

NISTIR 8109

**Tattoo Recognition Technology – Best Practices
(Tatt-BP)
Guidelines for Tattoo Image Collection
*Revision 1.0***

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U.S. Department of Commerce
Penny Pritzker, Secretary

National Institute of Standards and Technology
Willie May, Acting Under Secretary of Commerce for Standards and Technology and Acting Director



Tattoo Recognition Technology - Best Practices (Tatt-BP)

Guidelines for Tattoo Image Collection

NIST Interagency Report 8109

(Revision 1.0)

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Image Group
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National Institute of Standards and Technology



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Disclaimer

While this guide provides recommendations on handling acquisition issues commonly seen in operations, there may exist a small fraction of circumstances that are not covered in this document.

Release Notes

- ▷ **Versioning:** This document is Revision 1.0 of the original report, which was originally published February 2016.
- ▷ **Typesetting:** Virtually all of the tabulated content in this report was produced automatically. This involved the use of scripting tools to generate directly type-settable \LaTeX content. This improves timeliness, flexibility, maintainability, and reduces transcription errors.
- ▷ **Contact:** Correspondence regarding this report should be directed to tattoo@nist.gov.

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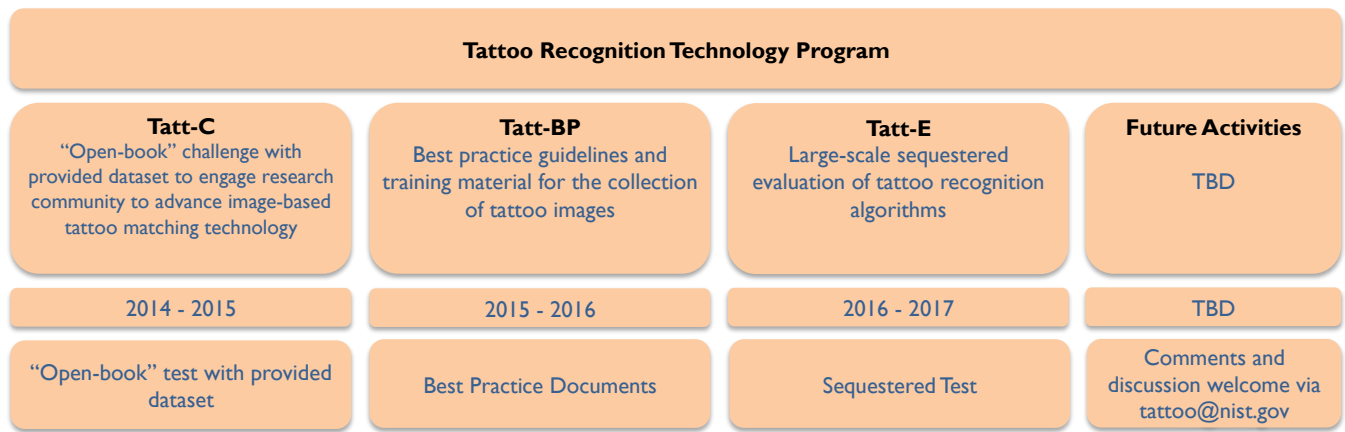


Figure 1: Activities under the Tattoo Recognition Technology Program, including planned future projects. See website <http://www.nist.gov/itl/iad/ig/tattoo.cfm> for latest project status.

1 Introduction

This document, along with a supplementary poster [3] and a set of instructional slides [2], provides best practice guidelines for the collection of good quality tattoo images. As an outcome of the Tatt-C 2015 [5] activity, algorithm failure to correctly match a tattoo is often related to the consistency and quality of image capture. Notably, inconsistencies in image angle, orientation, size of the tattoo relative to the entire image and poor collection characteristics such as poor illumination, low contrast, blur, and the existence of clothing and background clutter caused failures for tattoo detection and matching algorithms. While some problems can potentially be rectified via post-capture image processing, which imposes additional human labor, certain properties cannot be recovered after the photograph is taken. As such, certain guidelines should be followed to ensure good quality images are collected. For the purpose of this document, for specific photographic guidance that is not detailed in this document, the recommendations of ANSI/NIST-ITL Standard [1] Annex E (Facial Capture) apply.

