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

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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

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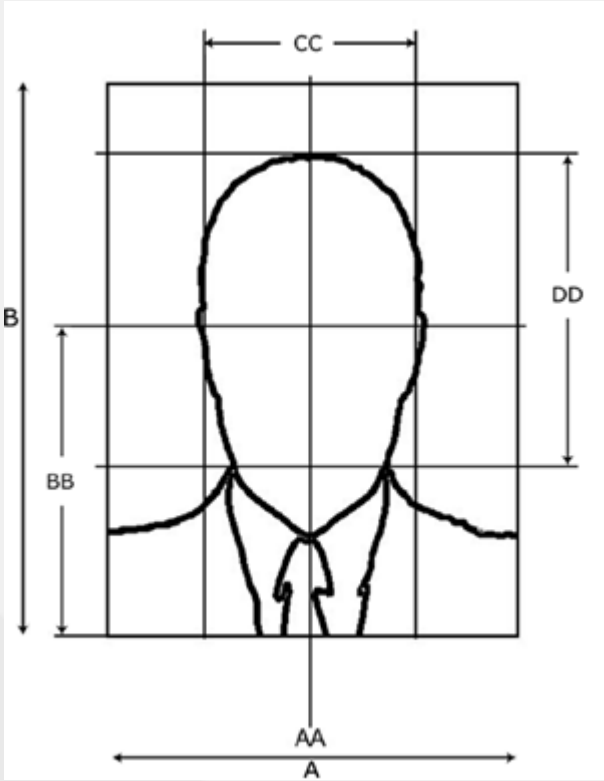
US and International Face Image Standards

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.



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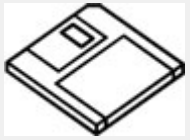
Scope of the Standard

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	

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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

<u>Can specify face information seen on photograph</u>

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

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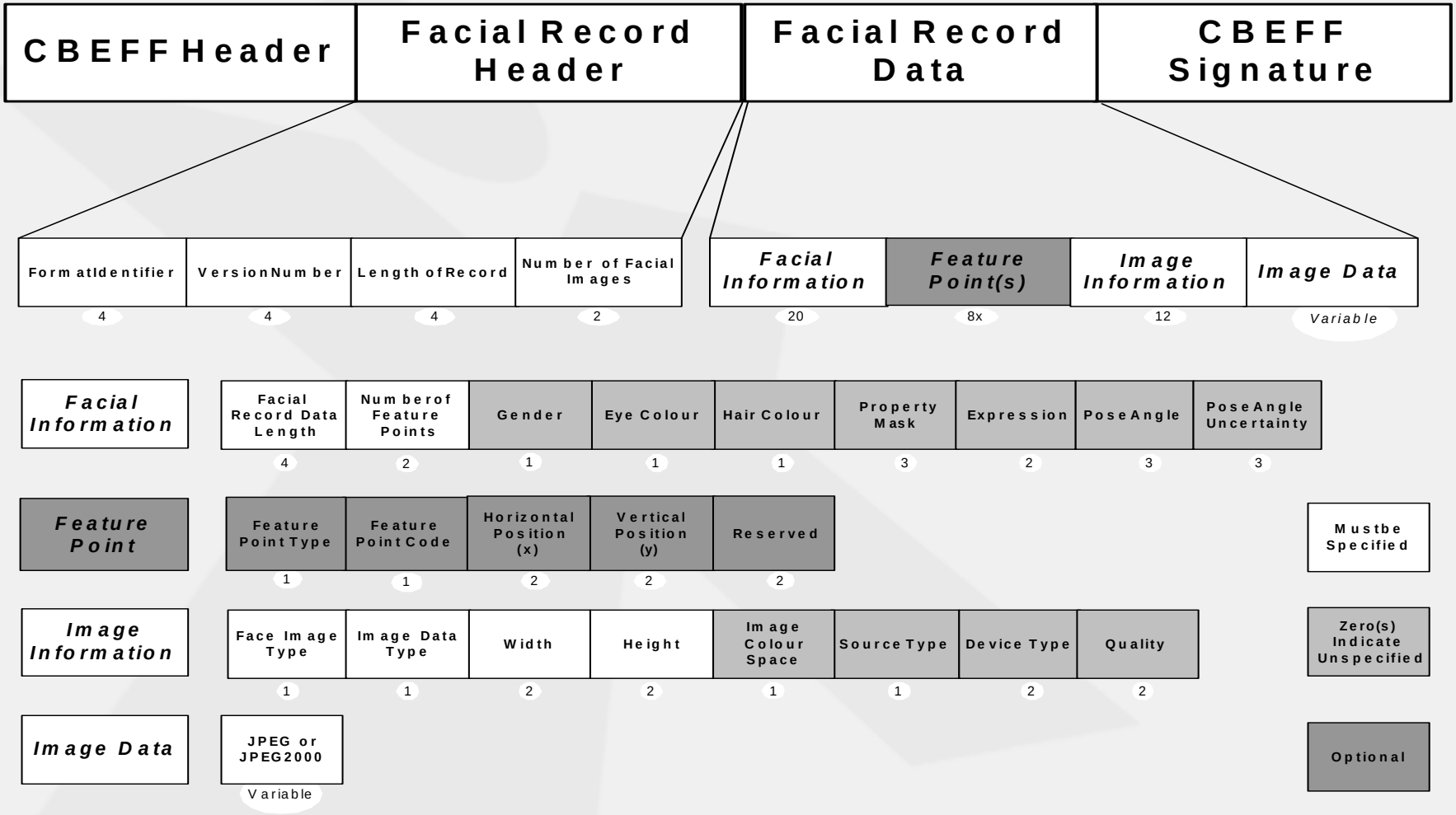
Record Format – Specification (ISO)



