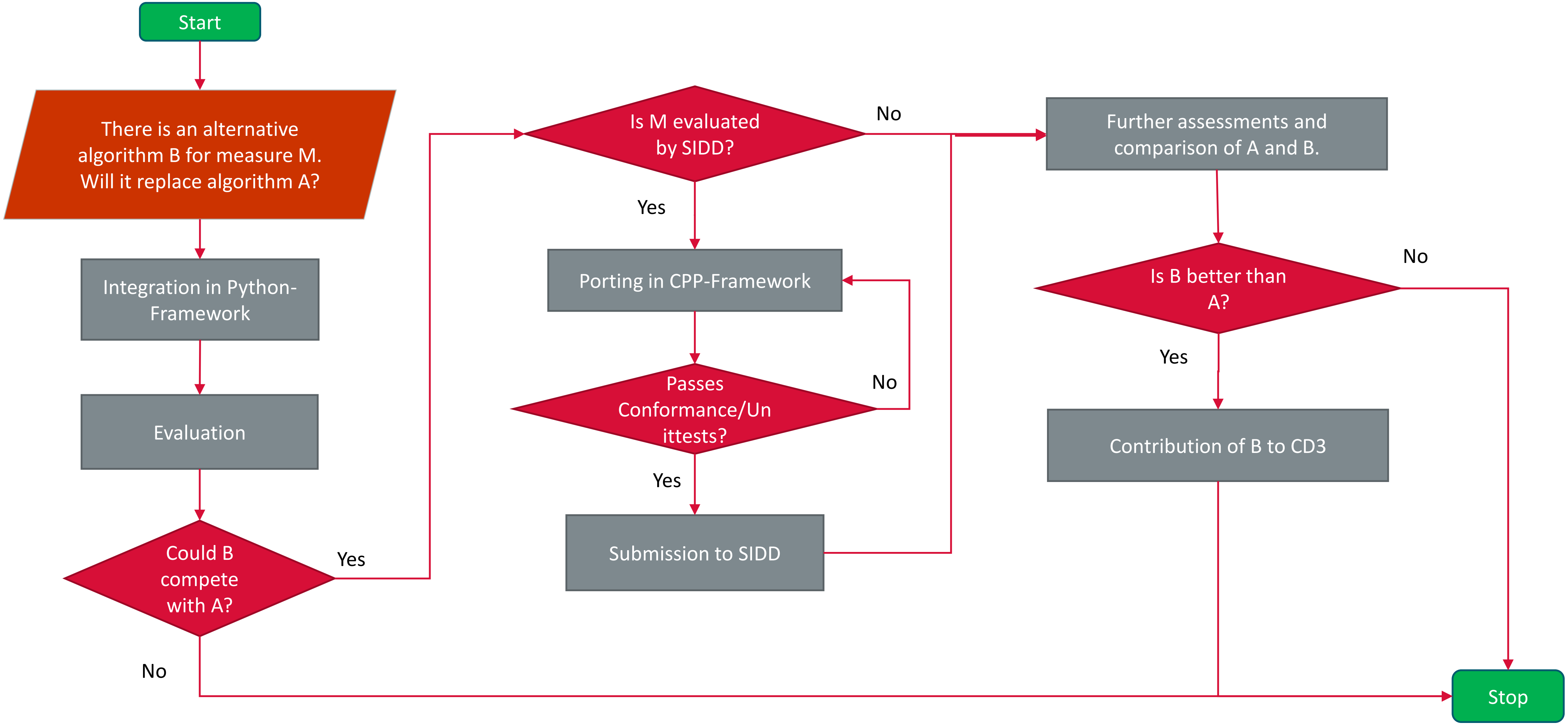


*SIDD = Specific Image Defection Detection (https://pages.nist.gov/frvt/api/FRVT_ongoing_quality_sidd_api.pdf)

Example: Background Uniformity

- Algorithm A
  - Entropy of Luminance on the background
- Algorithm B
  - Mean gradient of background
  - Only upper part of aligned face image

