

Understanding The Face Image Format Standards

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Topics

- The Face Image Standard
 - The Record Format
 - Frontal Face Images
 - Face Images and Compression
- On 3D Face Recognition
- Conformance Standards and Testing



The Face Image Format

General Approach to the Face Format

- Specify face images because there is no agreement on a standard face recognition template
 - Unlike finger minutia ...
- Specify how a photograph should appear rather than how to take the photograph (i.e. lighting and cameras)
 - A new project to address this is under way in SC37
- Allow for the specification of additional visible information discernable by an operator pertaining to the face, such as gender and eye color
 - To improve identification performance
- Verify that specified format and compression allow for good face recognition performance
 - Tested standard using leading algorithms on passport databases
- Best practice appendices developed to allow for optimized face recognition
 - Note: some ISO best practices are ICAO requirements

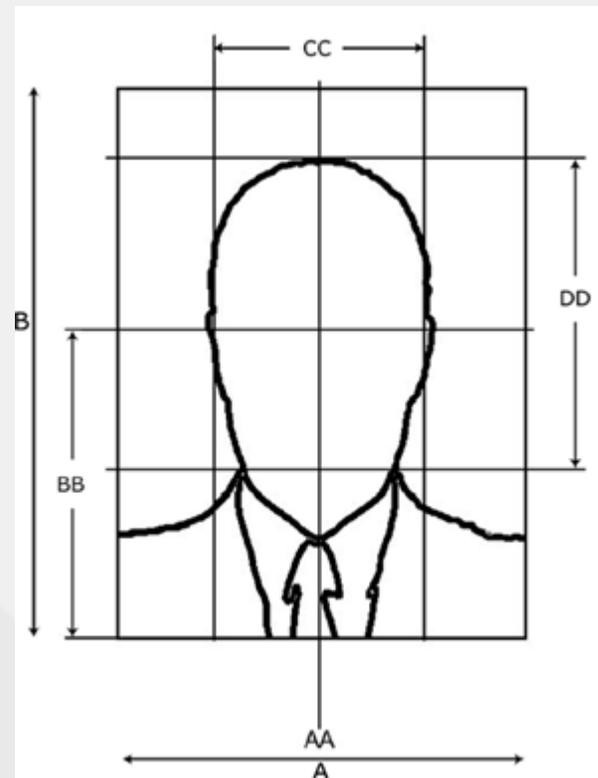
US and International Face Image Standards

ANSI – ANSI INCITS 385 - May 2004, the US Standard for Digital Image Formats for use with the Facial Biometric

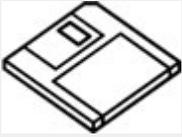
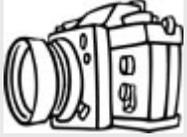
- Referenced by DoC for US PIV ID Card, DHS for face capture

• ISO – 19794-5 FDIS – November 2004, the Final Draft International Standard of Biometric Data Interchange Formats - Part 5 – Face Image Data.

- Referenced by ICAO “Biometrics Deployment of Machine Readable Travel Documents”, TAG MRTD/NTWG May 2004.



Scope of the Standard

Requirements Specified in the Standard			
Scene	Photographic	Digital	Format
 Lighting	 Positioning	 Digital Camera	 Digital Specifications
 Image and Subject	 Camera Attributes	 Analogue to Digital	 Record Format and Organization
		 Image Scanning	