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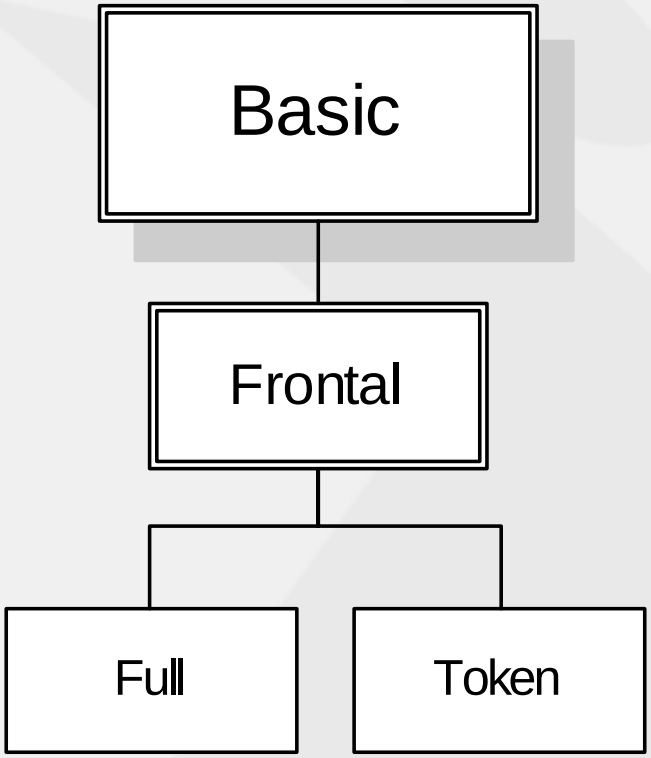
Face Image Types



- **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.

