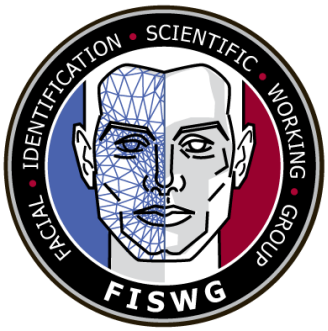

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Non-Frontal Facial Image Capture and Use Guidelines

1. Scope

1.1 This document provides guidelines for capturing non-frontal facial images for use with a Facial Recognition System (FRS).

2. Referenced Documents

2.1 NIST

ANSI/NIST-ITL-1-2011 Update 2015: Data Format for the Interchange of Fingerprint, Facial and Other Biometric Information[1]

Face Recognition Technology Evaluation (FRTE) 1:N Identification[2]

2.2 FISWG

Standard Guide for Capturing Facial Images for Use with Facial Recognition Systems[3]

3. Terminology

3.1 *Acronyms:*

3.1.1 *IOD, n*—Interocular Distance (pixels)

3.1.2 *FRS, n—Facial Recognition System*

3.1.3 *FRTE, n—Face Recognition Technology Evaluation*

3.1.4 *OCD, n*—Ocular chin distance (pixels)

[1] https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.500-290e3.pdf

[2] https://pages.nist.gov/frvt/html/frvt1N.html

[3] https://fiswg.org/FISWG_Guide_for_Capturing_Facial_Images_for_FR_Use_v2.0_20190510.pdf

3.1.5 *SDK, n*—Software development kit

4. Summary of Guide

4.1 Legacy facial image capture guidance has recommended to capture facial images of a frontal pose with angled and profile poses being optional. Until a few years ago the facial algorithms being used had degraded accuracy when an angled or a profile was captured. This limitation has now been addressed with the latest facial algorithms as verified by NIST FRTE testing. While all facial algorithms do not support this pose invariance, it can be assumed that all facial algorithms will evolve to support pose invariance.

4.2 The capture of angled and profile poses should be done in a controlled manner in order to achieve consistency for all images captured regardless of pose.

4.3 The intended audience is for use by practitioners who are choosing, setting up, and operating photographic equipment designed to capture facial images for use with an FRS.

5. Foundational Knowledge

5.1 From “ANSI/NIST-ITL-1-2011 Update 2015: Data Format for the Interchange of Fingerprint, Facial and Other Biometric Information”:

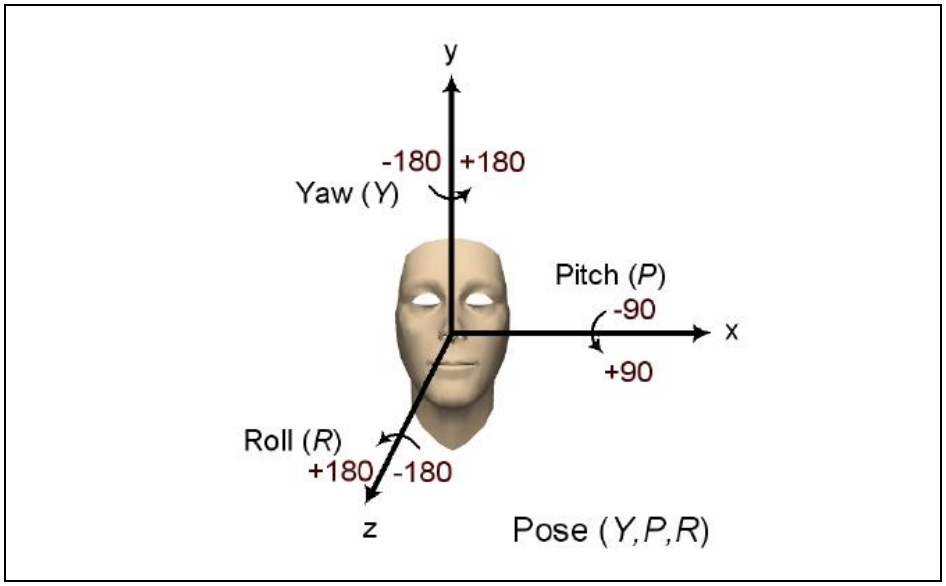
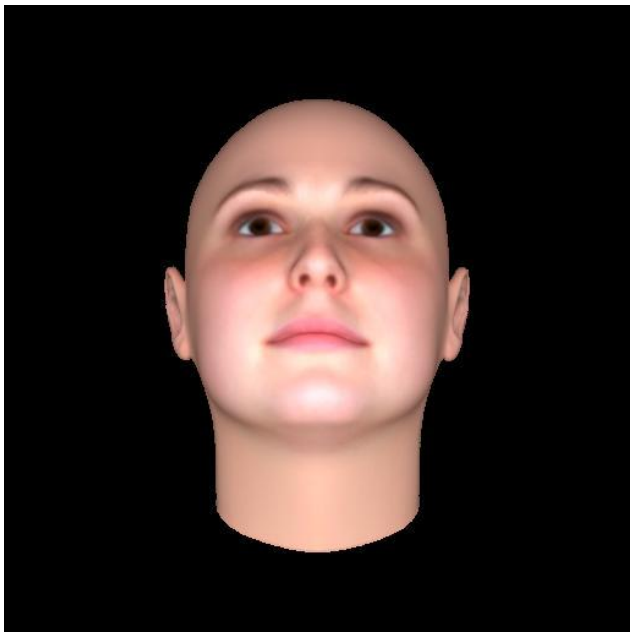
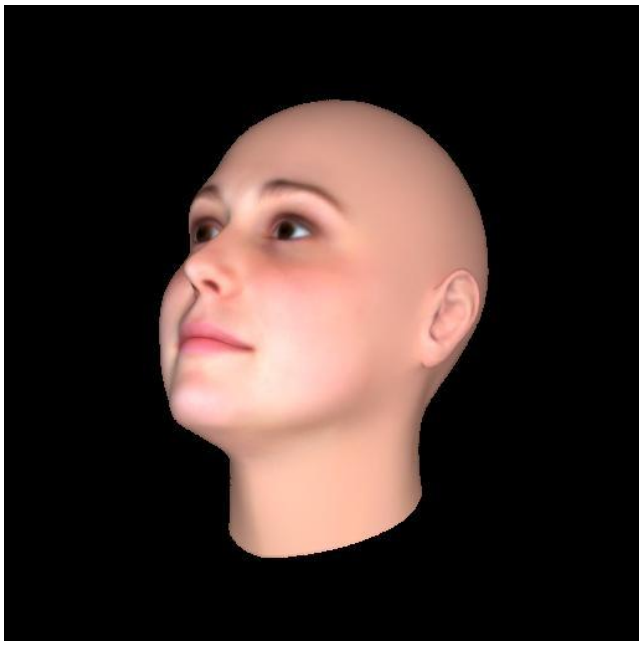
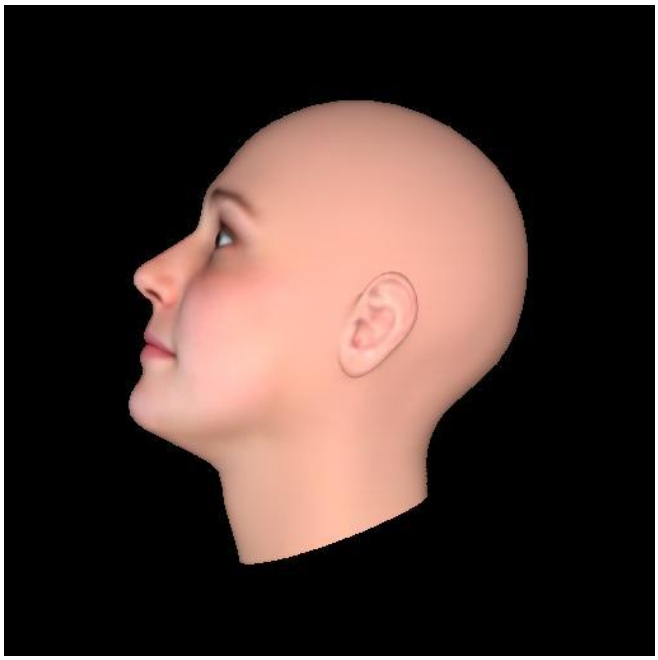
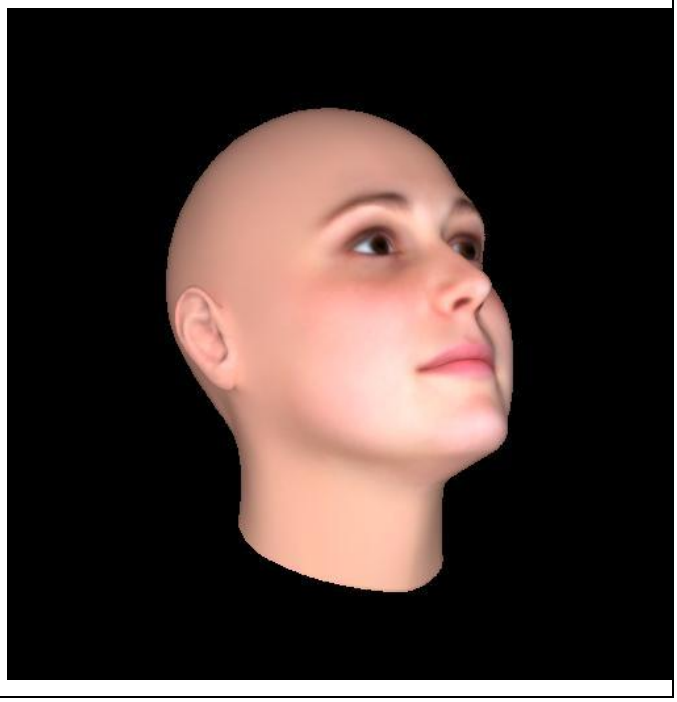


