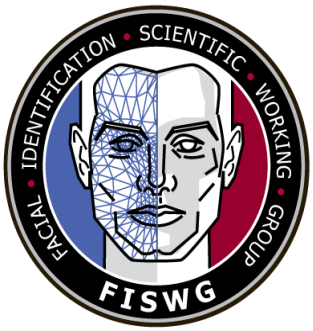

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Standard Guide for Capturing Facial Images for Use with Facial Recognition Systems

1. Scope

1.1. This guide is intended for use by practitioners who are choosing, setting up, and operating photographic equipment designed to capture facial images for use with an automated Facial Recognition System or used for manual comparisons by a trained facial examiner. This document provides an overview of how to achieve the specifications defined in ANNEX E of "ANSI/NIST-ITL-1-2011 Update 2015: Data Format for the Interchange of Fingerprint, Facial and Other Biometric Information" for capturing facial images".

1.2. ANNEX E of ANSI/NIST-ITL-1-2011defines a well-controlled capture environment and subject whereas this document will give guidance where tight controls in the capture environment and subject control cannot be achieved.

1.3. This document addresses equipment considerations for two-dimensional (2D) conventional images. It does not address video, scanners or three-dimensional (3D) capture.

2. Referenced Documents

2.1. ASTM Standard:

E2916 Terminology for Digital and Multimedia Evidence Examination1

2.2. Other Biometric Standards:

ANSI/NIST-ITL-1-2011 Update 2015: Data Format for the Interchange of Fingerprint, Facial and Other Biometric Information[2]

[1] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@asstm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

[2] Available from http://ws680.nist.gov/publication/get_pdf.cfm?pub_id=921456.

NIST Special Publication 500-280v2: Mobile ID Device Best Practice Recommendation Version 2.0[3]

3. Terminology

3.1. Definitions: See ASTM E2916 Terminology for digital and multimedia evidence examination terms.

- Fisheye effect: a type of distortion, where central objects of the image erroneously appear closer than those at the edge typically resulting in what appear to be unusually large noses in the image.

3.2. Acronyms:

- 2D—two-dimensional
- FR—facial recognition

4. Significance and Use

4.1. The key factors that determine image quality for highly controlled facial images (for example: passports, police mugshots, driver's license, etc.) are well understood with respect to their use in automated FR systems and are a critical factor which directly affects the searching accuracy of the FR system.

4.2. Image quality also plays a major role in determining the extent to which a trained facial examiner is able to reach a conclusion as to whether two images containing faces are likely to be of the same person or not. This applies to either reviewing a FR system candidate result set or 1:1 image comparisons.

4.3. This document provides guidance for the capture of facial images under controlled, semi-controlled, and uncontrolled scenarios for constraints which can be categorized into the following types of requirements:

- Scene: refers to the content, subject and background in the image,
- Photographic: refers to lighting, focus and other constraints required for image capture,
- Image Capture: refers to the conversion of the captured image into a digital record.

[3] Available from: http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.500-280v2.pdf

5. Scenarios

5.1. Controlled acquisition

5.1.1. This scenario is when all constraints can be controlled including image capture equipment, the photographic environment (camera position, lighting, distance, background, and resolution), and the pose and positioning of the subject. The subject can be directed or positioned, the environment can be arranged to provide ideal illumination, and other equipment used has been appropriately selected and available for use.

5.1.2. Referenced document "ANSI/NIST-ITL-1-2011 Update 2015 Annex E: Facial Capture – SAPs 30 and above" provides specifications on all aspects of controlled acquisition scenarios.

5.1.3. Fig.1 and Fig.2 in this document presents illustrative examples for controlled capture scenarios.

5.1.4. Fig. 1 provides an example of an optimal setting for a controlled capture environment. The selection and placement of the lighting addresses the following variables:

- There is sufficient and uniform lighting to capture all visible skin characteristics (that is, blemishes, moles, marks, etc.)
- To avoid hot spots and shadows on the subject's face
- The 0.3 m - 0.6 m (1ft. - 2 ft.) distance (with or without a backlight) between the background and the subject is intended to reduce background shadows.