Process algorithm assessment



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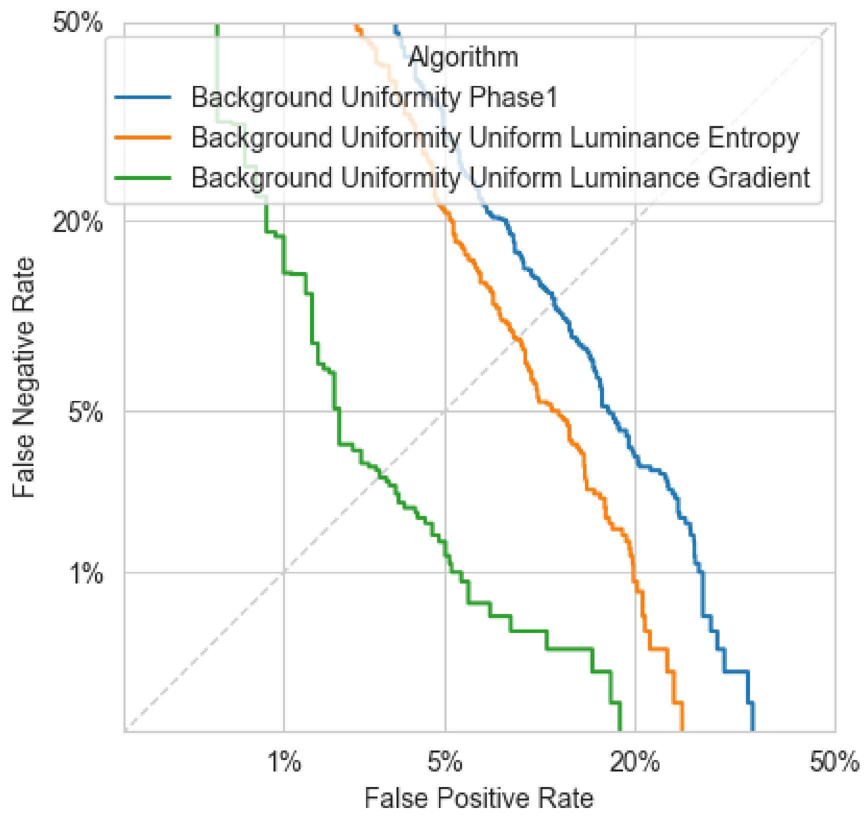
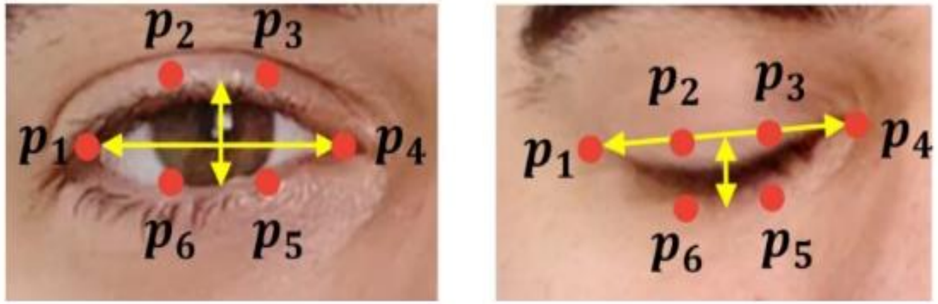


Example for Quality Component: Eyes Open

- Algorithm A
  - Eye Aspect Ratio-based
- Algorithm B
  - ISO/IEC WD5 29794-5
- Algorithm C
  - CNN from repository Eye State Detection
  - re-trained by student using larger training set (2 x 14,000 vs. 1,500 images) -> greatly improved accuracy



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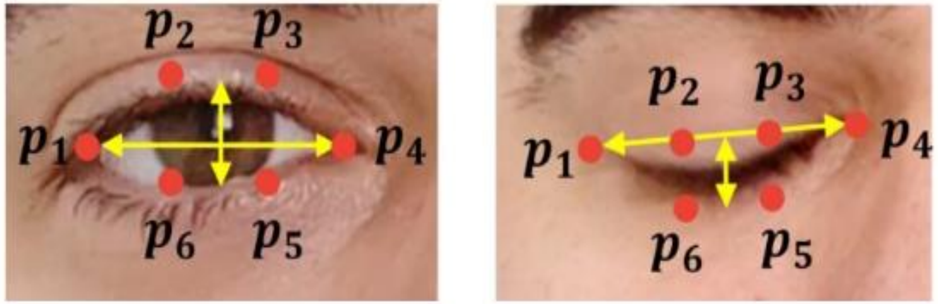