Figure 1: NIST Pose Definitions

5.2 As yaw (see Figure 1) goes from zero degrees to a positive value the facial pose shows the right side of the face. As yaw goes from zero degrees to a negative value, the facial pose shows the left side of the face. All the images in Figure 2 give

examples of yaw but they also have a slight upward pitch (see Figure 1) which can be ignored for the purpose of this document.

Frontal pose: yaw = 0 degrees	
Left Angled: yaw = -45 degrees	

Left Profile yaw: = -90 degrees	
Right Angled: = +45 degrees	

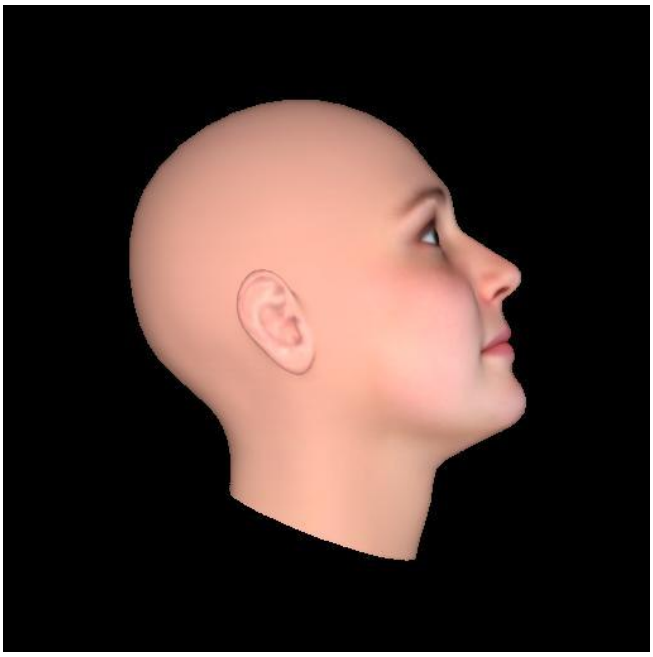
Right Profile: = +90 degrees	

Figure 2: Examples of Yaw

5.3 Observations from varying yaw include the following:

5.3.1 As yaw approaches ~15-20 degrees in either direction the ear on the far side may begin to disappear from the image.