The Record Format

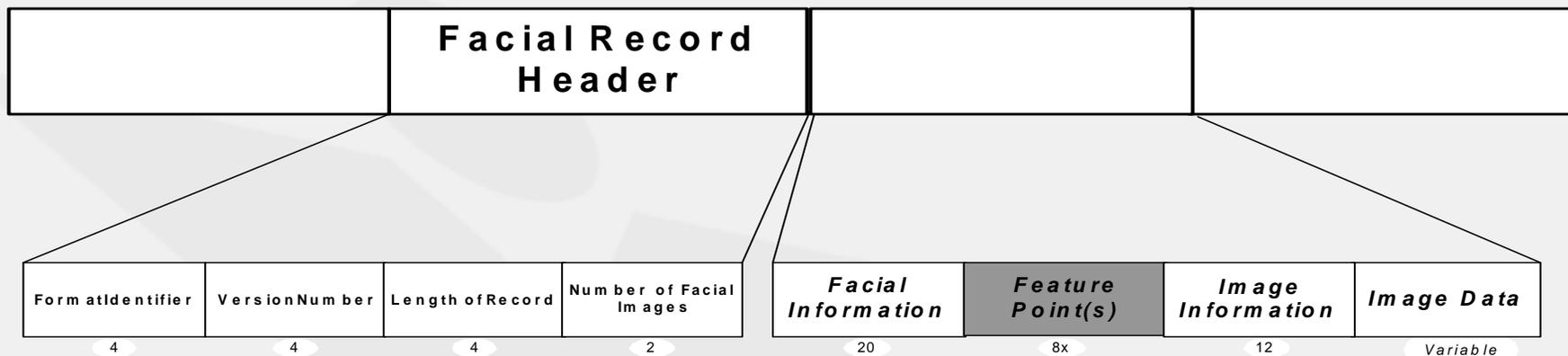
Record Format Highlights

- CBEFF header
- Multiple images per record allowed
- Can encode
 - Image source type (video or still)
 - Image color space
 - Vendor-specific device
 - Quality (to be defined)
- JPEG or JPEG2000 encoding and compression allowed

Can specify face information seen on photograph

- Gender
- Eye color
- Hair color
- Expression
- Properties (glasses, etc)
- Pose angles (yaw, pitch, and roll)
- Feature Point Positions (e.g. eye positions)

Record Format – Specification (ISO)



Facial Information



Feature Point



Image Information

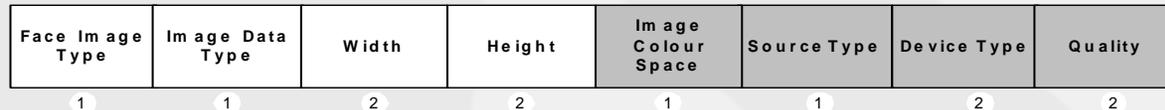
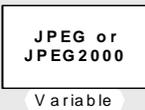
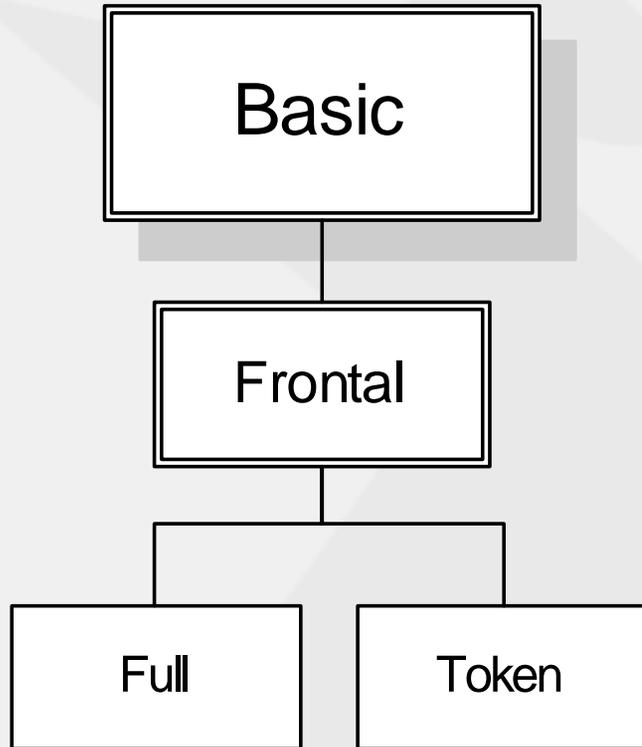