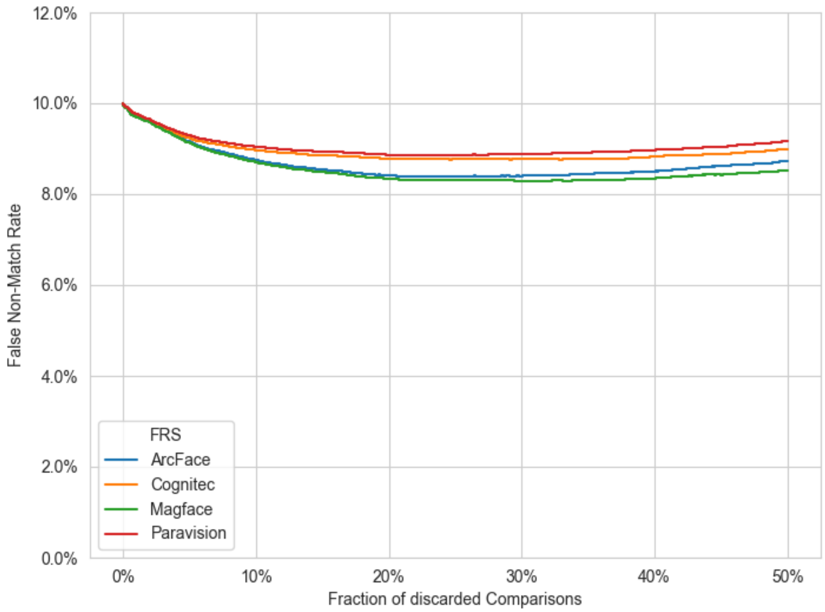

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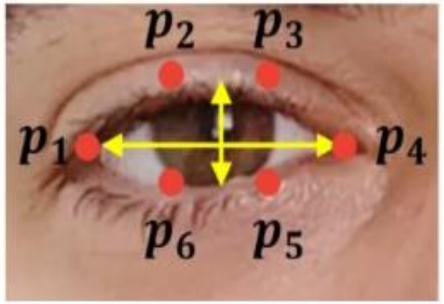