1.1 Audience

The intended audience of this document is law enforcement professionals or officers who photograph tattoos and/or design or specify image collection processes. The recommendations provided are simple and straightforward. Although the number of ways image collection can go wrong might appear quite numerous, a single adjustment can often rectify several problems at once. Thus, the operator only needs to remember a few simple guidelines to deal with the majority of problems that might occur.

2 The Tattoo Recognition Technology Program

The Tattoo Recognition Technology Program (Figure 1) was organized by NIST to provide a measurement and testing foundation to support law enforcement needs and applications for image-based tattoo recognition. The program provides quantitative support for tattoo recognition development and best practice guidelines. A summary of past, ongoing, and planned activities is provided below.

- **Tatt-C [5]** was an initial challenge activity that provided operational data (from the FBI) and use cases to engage the research community into advancing research and development into automated image-based tattoo technologies. It also sought to assess the state-of-the-art to determine what methods are effective and viable for pertinent operational scenarios. NIST hosted a culminating industry workshop and published a public report on the outcomes and recommendations from the Tatt-C activity. Please visit <http://www.nist.gov/itl/iad/ig/tatt-c.cfm> for more information.

- **Tatt-BP** provides best practice guidance material (including this document) for the proper collection of tattoo images to support image-based tattoo recognition. Recognition failure in Tatt-C was often related to the consistency and quality of image capture, and Tatt-BP aims to provide guidelines on improving the quality of tattoo images collected operationally. Please visit <http://www.nist.gov/itl/iad/ig/tatt-bp.cfm> for more information.
- **Tatt-E** will be a sequestered evaluation intended to assess tattoo recognition algorithm performance over a large-scale operational dataset. Please visit <http://www.nist.gov/itl/iad/ig/tatt-e.cfm> for more information.

3 Number of Photographs

3.1 Single Tattoos

A minimum of two photographs should be taken of a tattoo - one photo that is far enough away to expose the body location of tattoo and one close-up photo in which the tattoo occupies at least 75% of the image (i.e., tattoo-to-image ratio of 75%) (Figure 2). Capturing body location context in a tattoo image has forensic and investigative value while a zoomed close-up of the tattoo may aid automated tattoo recognition software. In the event that a close-up photograph is not collected, manual cropping of the image (e.g., using an image editor) is an acceptable alternative. There is a field in the ANSI/NIST-ITL [1] Type-10 record (Field 10.039 Type-10 reference number) used to link two or more images of the same tattoo by using the same index reference for all of the associated images in a transaction.



Figure 2: Examples of photos far enough away to expose body location (#1) and close-up photos (#2).

3.2 Tattoos on Multiple Body Locations

3.2.1 Distinctly Separate Tattoos

For distinctly separate tattoos on different body locations, separate photographs for each tattoo should be taken, which includes a far away photo exposing the body location and a zoomed close-up (Figure 3).