Image Data

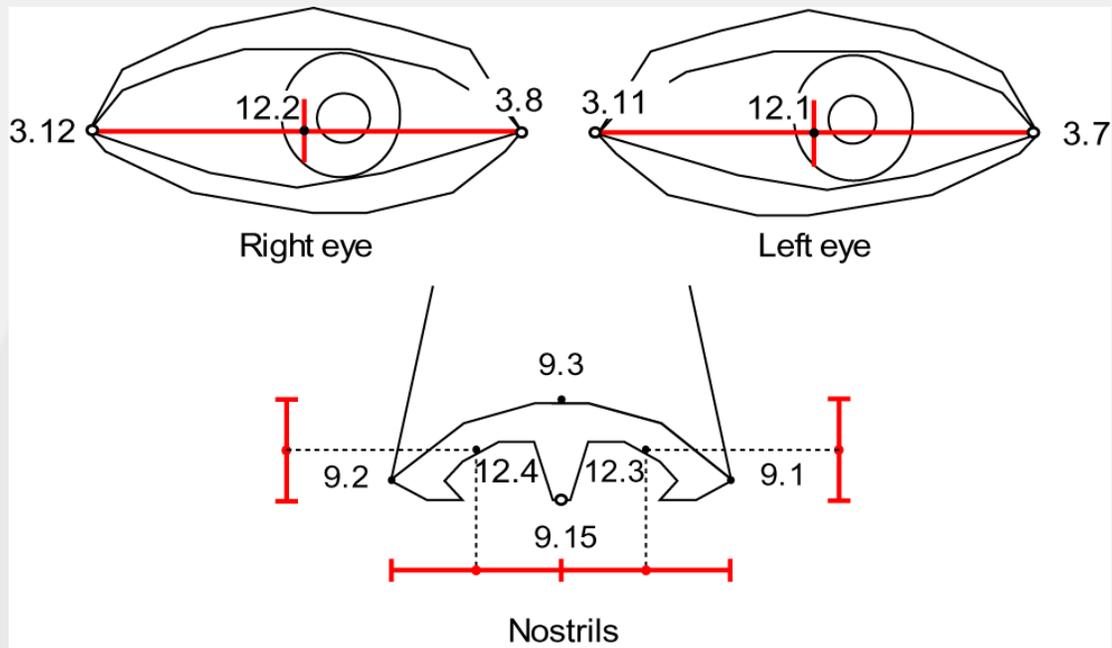
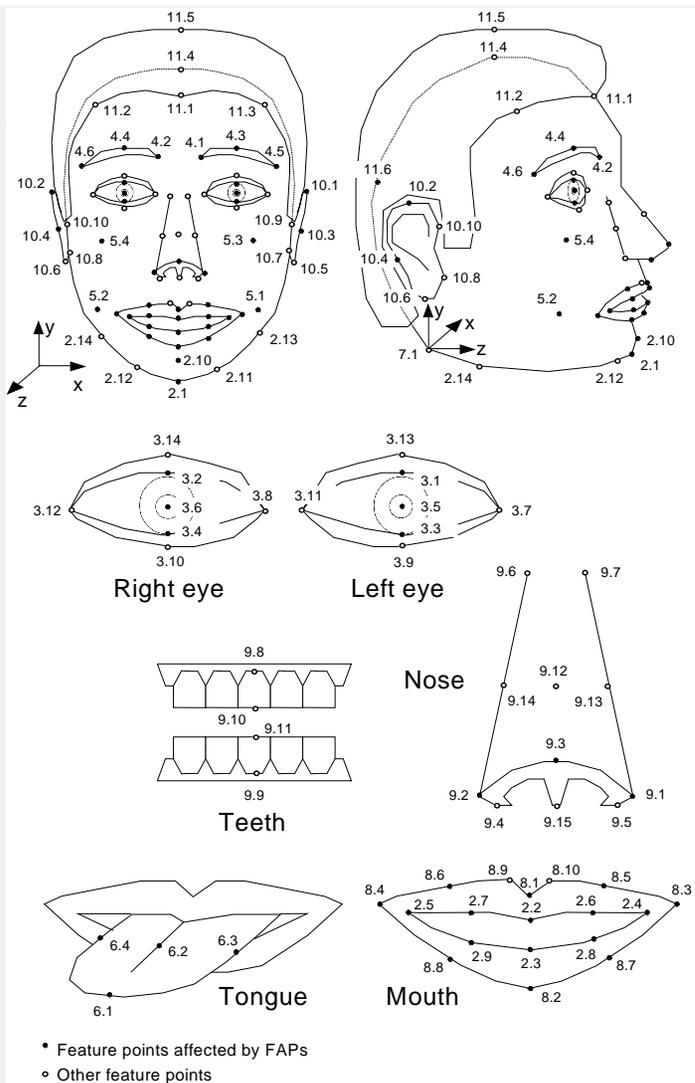


Face Image Types



- **Basic:** The fundamental Face Image Type that specifies a record format including header and image data.
 - No mandatory scene, photographic and digital requirements are specified for this image type.
- **Frontal:** A face that adheres to additional requirements appropriate for frontal face recognition and/or human examination. Either Full or Token.
- **Full Frontal:** This type of Frontal Image includes the full head with all hair in most cases, as well as neck and shoulders.
 - **Used for ePassports**
- **Token Frontal:** A Face Image Type that specifies frontal images with a specific geometric size and eye positioning based on the width and height of the image.

