



Designation: E3445 – 24

Standard Practice for Image Processing to Improve Automated Facial Recognition Search Performance¹

This standard is issued under the fixed designation E3445; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes the steps to process a probe image to maximize the likelihood that a facial recognition system (FRS) search returns a potential candidate.

1.2 The practice does not address the necessary steps and processes for a manual examination.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This standard cannot replace knowledge, skill, or ability acquired through appropriate education, training, and experience and should be used in conjunction with sound professional judgment.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

E2825 Guide for Forensic Digital Image Processing

E2916 Terminology for Digital and Multimedia Evidence Examination

2.2 Other Standards:

ANSI/NIST ITL-1-2011 Data Format for the Interchange of Fingerprint, Facial & Other Biometric Information³

¹ This practice is under the jurisdiction of ASTM Committee E30 on Forensic Sciences and is the direct responsibility of Subcommittee E30.12 on Digital and Multimedia Evidence.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ <https://www.nist.gov/programs-projects/ansinist-itl-standard>.

FISWG Facial Recognition Systems Metadata Usage⁴

ISO/IEC 19794-5 Information Technology—Biometric Data Interchange Formats—Part 5: Face Image Data⁵

NIST Special Publication 500-290 Edition 3 (2015)⁶

3. Terminology

3.1 Definitions:

3.1.1 See Terminology E2916 for digital and multimedia evidence examination terms.

3.1.2 *candidate list, n*—in facial identification, a rank ordered list generated from a facial recognition search.

3.1.3 *pass, v*—a FR search of a probe image against a database to generate a candidate list.

3.1.4 *probe, n*—in facial identification, a facial image or template searched against the gallery in a facial recognition (FR) system.

3.2 Acronyms:

3.2.1 FRS—facial recognition systems

4. Summary of Practice

4.1 The image processing steps presented in this practice are limited to the manual processing of images intended to be submitted as probe images for facial recognition systems (FRS) searches. Internal image processing applied by the FRS and issues associated with still image extraction from video, scanning of printed imagery, and the use of forensic sketches, reconstructions, and composites are beyond the scope of this practice.

4.2 This practice describes a progression (minimal to complex) for the manual processing of probe images of less-than-optimal quality for an FRS. These steps are intended to maximize the likelihood of obtaining a potential candidate while minimizing the amount of processing of the probe image.

⁴ Available from the Facial Identification Scientific Working Group (FISWG), <https://www.fiswg.org/document/viewDocuments>.

⁵ Available from <https://www.iso.org/standard/38749.html>.

⁶ Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, <http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.500-290e3.pdf>.

5. Significance and Use

5.1 Images that meet agreed upon international standards (such as ISO/IEC 19794-5: Face Image Data) can normally be submitted to an FRS for searching with little or no operator intervention.

5.2 Manual processing may be beneficial for sub-optimal images (for example, low resolution, heavily compressed, or where the subject's pose, illumination, or expression are non-neutral). The processing techniques presented in this practice may be applied over an entire image or in localized areas. However, some images may be degraded to the extent that manual processing will not improve the FR search outcome.

5.3 The image processing topics presented in this practice are not intended to override recommendations for maintaining the forensic quality of images intended for a one-to-one comparison. These processes specifically apply to preparing a facial image to submit as a probe into an automated FRS maximizing the likelihood that a potential candidate will be returned in a search result set.

5.4 The goal of any image processing should be to optimize the image for searching by the FRS, not to create an aesthetically pleasing image. An image that looks 'good' is not necessarily the same as one optimized for use by an FRS due to image processing done within vendor specific algorithms.

5.4.1 The effect of any manual image processing will vary with different FRS and, in some cases, may degrade performance rather than improve it.

5.4.2 Image processing to the probe image before an FRS search differs from the operational processes performed for a one-to-one manual comparison.

5.4.3 Any decision regarding whether a candidate returned from an FRS search is from the same source as the probe image must be made based on a comparison with the original (unedited) image and NOT the processed image.