5.3.2 As yaw approaches ~45-50 degrees in either direction the ear, eye, eyebrow, and cheek on the far side will continue to disappear from the image.

5.3.3 As yaw approaches ~90 degrees in either direction the ear, eye, and cheek on the far side will completely disappear from the image.

6. Significance and Use

6.1 The FISWG document “Standard Guide for Capturing Facial Images for Use with Facial Recognition Systems” focuses on capturing frontal images. As reported by NIST FRTE testing the recent algorithmic advances achieve high search accuracy with non-frontal poses that range from +/- 90-degree profile images.

6.2 From “Standard Guide for Capturing Facial Images for Use with Facial Recognition Systems”, a controlled facial capture environment is illustrated in Figure 3:

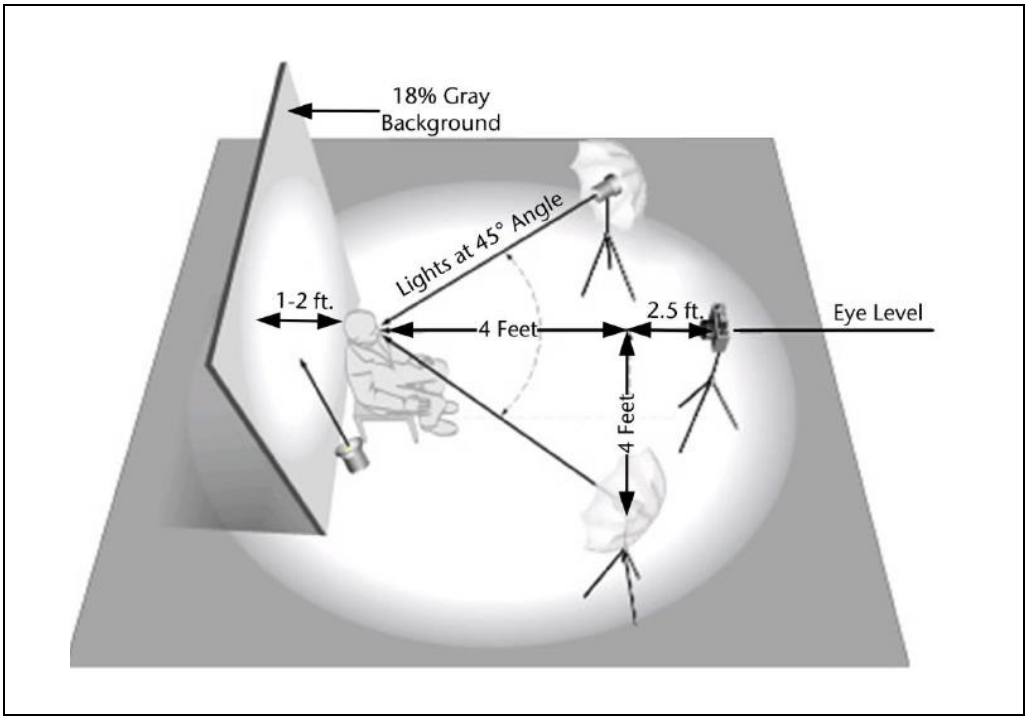


Figure 3: Controlled Acquisition Environment

6.3 For capturing a set of five facial poses: frontal, +/- 45-degree angled, and +/- 90-degree profile, it is suggested to use guides on the floor or wall to assist the rotation of the person being imaged in a consistent manner by turning their body in the direction indicated by the footprints on the floor or markers on the wall rather than simply turning their head. See Figure 4 for examples.