Feature Points (Optional)



- The (optional) feature points allow for specification of eye positions and other face registration information used by face recognition algorithms
- Definitions based on SC29/MPEG4

Frontal Face Images



Frontal Images

- Pose
 - Pose is known to strongly affect performance of automated face recognition systems.
 - The full-face frontal pose shall be used. Rotation of the head shall be less than +/- 5 degrees from frontal in every direction – roll, pitch and yaw.
- Expression
 - The ISO best practice requirement is:
 - The expression should be neutral (non-smiling) with both eyes open normally (i.e. not wide-open), and mouth closed. Every effort should be made to have supplied images comply with this specification. A smile with closed jaw is not recommended.
- Background
 - The ISO best practice requirement is:
 - The background should be plain, and shall contain no texture containing lines or curves that could cause computer face finding algorithms to become confused. Therefore the background should be a uniform colour or a single colour pattern with gradual changes from light to dark luminosity in a single direction.

Frontal Images

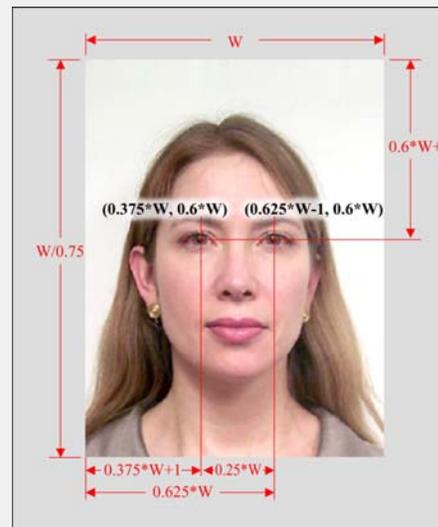
- Lighting
 - No shadows or point light source (single flash)
 - Lighting shall be equally distributed on the face. There shall be no significant direction of the light from the point of view of the photographer.
 - Diffused lighting, multiple balanced sources or other lighting methods shall be used.
 - A single bare “point” light source is not acceptable for imaging. Instead, the illumination should be accomplished using other methods that meet requirements specified...
- No Camera Capture Artifacts
 - No NTSC or PAL video frames
 - Interlaced video frames are not allowed for the Frontal Image Type. All interlacing must be absent (not simply removed, but absent).
 - No stretched images
 - Digital cameras and scanners used to capture facial images shall produce images with a pixel aspect ratio of 1:1.

Full Frontal or Token Frontal?



Full Frontal

- Cropping requirements specified to allow for full capture of face and shoulders
- Consistent with most current mug-shot and passport standards
- **Recommended for use with ePassports, both on the printed passport and stored in the chip**

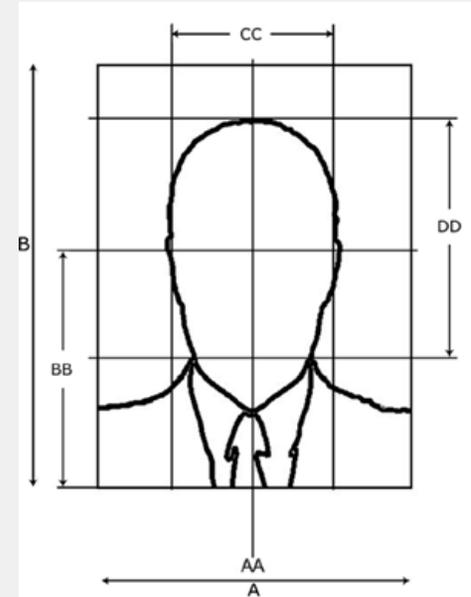


Token Frontal

- Eye positions in fixed positions on image. The image aspect ratio is fixed. Storage size is reduced
- **A 90 or 120 pixels from eye to eye Token can be used in the MRTD chip**