5.1.5. Fig. 2 provides examples of optimal facial images captured. Frontal, right, left, and three-quarter profile images should be captured as these provide additional value for examiners undertaking forensic comparison. The subjects head is positioned in the image as shown.

5.1.6. Automated image quality software is available from various commercial suppliers that can help to determine if the frontal image is captured as per the recommendations. However, in all cases, a manual check is advised as the software may not take into account all of the constraints.

5.2. Semi-controlled acquisition

5.2.1. This scenario refers to when some, but not all, constraints can be controlled. Example scenarios of this include passport photos not taken in a controlled environment, law enforcement mobile capture, crime scenes, access control, walk-through automated gates. In these situations, selection of image capture

equipment may vary, lighting may not be rigidly controlled, and subject pose may be difficult to control.

5.2.2. In a semi-controlled environment, the following constraints should be considered as a priority:

- Illumination
- A single frontal face with open eyes and neutral expression
- Reduction of perspective distortion (subject should be more than 1 m (3.25 ft.) from the camera)
- Elimination of obstructions
- Where available, multiple images should be captured to compensate for shortcomings in individual images

5.3. Uncontrolled acquisition

5.3.1. This scenario refers to when neither the environment nor the subject can be controlled. Example scenarios of this include: surveillance, hand held camera, body cameras, cell phones, etc. These are characterized by high variations in quality and content and typically require human review and specialized tools to identify and extract usable facial content. In these situations, selection of image capture equipment will vary, lighting may be uncontrolled, and subject pose may be difficult to control. (See NIST Special Publication 500-280v2.)

5.3.2. In these situations, the person capturing the image should improvise to get the best image possible (see Fig. 3):

- When appropriate use a camera flash or additional lights source(s) to improve illumination
- Position the camera to get the best pose possible or provide a visual attractor to influence the pose
- A single frontal face with open eyes
- Reduction of perspective distortion (subject should be more than 1 m (3.25 ft.) from the camera)
- Elimination of obstructions
- In these uncontrolled scenarios, multiple images should be captured to compensate for shortcomings in individual images

6. Keywords

6.1. capture equipment; facial image; facial recognition

ANNEX
Mandatory Information
A1. TABLES

TABLE A1.1 Description of a Controlled Acquisition Environment (Critical environmental factors when capturing images)

No.	Item	Description	Comments
1	Illumination	Lighting shall uniformly illuminate the subject and the background. Hot spots or reflections shall be minimized. Lighting should simulate the lighting conditions of a bright but cloudy day.	Use of an optional third light as a backlight (to eliminate shadows on the background) generally requires about 1m (3.25 ft.) of additional floor space behind the subject. This additional space may not be available in all environments. Use of flash is discouraged. However, if a flash is used, where possible, either diffuse the light or bounce the light off a neutral-colored ceiling to avoid harsh, uneven lighting. Consideration should be made to the color of the ceiling to avoid casting unnatural color on the subject.
2	Camera position	The camera shall be at eye level and shall be mounted in a horizontal position with no tilt. The camera height shall be positioned at the same height as the subject's eyes and positioned approximately 2 m (6.5 ft.) from the subject.	Possible solutions are to place subject in an adjustable seated position or to mount the camera on a pole and adjust its height.

No.	Item	Description	Comments
3	Background	Background should be uniform light gray.	18 % gray is recommended as a background color. 18 % photographic gray cards and backgrounds are widely available from photographic suppliers. The level of gray is less important than ensuring that it is a neutral gray and that the subject's head is clearly distinguishable from the background with no shadows or other objects visible in the frame. The background shall completely fill the image frame behind the subject.