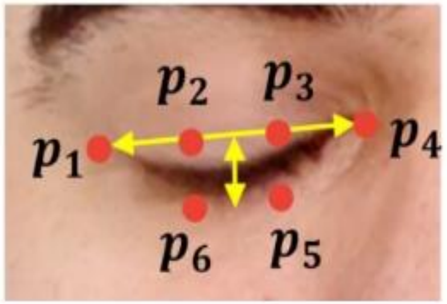

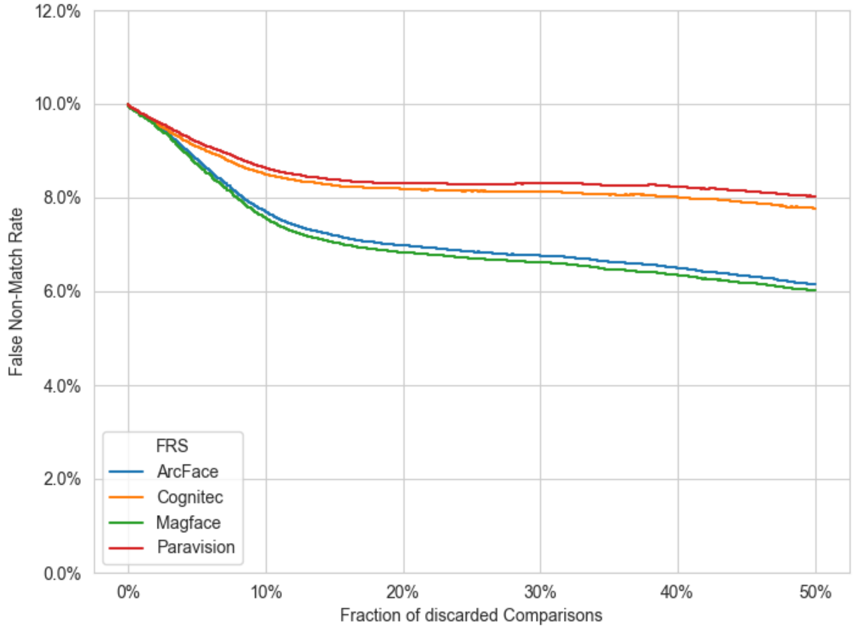

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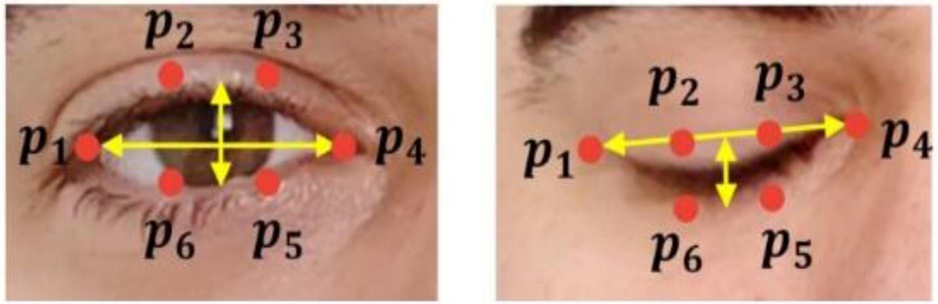

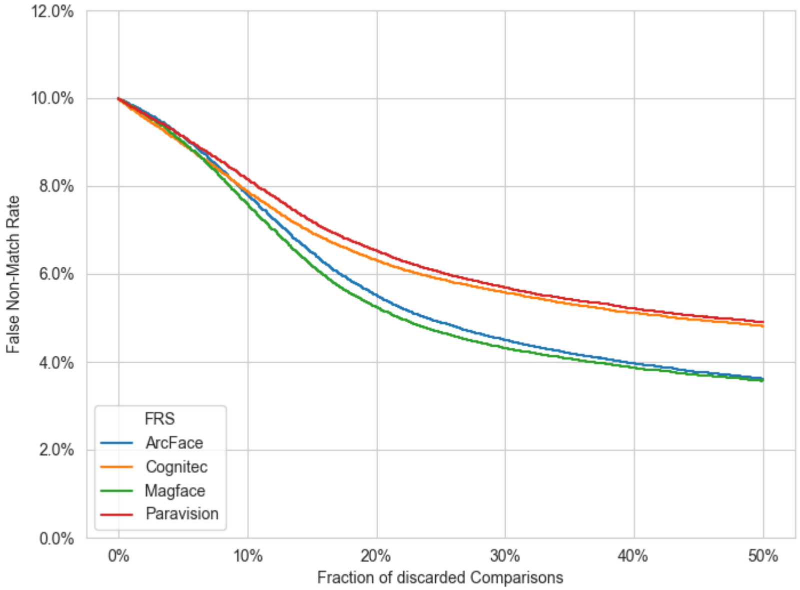

Example: No Face Occlusion

- Algorithm A
  - FaceExtraction vs. Convex hull of landmarks
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  - Trained an own CNN
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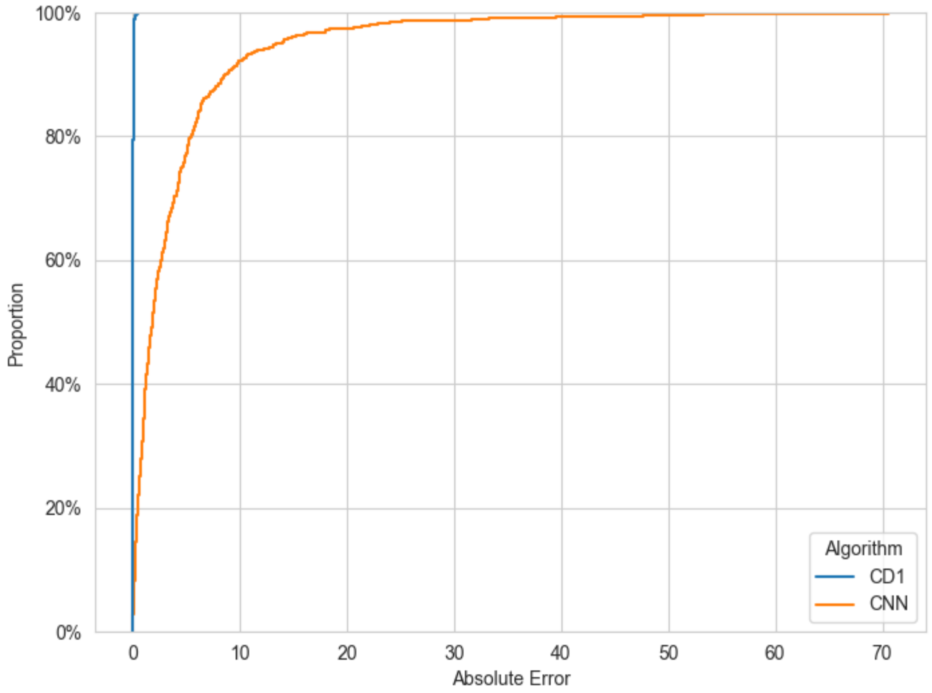