Full Frontal Images – Geometric Constraints

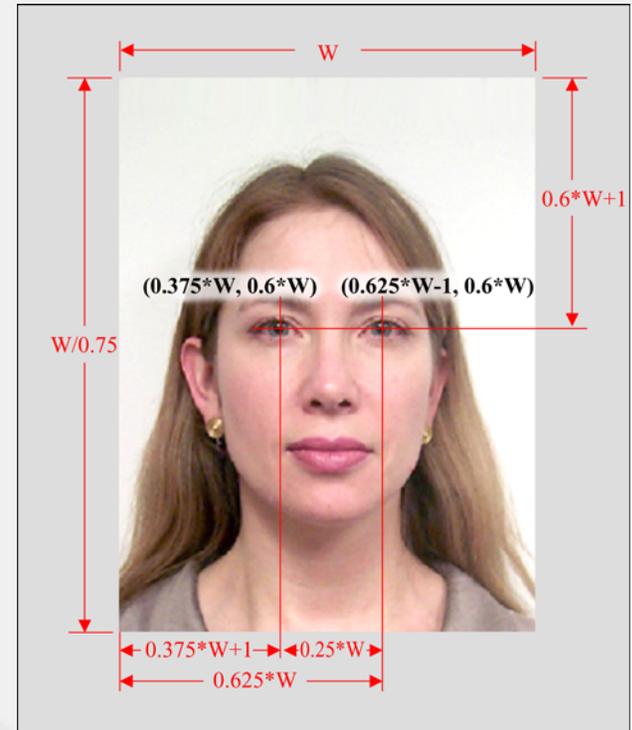
Definition	Requirements
Vertical Position of Face	$0.5 B \leq BB \leq 0.7 B$
Vertical Position of Face (Children under the age of 11)	$0.4 B \leq BB \leq 0.7 B$
Width of Head	$A \geq 1.4 CC$
Length of Head	$B \geq 1.25 DD$



- 90 pixels from eye to eye is required
- **120 pixels – best practice recommendation**

Token Frontal Images – Geometric Constraints

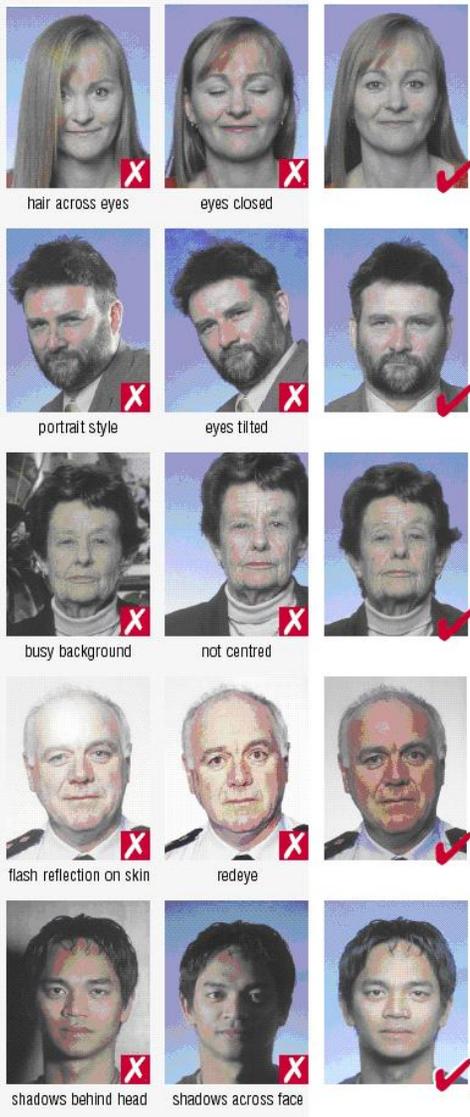
Feature or Parameter	Value
Image Width	W
Image Height	$W/0.75$
Y coordinate of Eyes	$0.6 * W$
X coordinate of First (right) Eye	$0.375 * W$
X coordinate of Second (left) Eye = $0.625 * W$	$(0.625 * W) - 1$
Width from eye to eye (inclusive)	$0.25 * W$



Width = 240 corresponds to 60 pixels from eye to eye

Width = 480 corresponds to 120 pixels from eye to eye

Frontal Images – Scene Constraints (1)



- No hair covering front of face
- Eyes open
- No portrait style images
- Eyes on same horizontal line
- Single color background
- Face centered
- No single flash or flash artifacts
- No red-eye
- No shadows on background
- No shadows on face

Frontal Images – Scene Constraints (2)



- No sunglasses
- No glare on glasses
- Tinted glasses OK (if required)
- Glasses avoid eyes (if possible)
- Remove hats
- Remove caps (affects algorithms)
- No shadows on face from religious headgear
- Lower veil to expose center of face from roughly crown to chin and ear to ear.
- No other face or partial face in image
- No toys or other objects in image