TABLE A1.2 Optimal Subject Appearance
(Critical factors for controlling subject poses when capturing images)

No	Item	Description	Comments
1	Facing	Frontal: Subject shall face directly towards the camera with no more than ±5° variance from frontal in roll, pitch, and yaw. Profile: When there is a requirement for profile shots, the whole body shall be turned 45 and 90° right and left.	Visual cues that can assist an operator in determining "forward orientation" are: 1. Both eyes are level on an imaginary horizontal line (zero roll angle), 2. Both ears are equally visible if unobstructed by hair) and nose is forward (zero yaw angle), and 3. The chin is neither elevated or dropped (zero pitch angle).
2	Head coverings	Head coverings, including hats and scarves, shall not be worn, unless for religious reasons or medical purposes.	The full face shall be displayed and the ears should be displayed.

3	Hair	When capturing both frontal and profile images, the subject's hair should be moved back.	The full face shall be displayed and the ears should be displayed.
4	Glasses	If the subject wears glasses, at least one frontal image should be captured with glasses and one image without glasses.	If the subject is wearing glasses, glare from the lenses shall be avoided, for example, by adjusting the lighting. Eye patches are allowed only for medical reasons.
5	Expression	Subject shall have a neutral expression.	It is the operator and subject's responsibility to ensure there are no smiles or grimaces.
6	Mouth	Mouth shall be closed.	
7	Shoulder position	Shoulder position shall be square and forward facing for frontal images. Shoulder position shall be perpendicular for profile images.	
8	Accessories	Accessories should be removed.	
9	Make-up and cleanliness	The subject's face shall be presented without heavy makeup or dirt.	Use of a disposable wipe cloth is recommended to remove excessive makeup or surface dirt. This may not be practical in noncriminal image capture.
10	Face count	Only one face per image is allowed.	Take measures to ensure that other subjects are not captured, such as a baby in arms.

11	Medical conditions	If bruising, injuries, bandages, or medical conditions are present, these should be presented as is.	The presence of injuries or bandages on the face will limit the value of the images for use with automated FR systems. Depending on the use case, it may be beneficial to capture an additional image at a later date when the injuries are not visible.

TABLE A1.3 Optimum Parameters for Controlled Acquisition
(Critical factors for the capture and storage of digital images)

No.	Item	Description	Comments
1	Camera type	Use a high-quality digital camera such as a digital single-lens reflex (DSLR) or a point and shoot camera with manual exposure override features.	Digital cameras that lack manual exposure override are less suitable. The use of webcams and cell phone cameras is not recommended.
2	Camera resolution	ANSI/NIST-ITL-1-2011 Update 2015 provides subject acquisition profiles (SAP) that describe a set of characteristics expected of the facial image with stringency of the requirements increasing with SAP level.	Higher SAP levels result in larger pixel image sizes (height, width), on-disk file storage, and will require a corresponding increase in the camera resolution. The highest level of SAP 50 and 51 are recommended for forensic image analysis.
3	ISO rating	If the ISO setting on the camera is adjustable, it should be set to the lowest value that also meets shutter and aperture requirements (per Items 7 and 8 in this table).	Operators should be familiar with the camera's automated features that may help simplify the adjustment of ISO, shutter speed, and f-stop to compensate for low light conditions. The setting should be set so that there is no visible noise in the image.
4	Focus	The operator can use auto or manual focus.	Do not use fixed focus (for example, cell phones or disposable cameras). Good results will normally be obtained by focusing on the eye area.
5	Face detection capability (face priority auto focus)	Optional.	If the camera has face detection capability, its use is recommended. If there are multiple subjects, it shall be verified that the correct face has been selected and is in focus.