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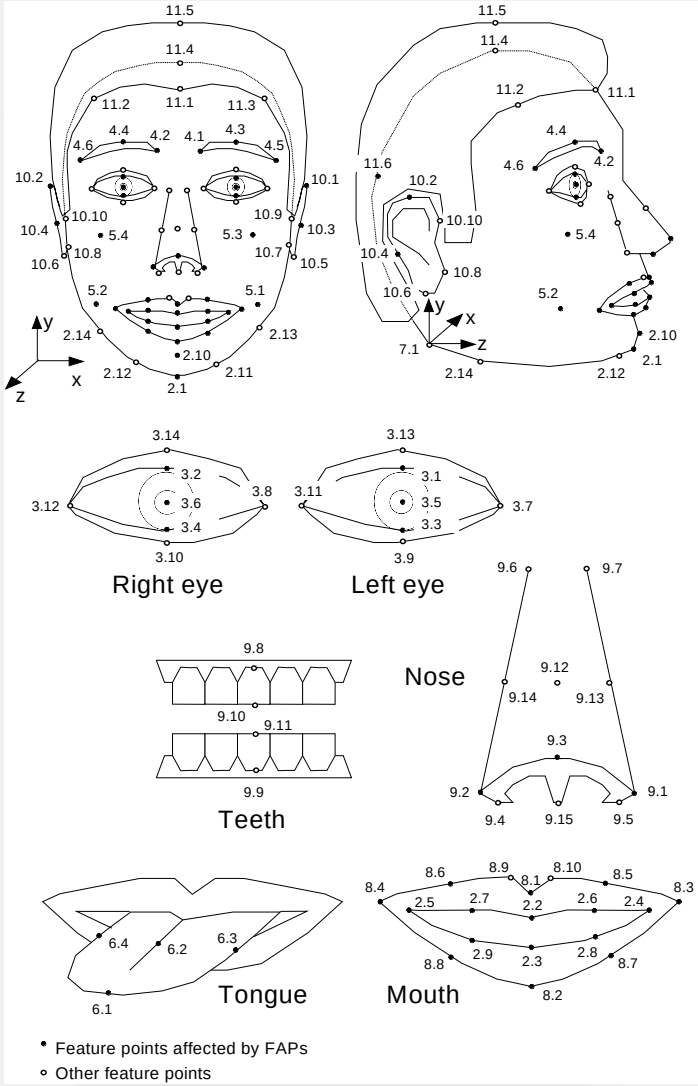
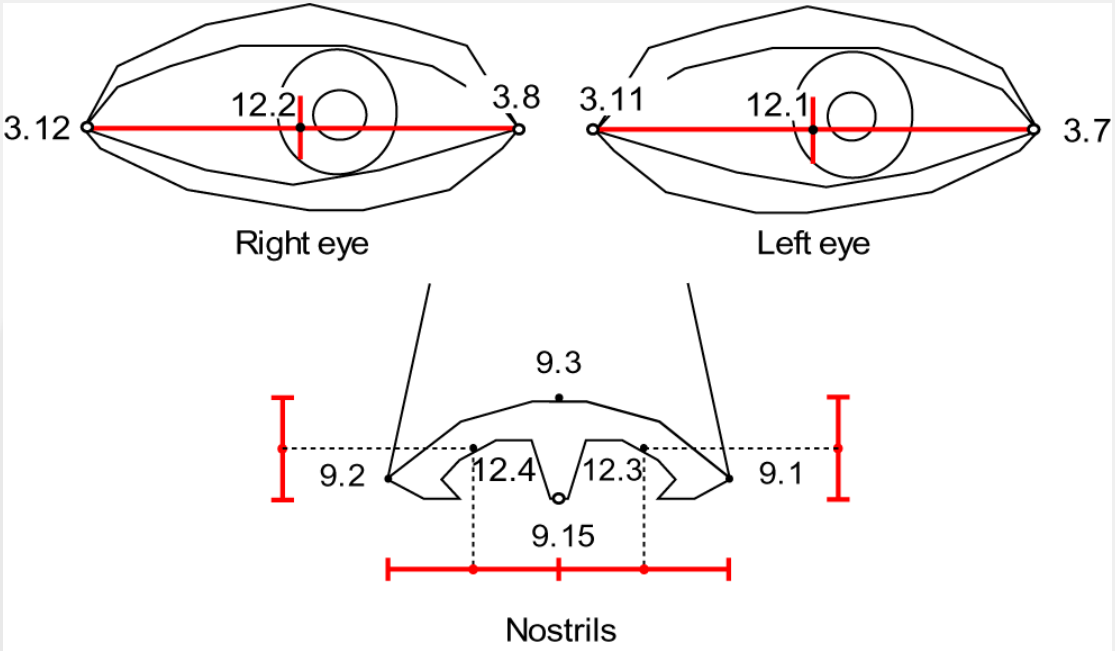
Feature Points (Optional)





- 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

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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.