Example for Quality Component: Motion Blur

- Algorithm A
  - SVM based on edge detection and difference with mean filtered image
  - Affects recognition performance
  - Cannot distinguish motion from normal blur
  - Test images contain noise
- Algorithm B
  - Cepstrum-based implementation

Synthetic motion blur

Real motion blur with artifacts

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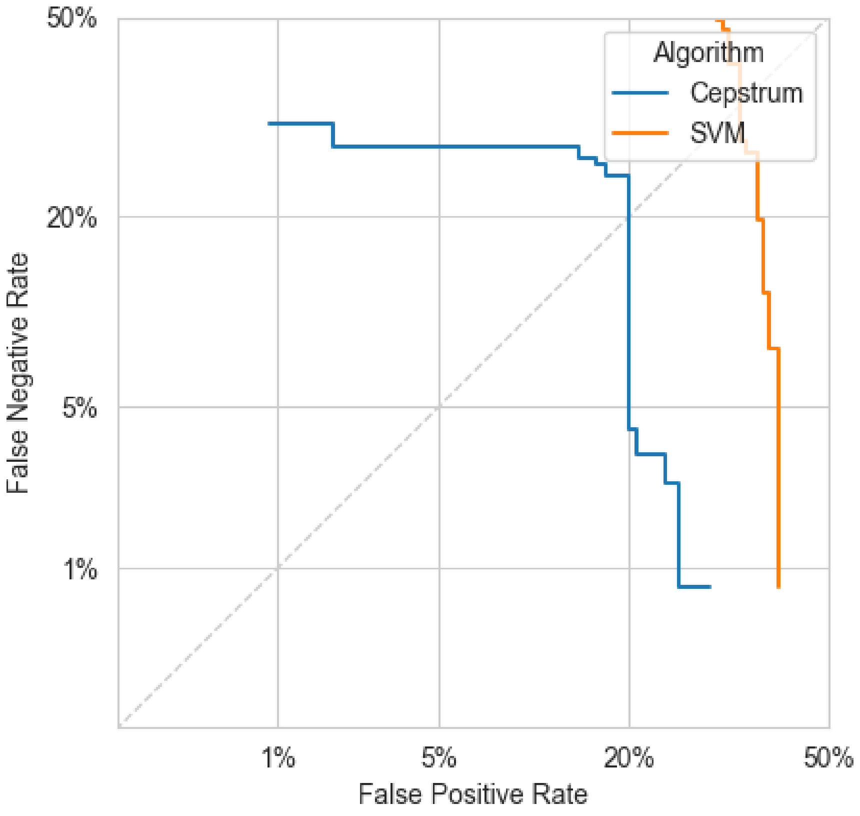
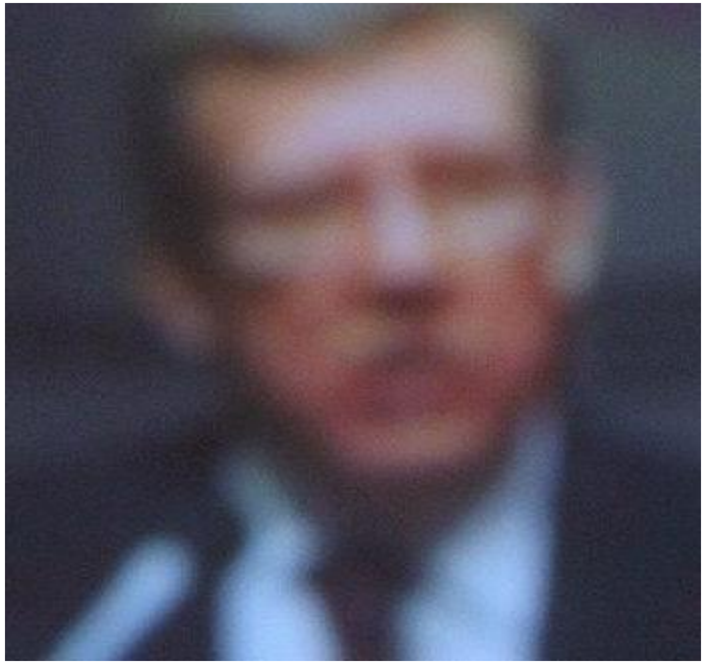