No.	Item	Description	Comments
6	White balance	The white balance setting on the camera should be adjustable to capture natural colors.	The white balance should be calibrated using 18 % gray background or gray card. Calibration should be done as part of a regular preventive maintenance program the agency uses.
7	Aperture f/stop	The recommended aperture setting is f/5.6-f/11.	This range of f/stop values will usually provide sufficient depth of field to obtain a focused picture that extends from the nose to the ear [with subject 2 m (6.5 ft.) from the camera]. Note that, in general, the aperture and shutter speed should be set using the camera's automatic feature. This feature will help to minimize image blur and optimize image focus.
8	Shutter speed	A general rule of thumb is that the shutter speed is at least 1/focal length or faster.	If electronic flash is being used, the shutter speed should be slower than, or equal to, the camera's flash synch speed.
9	Focal length	For digital camera sensors, the recommended focal length is two to three times the diagonal of the sensor.	The focal length should be between 90 and 130 mm (3.5 in. and 5 in.) 35 mm film equivalent.
10	Flash	Flash may be used if existing light is insufficient and no external light sources are available. An external flash should be used (do not use the in-built flash provided with the camera).	Subjects may blink in anticipation of flash. Use flash only if necessary (for example, existing illumination is insufficient to meet shutter speed and f/stop requirements).
11	File Format	Use an industry standard acceptable format. High-quality JPEG or JPEG2000 with EXIF data (that is, choose "highest-quality" image settings).	Most digital cameras support the use of EXIF data.
12	Compression	The best practice is to use lossless compression. It is acceptable to compress images up to 15:1.	

No.	Item	Description	Comments
13-	Color space	The recommended color space is sRGB because it is a device-independent specification.	LAB color space is also acceptable.
14	Tripod support	Required.	The camera should be mounted on a tripod with adjustable height. Note that seated subjects will have less height variability. If no tripod is available, then a camera with image stabilization should be used.
15	Memory interface	USB, memory card, or HDMI.	Memory card and USB is usually used for file transfer. HDMI is optional for a remote viewer and capture station.
16	Remote capture	Optional.	Remote capture software with appropriate connections allows computers to control a digital camera remotely.
17	Orientation	Images shall be captured using a portrait orientation. If landscape orientation is used, images shall be rotated to upright orientation (portrait) for submission and storage.	Any orientation done shall be done in 90-degree increments.
18	Metadata	Metadata stored within the image itself is critical to data integrity and any potential chain of evidence issues with the images captured.	All available metadata should be used for image capture. This includes such items as date/time, GPS, camera make/model/serial number, etc.