5.4.4 Agency-specific or mandated notes and audit trails shall be maintained at all times.

6. Image File Management

6.1 The initial steps for the management of probe imagery include, but are not limited to, the following:

6.2 A working copy shall be made of the original probe images.⁷ No image processing or modifications shall be made to these original probe image(s). When making final comparisons, always revert to the original probe image(s).

6.3 Make lossless working copies. All image processing steps should be done using a lossless file format.

6.4 If a probe image is not in an FRS-compatible format, follow the vendor's recommendations for conversion to a supported compatible format. If the supported compatible format is not lossless, this should be the last step, prior to searching.

6.5 All processed images used as search probes shall be retained. Retention of these probe images is required for

repeatability, as probe images processed differently could result in different candidate sets.

7. Search Progression

7.1 Within this practice, a "pass" refers to applying specified image processing, running an FRS search using the processed image as the probe, and assessing the resulting candidates. In all examples of "passes" presented in this practice, it is assumed that for every sequential "pass" the following steps shall be undertaken in every FRS search of a probe image. See [Fig. 1, Simplified Image Processing Flow Chart](#).

7.2 If possible, verify the eyes can be located using the facial localization processes from the FRS algorithm.

7.3 *Search and Review Results*—FRS results should be compared against the original image(s). If no potential candidates are returned in the candidate list, re-evaluate the probe and apply further processing.

7.4 If available within the FRS, consider using metadata binning. The FISWG document *Facial Recognition Systems Metadata Usage* should be referenced where metadata is accessible which refines searches by reducing the logical size of the search database.

8. First Pass: Original Image Search

8.1 The first pass should be initiated with the original image. If necessary and not undertaken automatically by the FRS, the relevant face(s) should be cropped. When cropping, ensure that the aspect ratio is maintained and aim to produce an image that is, as far as possible, in accordance with ANSI/NIST ITL-1-2011 or ISO specifications.

9. Second Pass: Isolated Face

9.1 When no potential candidates are developed from the first pass, or additional candidates would be of value, initiate a second pass where further processing of the probe image may yield additional candidate sets for review. The process may be carried out even if the first pass yields an acceptable outcome and more candidates may be of additional value or if the practitioner decides that the nature of the image warrants second pass processing prior to the initial FRS search.

9.2 The second pass may include the tasks below which are not necessarily sequential. However, if more than one is applied, where possible they should be performed one at a time in the order in which they are presented below. When processing images, care should be taken to not remove or alter portions of the subject's head (for example, portions of the ear, crown of the head, or portions of the neck).

9.2.1 *Rotate*—The image may be rotated to make the eye positions appear horizontally aligned.

9.2.2 *Secondary Crop*—The image processing steps done in this pass may require a secondary crop of the image. If this is done, the goal of this crop is again to produce an image that is more in accordance with the ANSI/NIST ITL-1-2011 or ISO specifications.

9.2.3 *Resize*—Modify the image size to achieve a recommended inter-pupillary distance. This document is the

⁷ See Guide [E2825](#), Standard Guide for Forensic Digital Image Processing.