Example for Quality Component: Sharpness/Focus

- Algorithm A
  - Classifier #1 (Boost)
- Algorithm B
  - Classier #2 (Rtree)
- Algorithm C
  - Classifier #3 (SVM)
- Algorithm D
  - Laplacian-based
- Algorithm E
  - Gaussian-based



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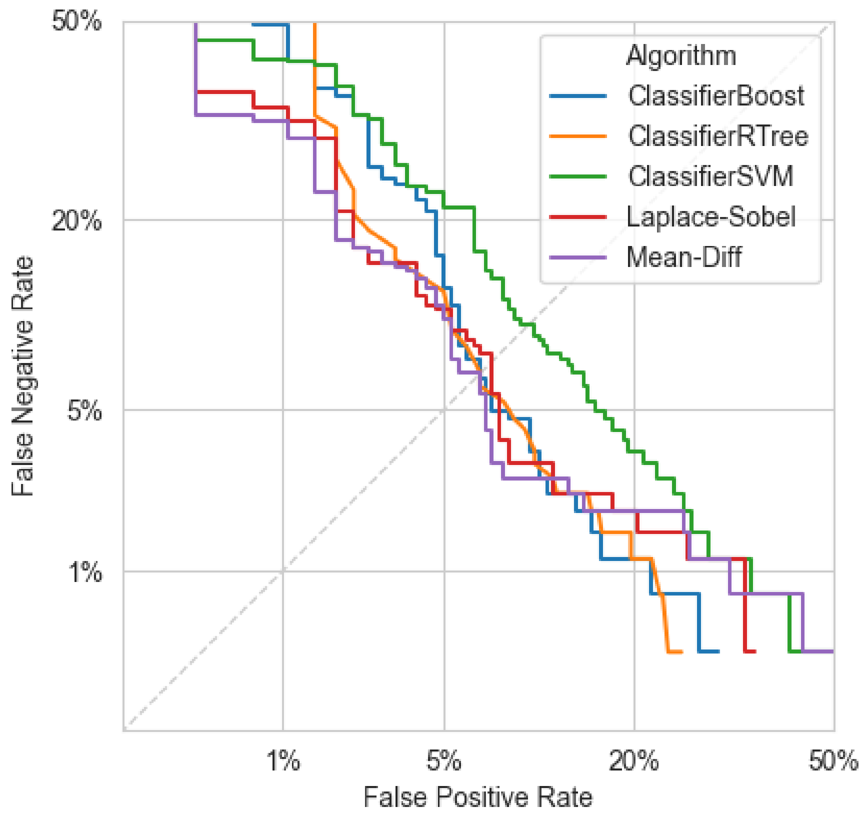

Example for Quality Component: Radial Distortion

- Algorithm A
  - Classifier by NTNU
- Radial Distortion is a hard classification problem!