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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.

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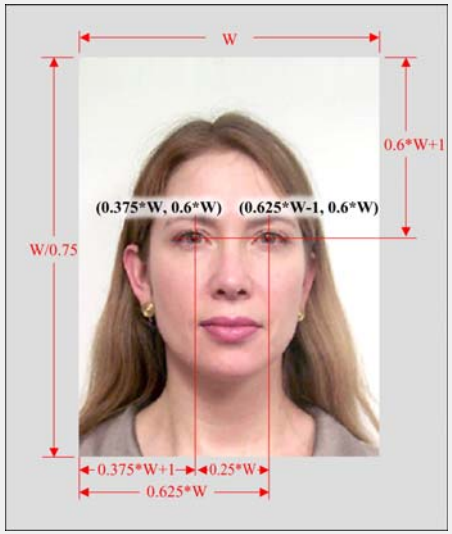
Full Frontal or Token Frontal?

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**

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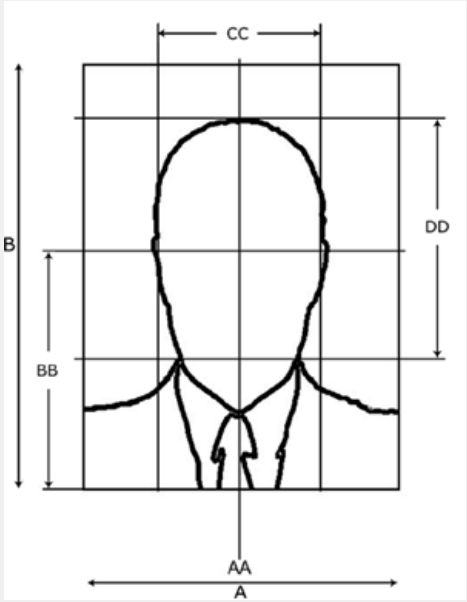
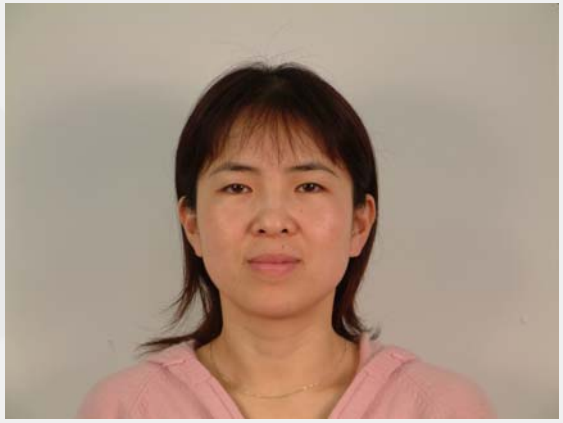
Full Frontal Images – Geometric Constraints