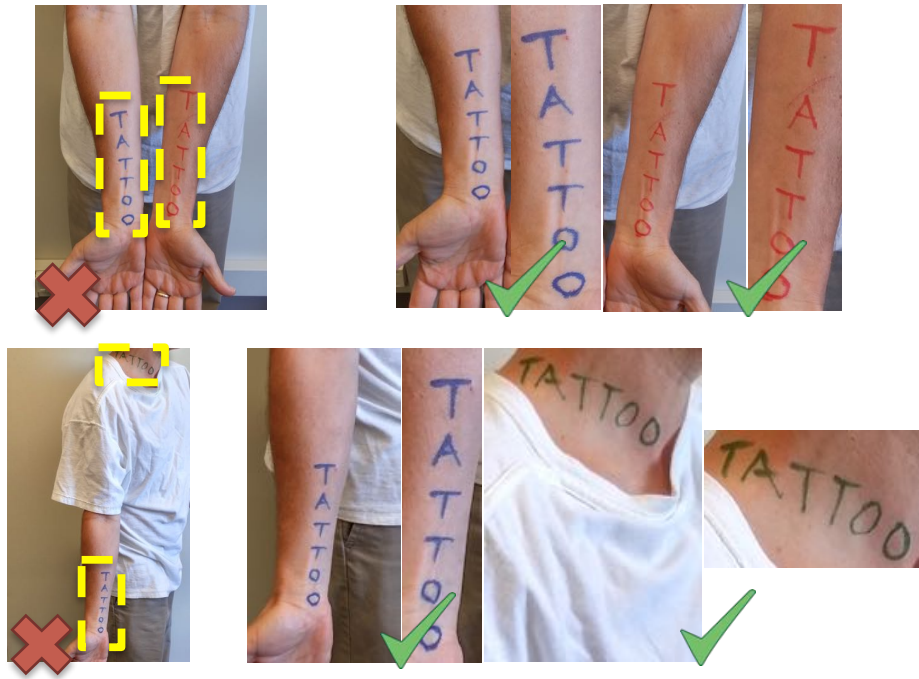


Figure 3: Examples of collecting images for multiple tattoos on distinctly separate body locations.

3.2.2 Multipart Tattoos

For tattoos that span multiple body locations, and it is not possible to capture the entire tattoo from a single angle, collect multiple images from different location viewpoints, with overlap where possible (Figure 4).



Figure 4: Example of collecting a tattoo that spans multiple body locations from different location viewpoints.

3.2.3 Full-body Tattoos

For large or full-body tattoos, in addition to collecting an image of the large tattoo, collect images of smaller portions of the tattoo (such as a detail of the tattoo that could be useful for determining gang affiliation [4]).

Each significant tattoo portion should be imaged separately, along with an image of the entire tattooed area (Figure 5).



Figure 5: Example of collecting a full-body tattoo, with one photo that captures the entire body (#1) and multiple close-up photos of areas of interest (#2 and #3).

4 Image Size

Collect tattoo images at least 1920×2560 (or 2560×1920) pixels or larger. This is equivalent to a photo resolution of 5 megapixels. Per the ANSI/NIST Standard [1] Annex E recommendations for facial capture compression algorithm, images shall be collected in JPEG format with a maximum compression ratio of 15:1 or less. The high resolution supports potential post-collection zooming or cropping of a wide range of tattoo-to-image ratios.

5 Standoff Distance

The subject should be at a minimum of one meter (approximately 3.3 feet) or more away from the camera to mitigate perspective distortion. The zoom lens settings on the camera should be adjusted accordingly to achieve the desired tattoo-to-image ratio for the close-up photo.

6 Common Collection Problems

This section describes the most commonly encountered collection problems that lead to poor quality tattoo images. Recommendations on identifying and rectifying each are provided.

6.1 Background

The discussion of background is important for tattoo recognition, because the first step in the tattoo recognition process is segmentation of the tattoo from the background. Where possible, the image should only contain the tattoo and the surrounding skin and should not contain anything else in the background, including patterned walls and floors, furniture, clothing, or other body parts. If elimination of the background is not possible, the background should be a plain, solid color in order to prevent pattern distractions that could interfere with automated segmentation using tattoo recognition software (Figure 6).

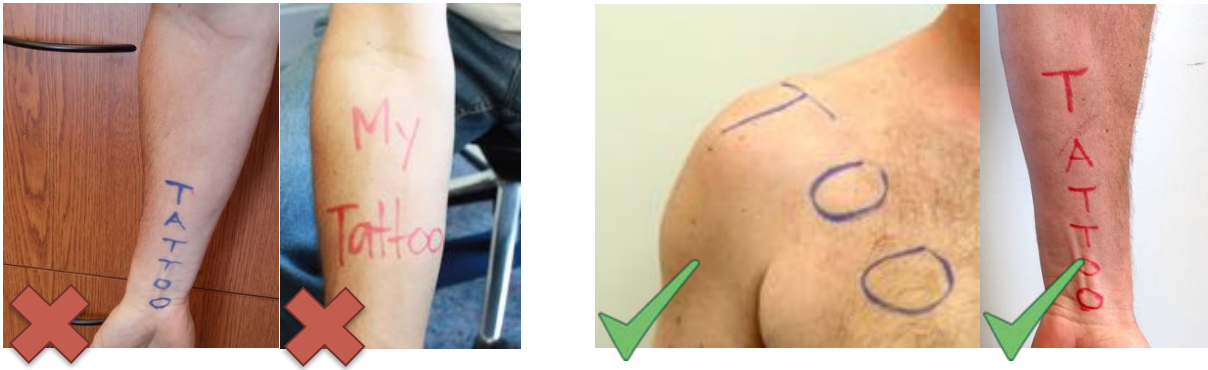


Figure 6: Examples of incorrect and correct background for photo collection.