Not (much) distorted

Heavy distortion

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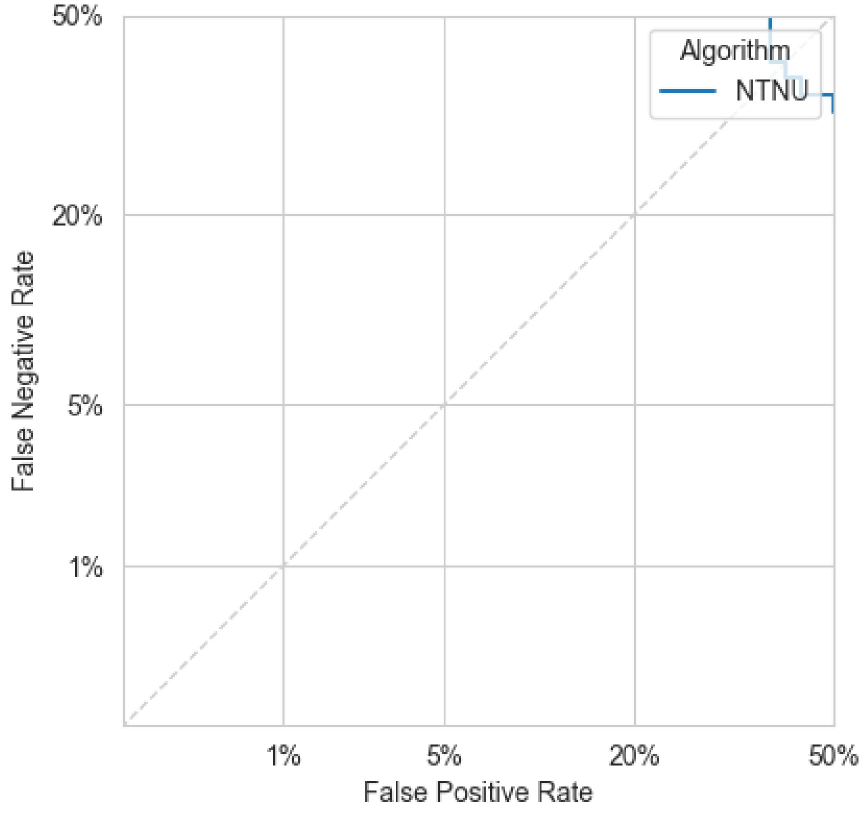
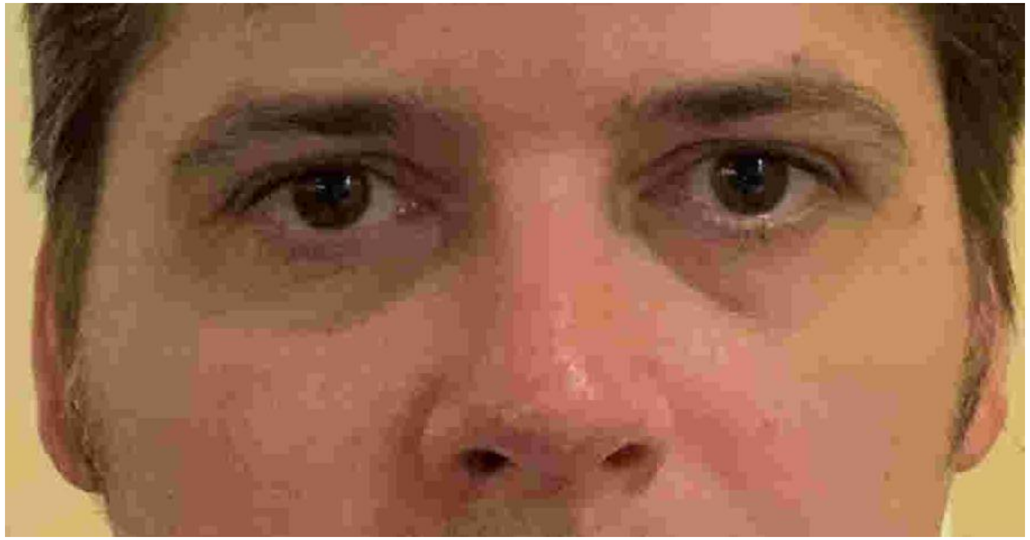


Example for Quality Component: Compression Artifacts

- Algorithm A
  - Peak-Signal-to-Noise-Ratio Classifier
- Algorithm B
  - Structured Similarity Classifier