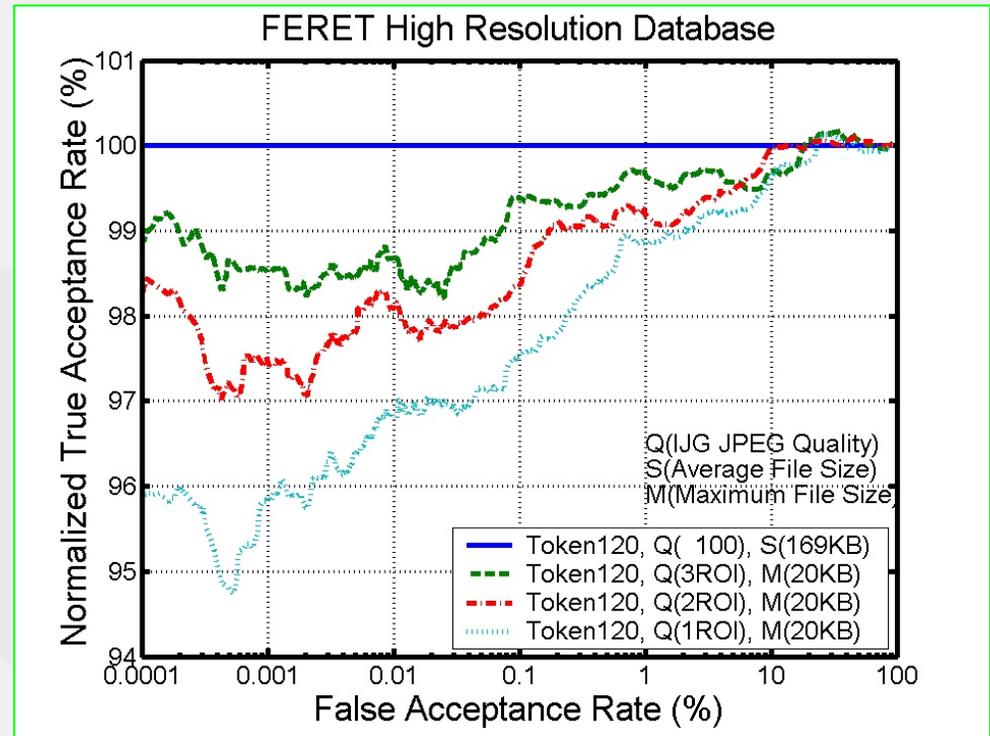
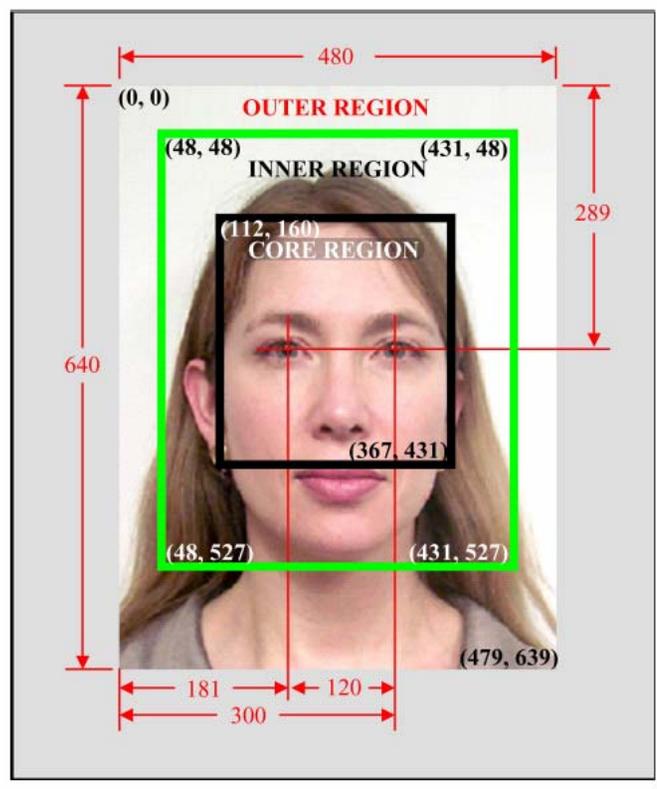
Face Images and Compression



Image Formats and Compression

- One of two possible encodings is to be used for all images
 - The JPEG Sequential baseline (ISO/IEC 10918-1) mode of operation and encoded in the JFIF file format (the JPEG file format)
 - The JPEG-2000 Part-1 Code Stream Format (ISO/IEC 15444-1) and encoded in the JP2 file format (the JPEG2000 file format).
 - Both JPEG and JPEG2000 work equally well.
- Face Recognition performance is a strong function of compression
 - Over-compressed images cannot be used for watch-list and background checks, and reduce verification effectiveness.
 - **Prevent re-compression**
- Best compromise between size and quality is Region of Interest compression with face region compression ratio of 20:1 to 24:1.
- For JPEG, and space concerns, use the allowed YUV422 colour space where twice as many bits are dedicated to luminance as to each of the two colour components.