	
Frontal Pose	Left Angled Pose

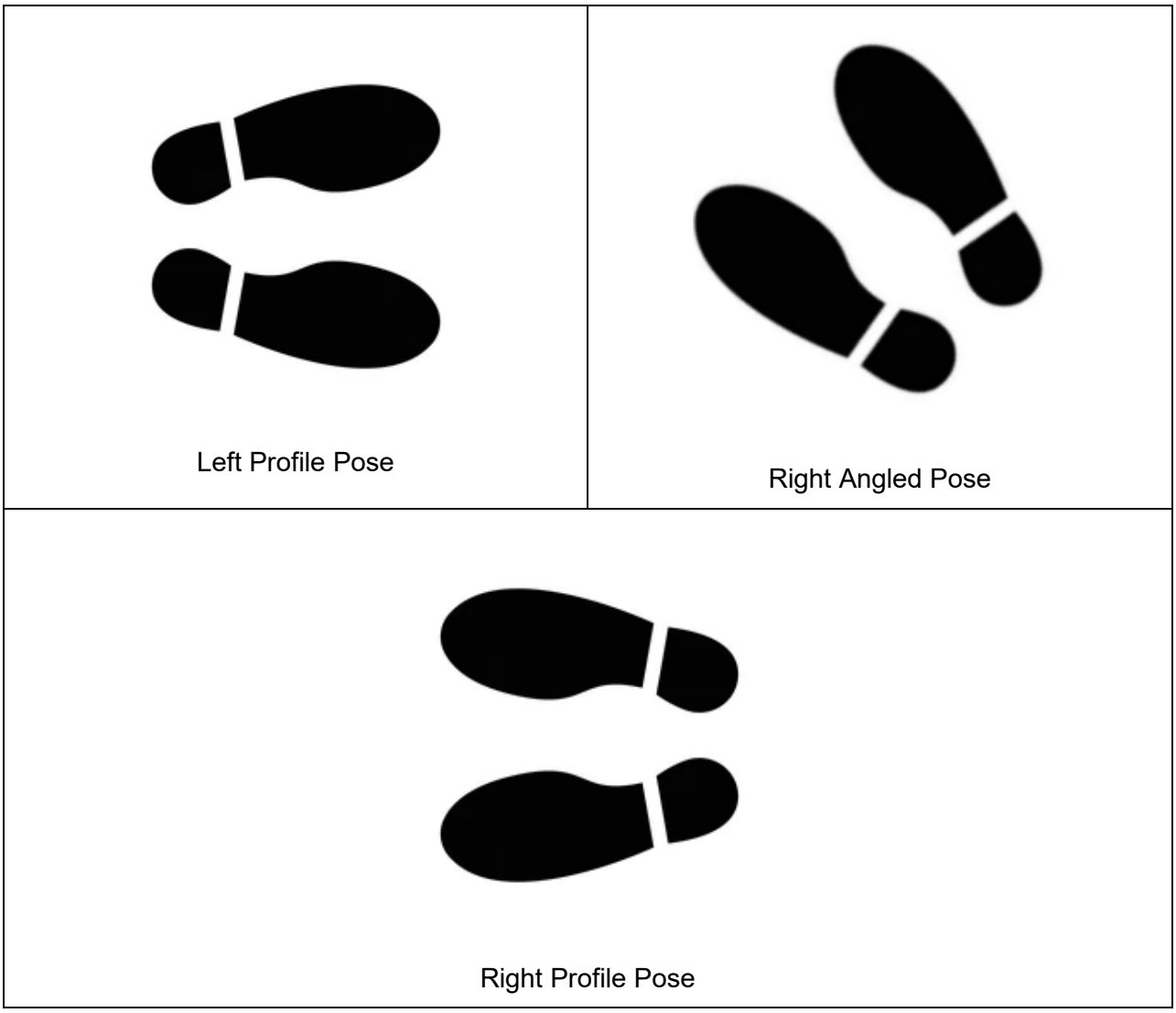


Figure 4: Footprint Guides

6.4 When capturing angled and profile poses, ensure the ear and neck area is not obstructed.

6.5 From the FISWG document[4] “Standard Guide for Capturing Facial Images for Use with Facial Recognition Systems”, the image capture settings defined should be used for all facial poses captured as illustrated in Figure 3.

6.6 When searching non frontal facial poses, practitioners should check with their algorithmic vendor or integrator and address the following topics:

6.6.1 Does the algorithm support pose invariant searching?

6.6.2 Is there a known accuracy decline as the pose yaw increases?

6.6.3 Are there any search parameters that could be adjusted as the pose yaw increases?

6.6.4 How is manual facial localization done when pose yaw increases and where both eyes are not visible? As illustrated in Figure 5, algorithms that support pose invariance may require the manual placement of additional facial landmarks (e.g., both eyes as well as the chin). The agency should check with the algorithm vendor for proper procedures here.