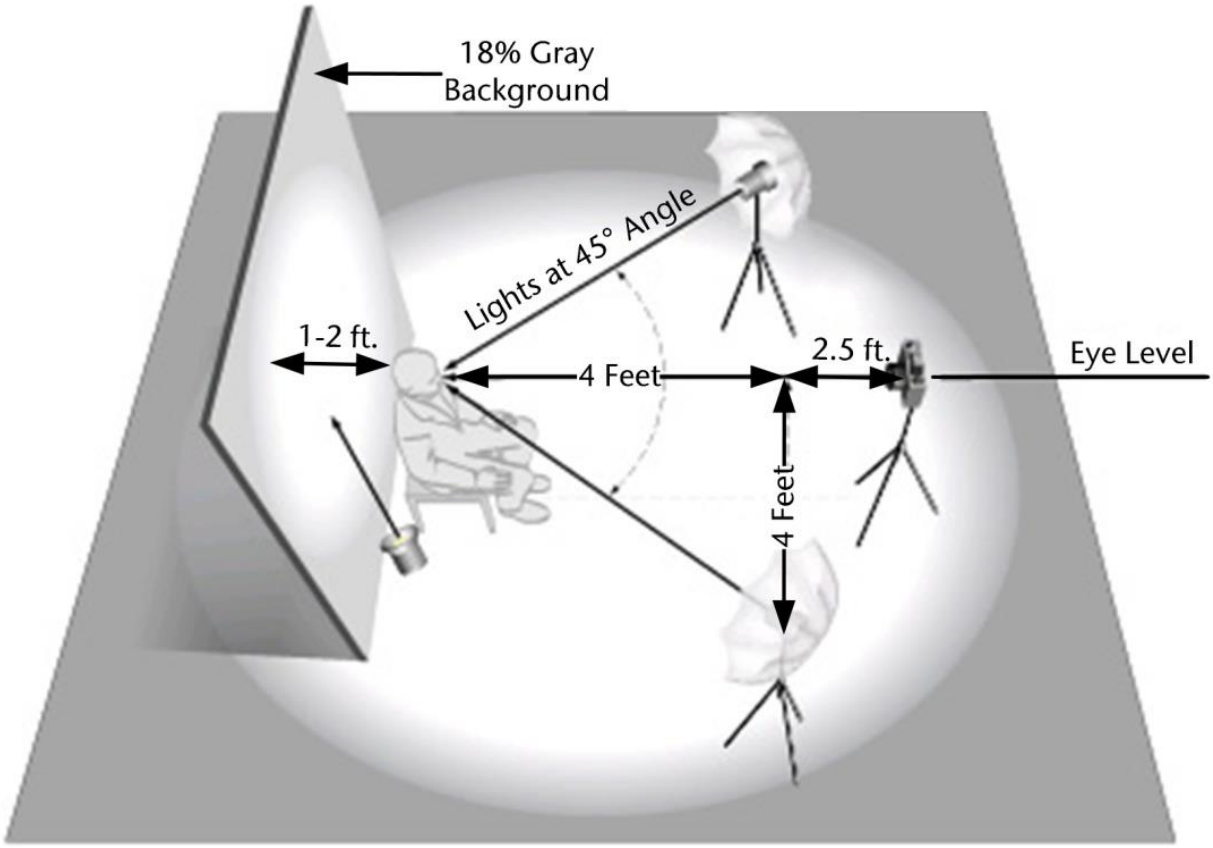

FIG. 1 Example of a Controlled Acquisition Environment

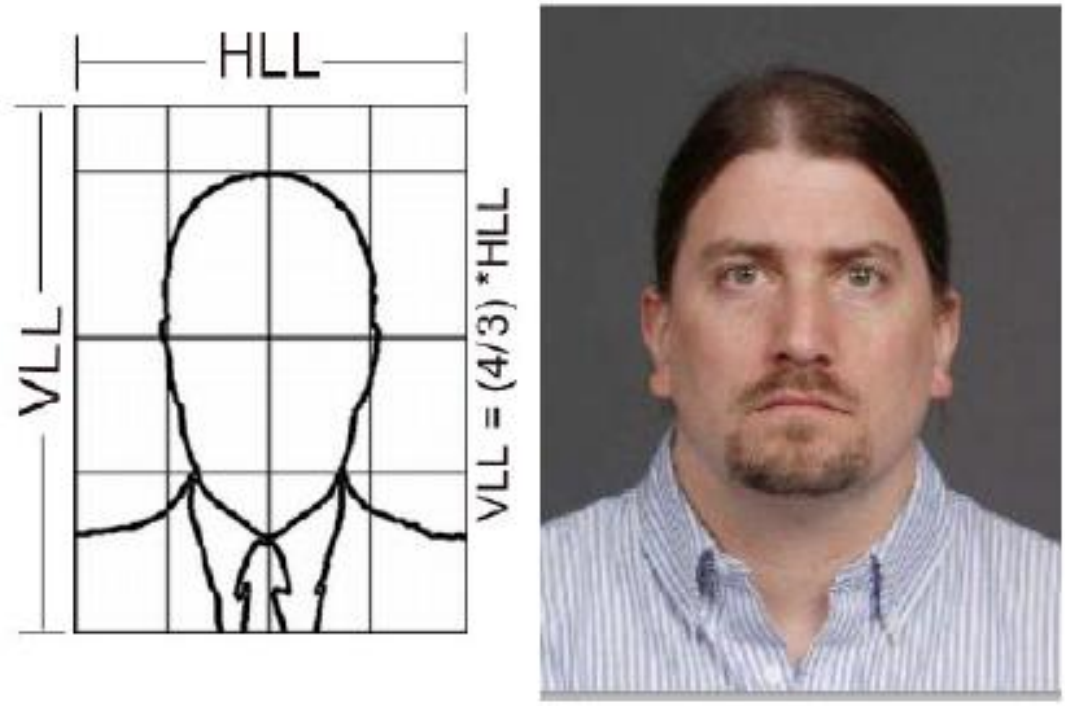

FIG. 2 Example Poses from a Controlled Acquisition Environment