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**

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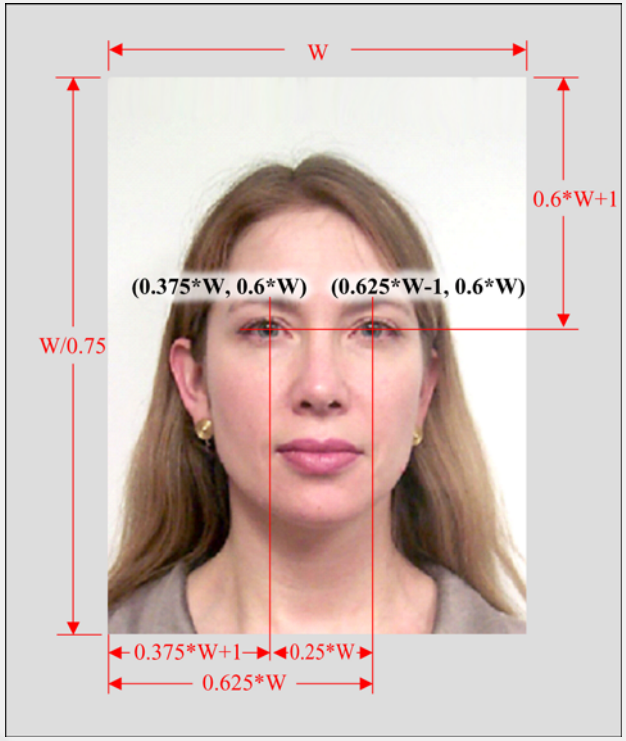
Token Frontal Images – Geometric Constraints

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

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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

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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

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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.

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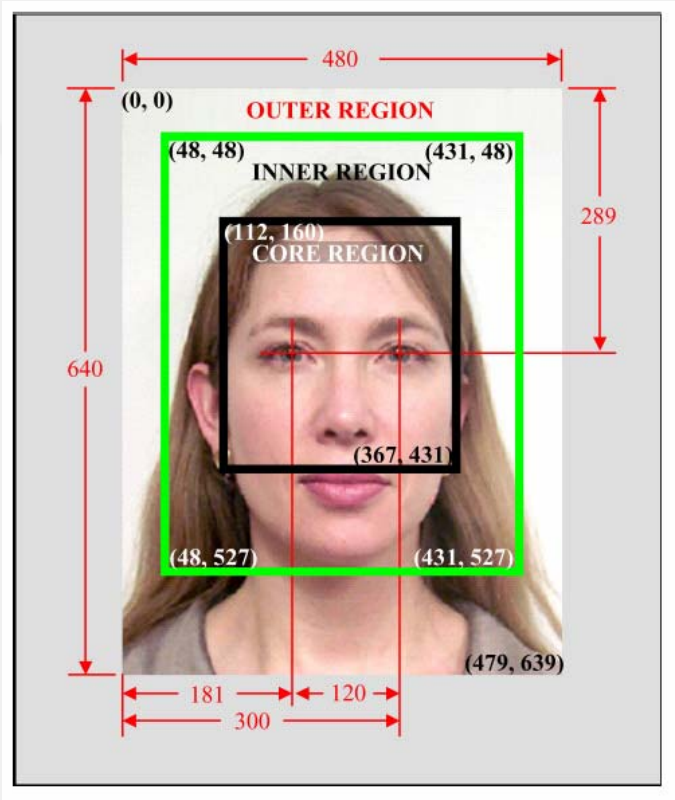
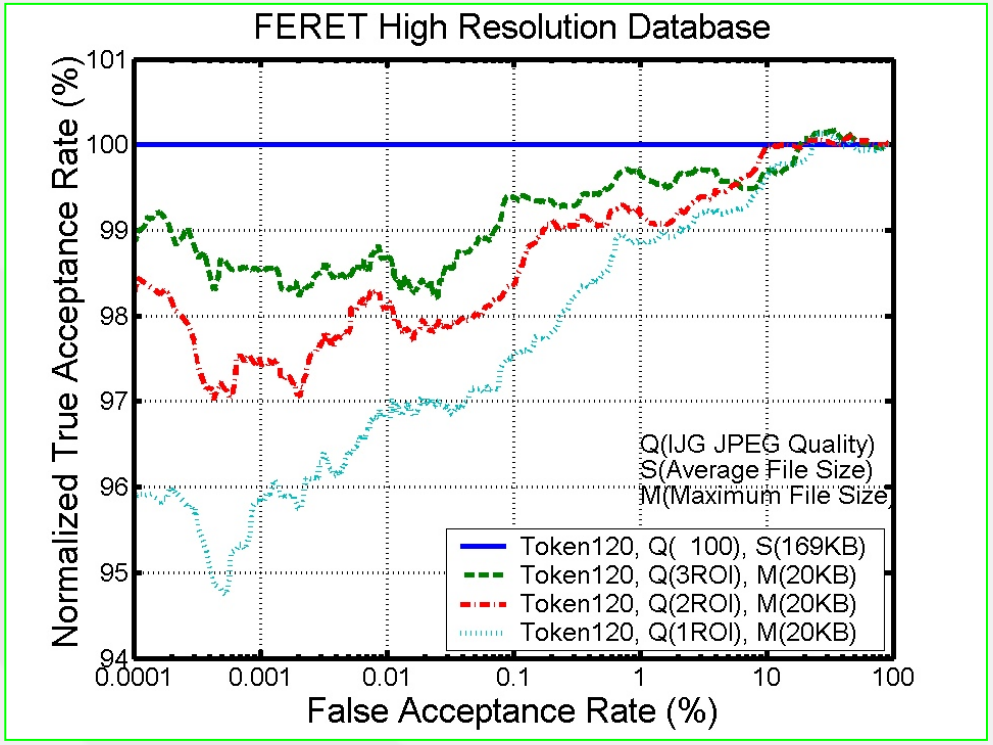
ROI JPEG Compression