ROI JPEG Compression



- To be discussed in more detail in another presentation

Additional Comments

3D Face Recognition

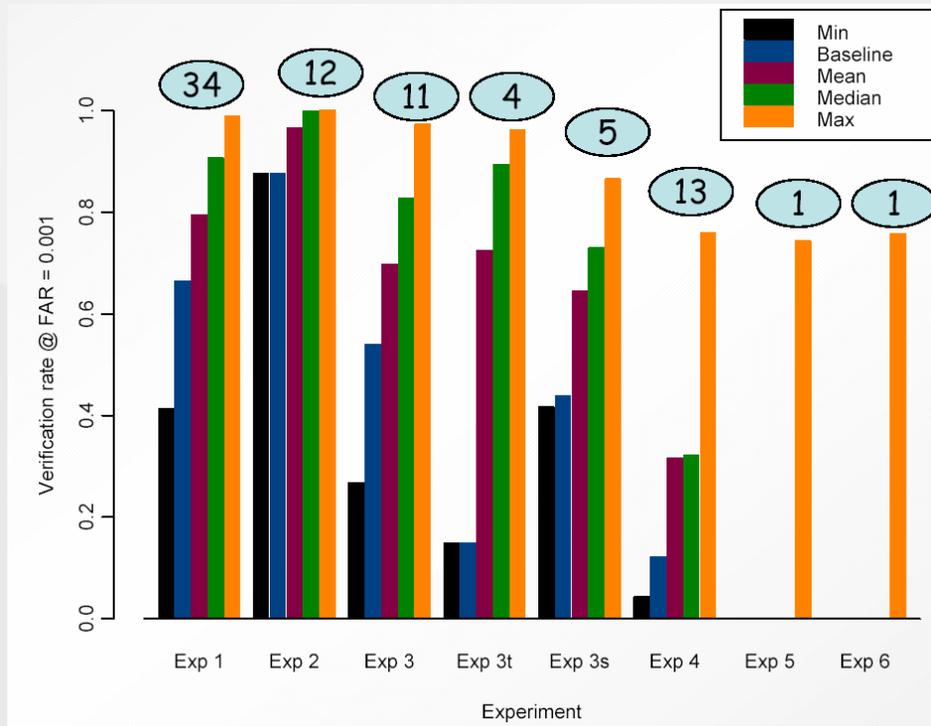
3D Face Recognition

- Standards Activities
 - INCITS M1 has a new work item to amend the ANSI 2D face standard to accommodate depth data.
 - A similar technical contribution has been made to SC37/WG3, to be presented in South Africa this summer.
- Every biometric should have standardized data formats, and in this context, 3D face is no different than hand geometry, voice, etc.
 - **This does not imply that 3D face automatically will be put on passports or in next generation NIST records as a piggyback to 2D face.**
- Performance Testing
 - Tested 3D face recognition on cooperative subjects in the Face Recognition Grand Challenge (FRGC)
 - Results:
 - <http://www.biometriccatalog.org/documents/Phillips%20FRGC%20-%20Feb%202005-5.pdf>

Current 2D vs. 3D Performance Results

FRGC Workshop 3

- Experiment #1
 - Single Face Image
- Experiment #2
 - 4 Face Images
- Experiment #3:
 - 3D (Texture + Shape)
- Experiment #3t
 - 3D (Texture only)
- Experiment #3s
 - 3D (Shape only)