Overview of algorithm selection 1

Pre-processing	Algorithms/implementation	Outcome
Face Detection	Dlib	
	MediaPipe	
	SSD -> most robust	Pre-finalist
	RetinaFace	
Landmark extraction	Dlib -> fastest	
	MediaPipe	
	ADNet -> most robust	Pre-finalist
Face Segmentation	Convex hull of landmarks	
	Increased size of the input, higher accuracy, specified in CD2	Pre-finalist
Occlusion Segmentation	FaceExtraction	Pre-finalist
Face Parsing	face-parsing.PyTorch	Pre-finalist
Facial Alignment	Custom algorithm	Pre-finalist

Overview of algorithm selection 2

Quality component	Algorithms/implementation	Outcome	SIDD
Unified Quality Score	MagFace iResNet100	good accuracy but slow	yes
	MagFace iResNet18	fast	
	MagFace iResNet50		
	MagFace iResNet50_2	Fast and good accuracy	yes
	Fusion of OFIQ components -> during finalization		
Background Uniformity	Entropy of the background via face parsing		
	Entropy-based approch, restriction to upper part		
	Gradient-based approch, restriction to upper part	Best accuracy	yes
Dynamic Range	ISO/IEC WD5 29794-5:2022		
Exposure	Computed on landmarked region		
	Adjustment of threshold parameter + sigmoid function		yes
Illumination Uniformity	ISO/IEC WD5 29794-5:2022		
Statistical Moments of Illumination	ISO/IEC WD5 29794-5:2022		
Sharpness (a.k.a. De-Focus)	Laplacian		TBD
	Gaussian		TBD
	Training of classifiers		TBD

Overview of algorithm selection 3

Quality component	Algorithms/implementation	Outcome	SIDD
Motion Blur	SVM-based method		Yes
	Cepstrum-based method		Yes
Unnatural Colour and Colour Balance	ISO/IEC WD5 29794-5:2022	Marginal impact	
	TRUST-based approach -> not yet implemented		
Face Occlusion	Trained an own CNN (estimates eye and mouth occlusion as well) evaluation		Yes
Mouth Occlusion	Occlusion segmentation on landmarks -> great impact	Great impact	
Eyes Visible	Occlusion segmentation of EVZ	Good accuracy and reasonable impact	
Mouth Open	ISO/IEC WD5 29794-5		
	ISO/IEC CD1 29794-5	Pre-finalist	Yes
Eyes Open	EAR	Worst accuracy	
	ISO/IEC WD5 29794-5		Yes
	Retrained CNN re-trained, best performance	Best accuracy	Yes
Inter-Eye distance	Euclidean distance		
	Considering secant of yaw angle from head pose	Pre-finalist	Yes

Overview of algorithm selection 4

Quality component	Algorithms/implementation	Outcome	SIDD
Head Pose	3DDFA-V2		
	Dense Head Pose		
	SynergyNet		Yes
	SyngeryNet with roll angle from alignment transform		
	SynergyNet with roll angle from eye landmarks		Yes
Expression Neutrality	SVM based on DAN		
	SVM based on DMUE		
	HSEMotion	Best accuracy	
	HSEMotion with two CNNs		
No Head Coverings	Proportion of pixels labeled as head cover as per face parsing		
	Modification considering clothes coverings above the eyes		
Compression artifacts	Own CNN		Yes
Radial Distortion	GeoProj	Rejected	
	FEGAN	Rejected	
	distortion-free-wide-angle.pytorch	Rejected	
	NTNU -> little impact		Yes
Shoulder Presentation	Shoulder often not visible	Rejected	

Finalization phase

- 2023-10-05: 2nd CD comment resolution zoom meeting
- 2023-10-16: Submission 3rd CD
- 2023-10-31: Finalization of Python-Framework and internal evaluations
- **2023-11-15: FATE-SIDD submission**
- **2023-12-01: FATE-SIDD report publication**
- 2023-12-13: Commenting deadline
- 2023-12-23: Submission editor's prop 3rd CD
- 2024-01-09: 3rd CD comment resolution meeting
  and distribution of DIS
- **2024-01-10: OFIQ: Finalization of implementation**
- **2024-07-01: Tentative OFIQ1.0 completion and release**

secunet