- To be discussed in more detail in another presentation

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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.biometricscatalog.org/documents/Phillips%20FRGC%20-%20Feb%202005-5.pdf

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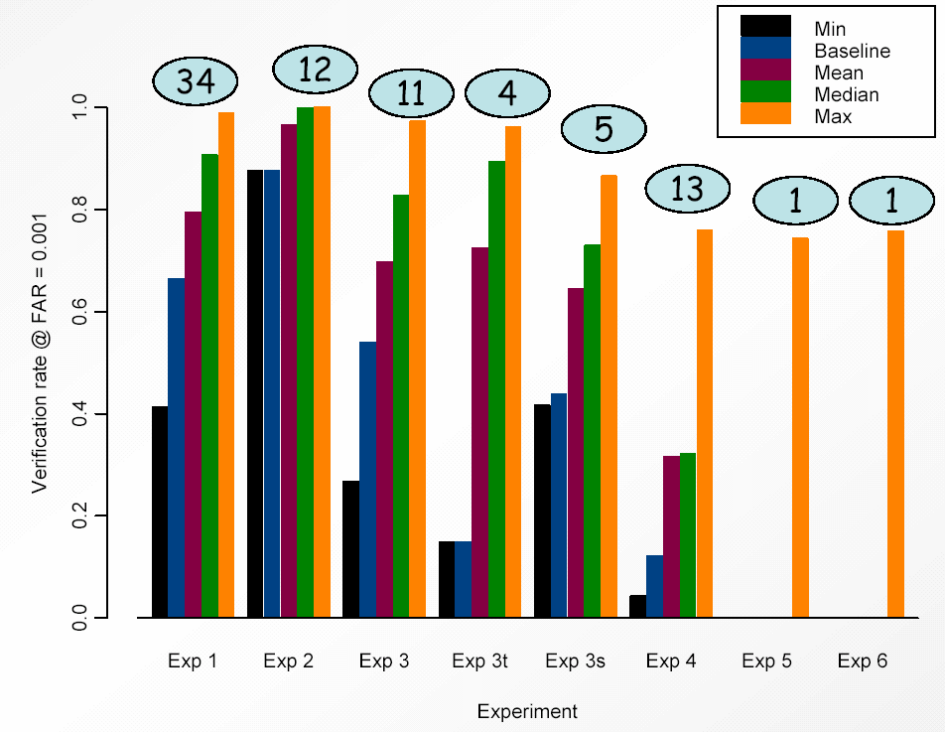
Current 2D vs. 3D Performance Results

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**

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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.