Frontal Pose	Right Profile Pose
	

Figure 5: Manual Localization

6.7 When evaluating non frontal facial poses, additional image quality metrics need to be evaluated and understood.

6.7.1 The Interocular Distance (IOD) is defined as the distance between eye centers (see the red line in Figure 6). As the facial pose rotates from a frontal pose to a full +/- 90-degree profile pose this pixel measurement will decrease and will approach a value of zero.

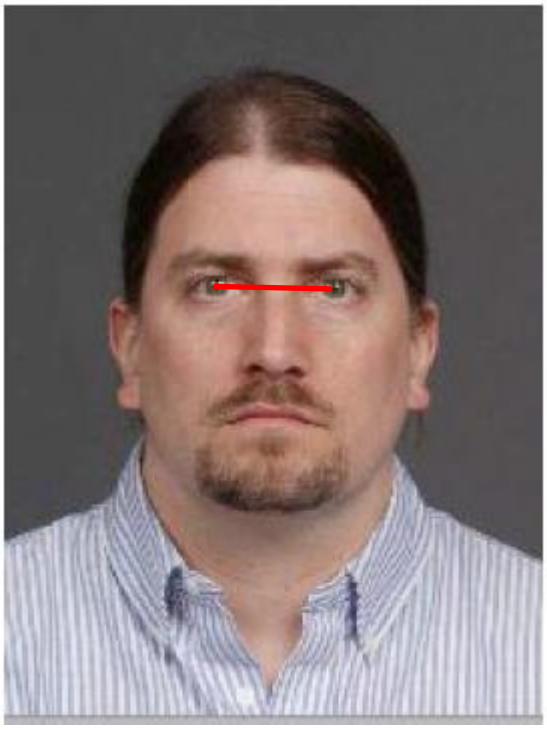


Figure 6: IOD

6.7.2 The Ocular Chin Distance (OCD) is defined as the distance between the eye center line and the chin (see the yellow line in Figure 7). As the facial pose rotates from a frontal pose to a full +/- 90-degree profile pose this pixel measurement will remain stable.

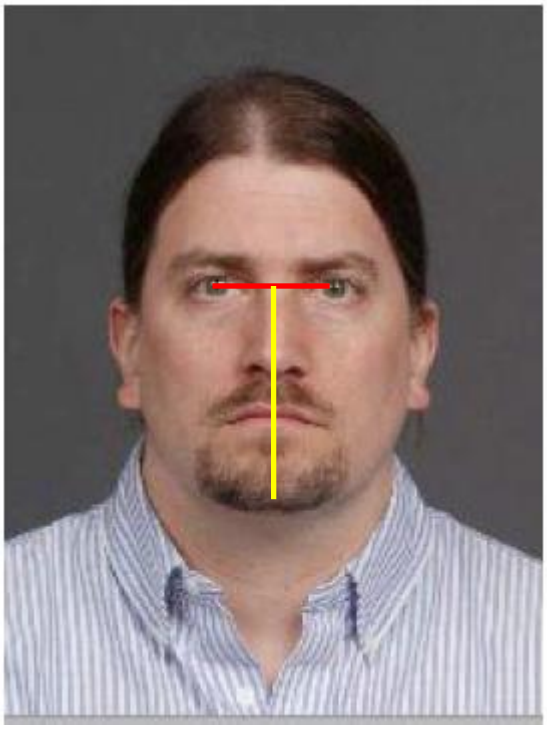


Figure 7: OCD

6.7.3 The algorithmic Software Development Kit (SDK) used should support yaw and tilt metrics that can be used to verify that the angled and profile poses are properly located by the algorithm. This should be verified during FRS testing of the algorithm to verify the pose rotation is being properly extracted.

6.7.4 Deployment testing of the FRS algorithm should include accuracy testing of all poses to all other poses to verify consistent accuracy. If there is a measurable decrease in accuracy, then operational workflows or search parameters may need to be adjusted.