6.2 Illumination

A tattoo image should be taken under uniform, diffuse lighting. Diffuse light is non-directional light, where the intensity of light is evenly distributed. Diffuse lighting produces very uniform, soft lighting which illuminates the entire space and makes objects visible, but avoids large shadows and hot spots/reflections (Figure 7). It is recommended that the room light level be at least 500 lux (e.g., bright office lighting). Per the ANSI/NIST-ITL Standard [1] Annex E recommendations for facial capture lighting, subject illumination should be accomplished using a minimum of three point-balanced illumination sources. Although a minimum of three photo lights is required, two of these lights should be sufficient for some operational environments. In cases where there is low contrast between the tattoo and the skin (e.g., black ink on dark skin or white ink on light skin), consider using an additional source of lighting to bring out the contrast between the tattoo and the skin. Typically, camera flash should not be used due to large light reflections that may be introduced.



Figure 7: Example photos with non-uniform or poor illumination versus exemplary photos of tattoos with adequate, uniform lighting.

6.3 Orientation/Body Positioning

To ensure orientation consistency, tattoos on body limbs should be captured with the body part parallel to the torso. For example, a tattoo on a forearm should be photographed with the arm pointing towards the ground. A tattoo on a leg should be collected with the subject standing upright (Figure 8).



Figure 8: Examples of incorrect versus correct body orientation.

6.4 Focus

The entire tattoo should be in clear focus, and no part of the tattoo should be blurry (Figure 9). Motion blur occurs when the camera or the subject is moving and can be mitigated or rectified by holding the camera still and ensuring the subject remains still during photo capture. Focus blur usually occurs, because the subject is too close or too far from the camera. This can be mitigated or rectified by ensuring the camera is at the proper distance from the subject and by adjusting the camera lens focus.



Figure 9: Examples of out-of-focus (bad) versus in-focus (good) photos.

6.5 Sensor Plane

Tattoos should always be captured parallel to the camera sensor plane. This means the tattoo should be in straight view and not at any vertical or horizontal angle. The camera should be pointing straight at the tattoo and not from a vertical or horizontal angle (Figure 10). If the tattoo is too large and parts of the tattoo aren't parallel to the camera sensor plane (often on arms and legs), then collect from multiple angles according to Section 3.2.2.



Figure 10: Examples of incorrect versus correct sensor plane alignment.

6.6 Body Hair

Hairy regions that are not a part of the tattooed region should be avoided as hair can introduce noise in the image that can affect tattoo recognition software. If irrelevant body hair cannot be avoided in the photograph that exposes the body location, then try to minimize body hair from the camera's field of view in the close-up image (Figure 11).



Figure 11: Examples of hairy regions near tattooed regions (outlined in red) and eliminating irrelevant body hair from camera's field of view in zoomed close-up photograph.

7 Transmission

Post-collection, we recommend storage and transmission of tattoo images to law enforcement agencies (e.g., FBI) using the ANSI/NIST-ITL Standard [1] Type-10 record. The Type-10 record contains additional supporting metadata fields such as body location and tattoo descriptors and is available at http://www.nist.gov/itl/iad/ig/ansi_standard.cfm.

8 Summary of Recommendations

This section provides a brief summary of the recommendations presented earlier on how to collect good quality tattoo images.

- **Capture Environment:** Ensure there is adequate, uniform, diffuse lighting (ideally with a minimum of two point-balanced light sources and lighting level of 500 lux). The background should be a plain, solid color and does not contain any background clutter.
- **Prior to Capture:** Verify the camera is set to collect images at a resolution of 5 megapixels or higher. Ensure there is a minimum of one meter (approximately 3.3 feet) between the subject and the camera. Instruct the subject (if able) to stand upright with both forearms pointing towards the ground and remain still. Ensure the entire tattoo is within the camera's field of view.
- **During Capture:** Ensure the camera is held still and properly aligned to capture the tattoo parallel to the sensor plane. For each tattoo, collect a minimum of two photographs - one that is far enough away to include the body location and one close-up photo where the tattoo occupies at least 75% of the image, with the entire tattoo visible within the camera's field of view, and ideally does not include any irrelevant body hair or background clutter. For tattoos that span multiple body locations, collect multiple images from different location viewpoints with overlap where possible. For full-body tattoos, collect an image of the entire tattoo, then separate photos of smaller areas of interest.
- **Post-Capture:** Ensure the tattoo is in focus, with good illumination and contrast against the skin. Ensure there are no large shadows or reflections over the tattoo.