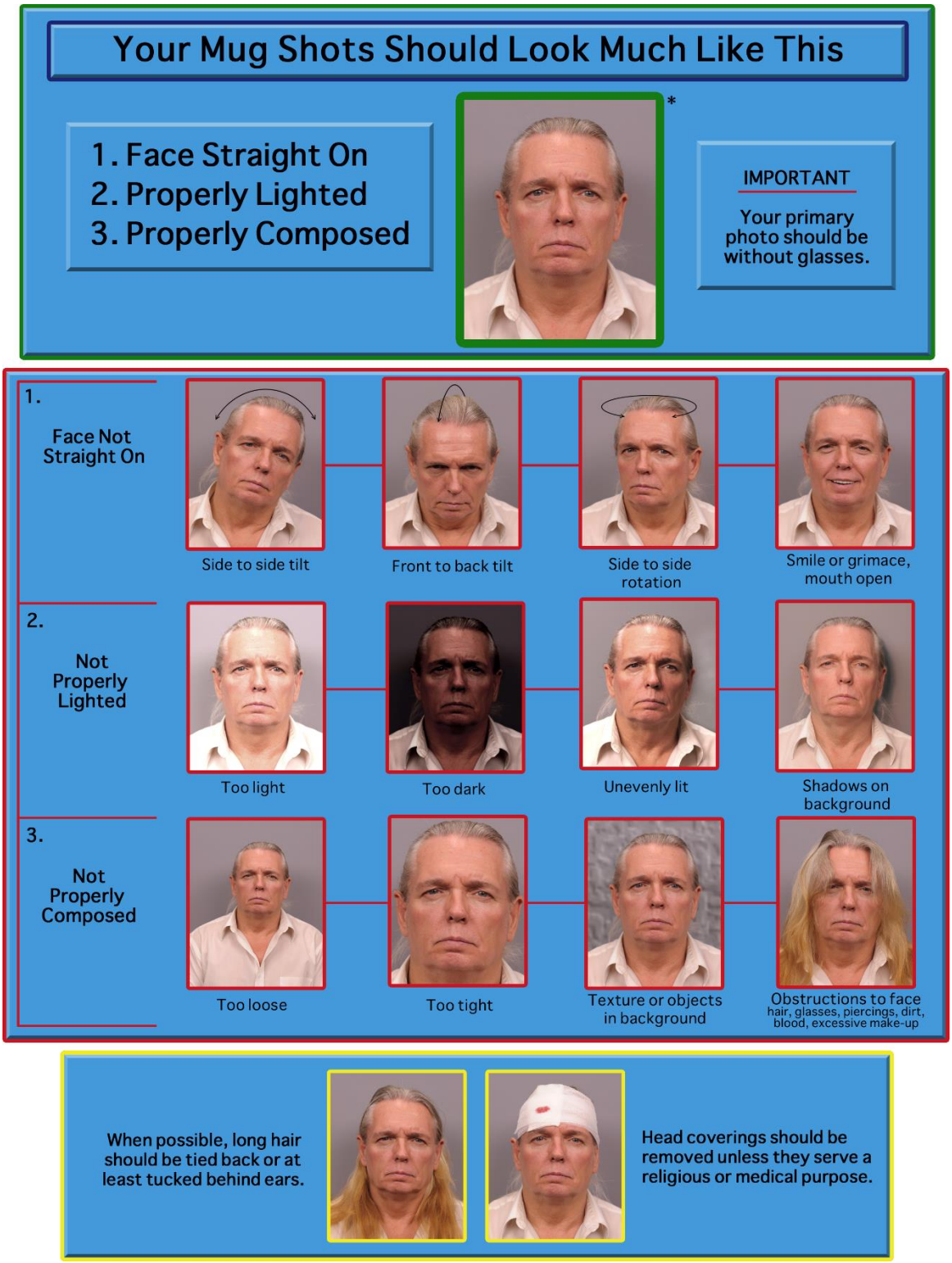

FIG. 3 Examples of Improper Poses from a Controlled Acquisition Environment
https://www.tn.gov/content/dam/tn/tbi/documents/Mug Shot Best Practices Poster.pdf.