Conclusions

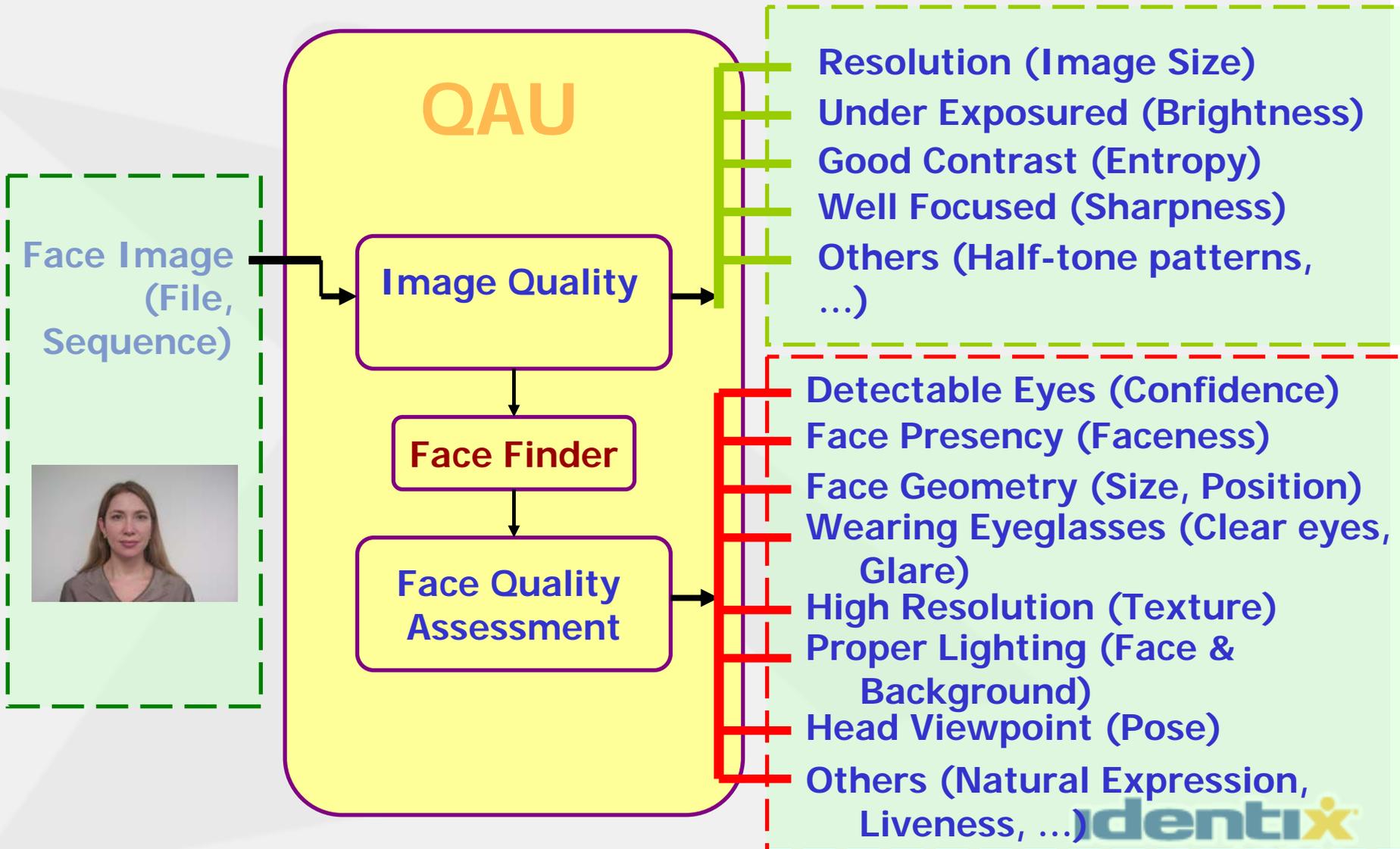
- **Texture (2D Image) is more important than Shape (3D)**
 - Most of the signal from 3D matching is from the 2D image
 - Addition of shape is less important than increasing resolution of 2D face data.
- **Single image matching generally beats matching with current 3D sensors**

Conformance Standards and Testing

Conformance – Standards and IQM

- Standards Activities
 - INCITS M1 is a new work item to study specify methods that automatically insure that face data complies with the face standards.
 - This new work item is currently being developed by Identix and NIST.
 - Conformance is for the format (make sure bytes are in the right places), photographic, digitization, and scene requirements.
 - Scene requirements in the standard are to be evaluated using an automated **image quality module**.
- Image Quality Module
 - Measures scene information to determine conformance to standard and the probability of good biometric performance
 - Focus, Exposure, Expression, etc.

Example: Identix Face IQM



Conformance - Summary

- Significant standards activity in developing conformance standards for capture and formatting systems
 - Need a certification program.
 - File format conformance specifications likely to be straightforward to determine with a reference dataset for common formats
 - But each biometric will likely have specific algorithms that measure sample data quality.
- Conformance testing is likely to require sequestered data.
 - Testing of relationship between IQM scores and matching scores
 - Testing of data interchange properties

Thank You. Questions?