Figure 12 shows an example of a good quality frontal image of a tattoo.

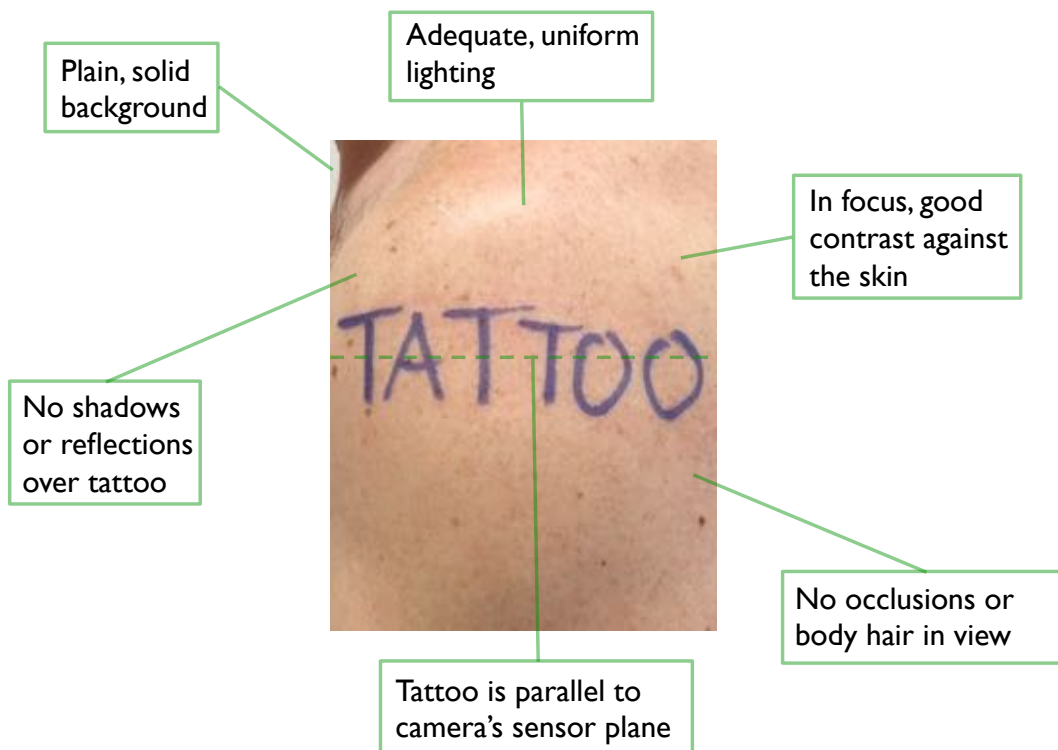


Figure 12: Example of a good quality frontal image of a tattoo, with some of its desirable properties marked up.

References

- [1] ANSI/NIST-ITL 1-2011:Update 2015, NIST Special Publication 500-290, Data Format for the Interchange of Fingerprint, Facial and Other Biometric Information. http://www.nist.gov/itl/iad/ig/ansi_standard.cfm.
- [2] NIST Tattoo Recognition Technology - Best Practices (Tatt-BP) Guidelines for Tattoo Image Collection (Instructional Slides). <http://www.nist.gov/itl/iad/ig/tatt-bp.cfm>.
- [3] NIST Tattoo Recognition Technology - Best Practices (Tatt-BP) Guidelines for Tattoo Image Collection (Poster). <http://www.nist.gov/itl/iad/ig/tatt-bp.cfm>.
- [4] National Gang Report 2013, 2013, pages 7,12. <https://www.fbi.gov/file-repository/stats-services-publications-national-gang-report-2013/view>.
- [5] M. Ngan, G. W. Quinn, and P. Grother. NISTIR 8078 Tattoo Recognition Technology Challenge (Tatt-C) Outcomes and Recommendations., September 2015. <http://www.nist.gov/itl/iad/ig/tatt-c.cfm>.