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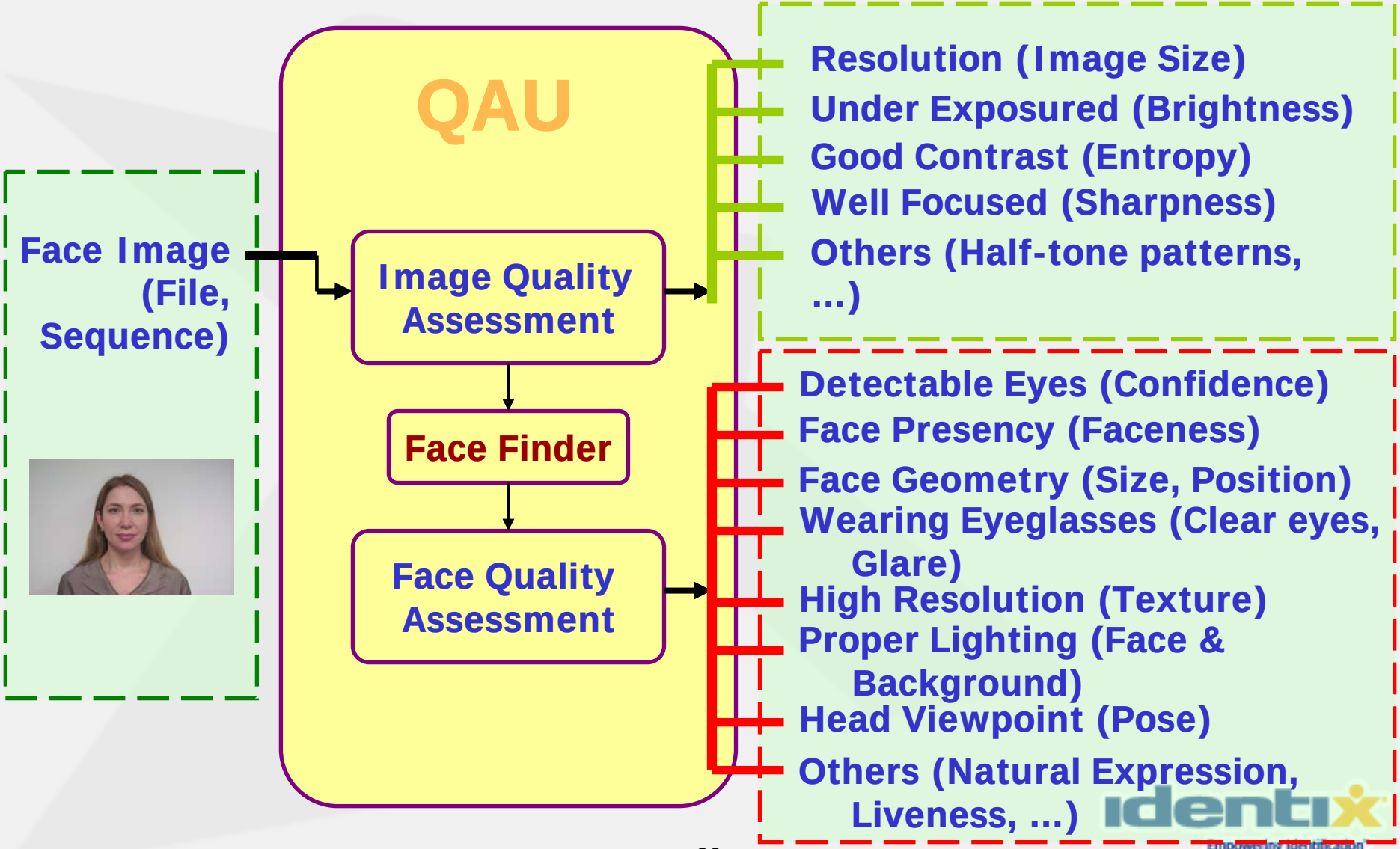
Example: Identix Face IQM



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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

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Thank You. Questions?