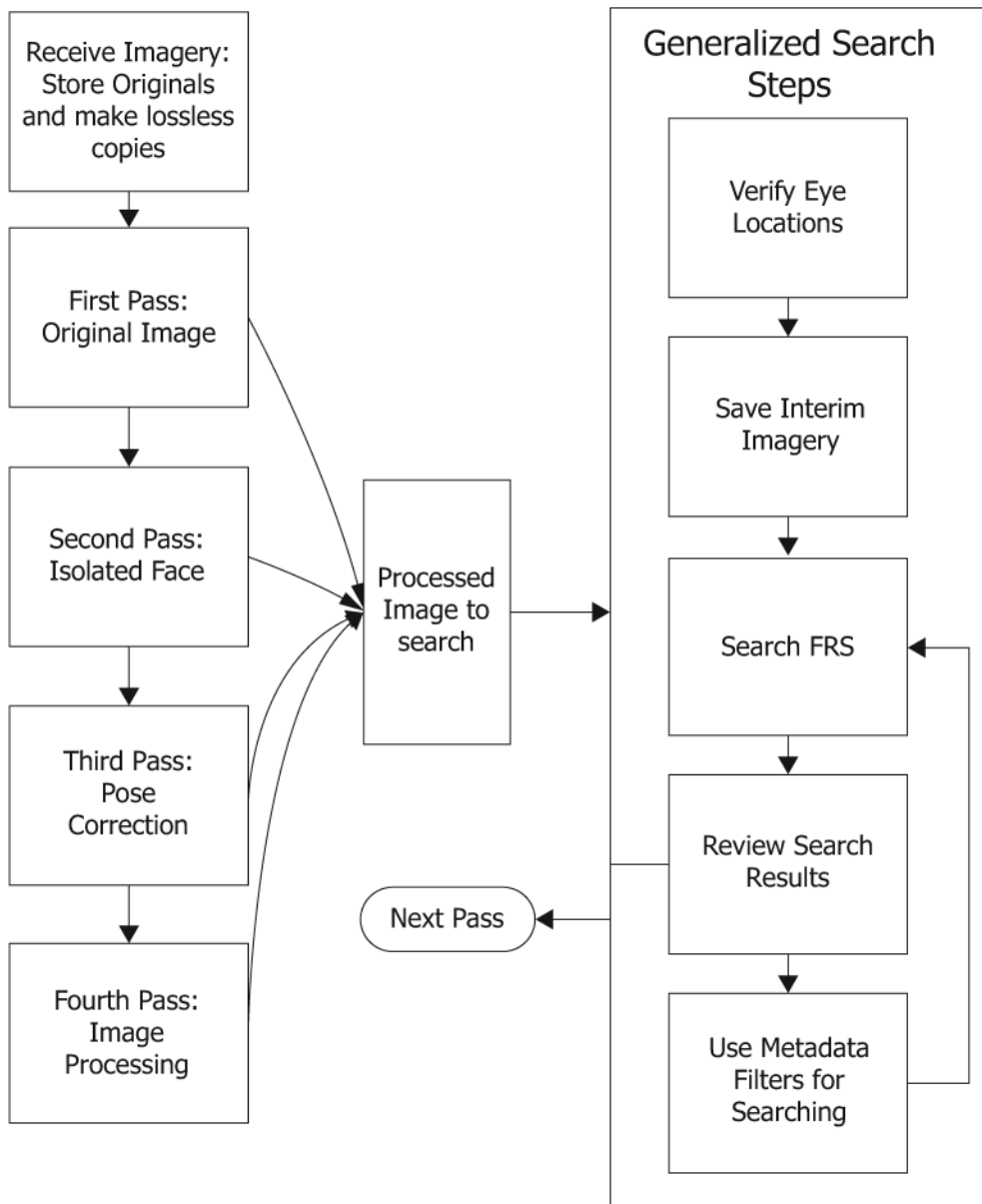


FIG. 1 Simplified Image Processing Flow Chart

agency defined consistency and based on FRS vendor recommendations (for example, 90 pixels). If resizing is done, then resizing of the images should be done in even multiples of the original image size while preserving the original image aspect ratio.

9.2.4 Blur Background—This is performed where the probe image has a non-neutral or busy background. The blurring process creates a consistent background preventing an FR engine from detecting items in the background. Examples include surveillance photos with people or items in the background and images captured with a background that varies in color and content.

9.2.5 Horizontal Flip—This is performed if the probe image submitted may have been taken as a reflection, captured incorrectly, or flipped left/right or right/left in transmission.

9.2.6 Aspect Ratio Correction—This is performed where the probe image is not in a 3:4 ratio.

10. Third Pass: Pose Correction

10.1 FRS algorithms may have varying sensitivities to non-frontal facial imagery. Claims of performance degradations will vary, but it is broadly accepted that any non-frontal pose movements will negatively affect FRS performance.

10.2 The standard definitions of pose angles are defined in NIST Special Publication 500-290 Edition 3 (2015) and ANSI/NIST-ITL 1-2011 Update: 2015 Data Format for the Interchange of Fingerprint, Facial, & Other Biometric Information as referenced in Figs. 2 and 3.