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Section 21

Procedure for Testing Scanner Resolution for Latent Print Imaging

INTRODUCTION

The purpose of this document is to describe a procedure to ensure that a scanner can capture a latent print image at an achievable resolution that enables recording of Level 3 detail.

LIMITATIONS

This procedure is designed to test the ability of a scanner in reflected light mode to capture the necessary level of detail when viewed on a monitor. This procedure does not address capture by a scanner in transmitted light mode. This procedure also does not address the output of image data to printed media.

A NOTE ON 1000 ppi STANDARD

The procedure described in this document is in accordance with current SWGFAST guidelines [Standard for Friction Ridge Digital Imaging (Latent/Tenprint)[1]], as well as National Institute of Standards and Technology (NIST) standard (NIST SPECIAL PUBLICATION 500-271, ANSI/NIST-ITL 1-2007[2]), which specify 1000 pixels per inch (ppi) at 1:1 as the minimum scanning resolution for latent print evidence. This standard appears primarily to be historical, though recent studies suggest that it is suitable for capturing level 3 detail[3].

While the 1000 ppi resolution standard permits the capture of level three detail in latent prints, it does not mean that any image recorded at a lower resolution would necessarily be of no value for comparison purposes. However, there are some latent print impressions that are so degraded or contain such limited quantity of information that at least 1000 ppi resolution is required to conduct an accurate examination. Some automated fingerprint identification systems require 1000 ppi for submission purposes.

As one commercial testing group notes, the relationship between nominal resolution and achievable resolution (sometimes called "resolving power") can vary greatly by manufacturer:

> …[T]here is … discrepancy between the nominal resolution of a scanner and the actual achievable resolution in the practice. In our film scanner tests we always measure the effective resolution of a

[1] www.swgfast.org/standard_for_friction_ridge_digital_imaging_1.0.pdf Accessed January 12, 2010.
[2] http://fingerprint.nist.gov/standard/ Accessed January 12, 2010.
[3] Jain, A.K., Chen, Y., and Demirkus, M. Pores and Ridges: High-Resolution Fingerprint Matching Using Level 3 Features. IEEE Trans. PAMI 29 (1): 15-27, 2007.

> scanner, thus the resolution that is achieved in practice… While in practice, [some] top-models achieve approximately 97% of their nominal resolution, in case of some film scanners of [other manufactures], the resulting value is of only 50%. Many times, the flat bed scanners with an integrated transparency unit only achieve 10-20% of their nominal resolution in practice. For the user, the effective resolution is the decisive value and not the nominal resolution…

(ref: Patrick Wagner Purchase of a film scanner, tips and purchase criteria http://www.filmscanner.info/en/FilmscannerKauf.html last accessed 11 Jan 2011)

There is a dearth of peer reviewed literature comparing nominal and achieved resolution, but the achieved resolution can be approximated. Jain has demonstrated that sampling at a nominal 1000 ppi can provide level three detail. Zhang, et al. have similar results. By application of the Nyquist theorem, a 1000 ppi nominal resolution can theoretically achieve a maximum resolution of 500 line pairs. In practice, as noted elsewhere, Nyquist sampling is inadequate, and three to four samples are required instead of two, resulting in resolution between 250-330 line pairs per inch, or 9.8-13 cycles per mm.

Ref: Jain 2007 already in footnotes.
Ref: Zhang D, Liu F, Shao Q., Lu G, Luo N. Selecting a reference high resolution for fingerprint recognition using minutiae and pores. IEEE Trans Intrument. Meas. 2010 99:1-9

EQUIPMENT/MATERIALS

- Scanner (and associated software and connection to computer and monitor)
- Resolution test target (e.g., T-90-N-CG "Ultra High Resolution Target")
- Loupe or magnifier

To determine that a scanner is capable of capturing an image at a given resolution, it is necessary to use a test target. The test target used in this procedure is the T-90-N-CG "Ultra High Resolution Target", from Applied Image, Inc., Rochester, NY. This target is used as an example, only, and its use here should not be construed as an endorsement. Other test targets are available, such as from the International Standards Organization (ISO), which has a standard target for measuring resolution of scanners "ISO-16067-1 Reflective Scanner Test Chart."

Description of Resolution Test Targets

Resolution test targets come in a variety of forms and styles. Horizontal and vertical multi-bar test targets are the focus of this procedure. Such multi-bar test targets consist of pairs of dark and light parallel lines ("bars") of equal width ("line pairs" or "cycle") which repeat at a given frequency. The frequency is then defined in terms of cycles per unit distance. On the T-90-N-CG chart, spatial frequencies are reported in cycles per millimeter.

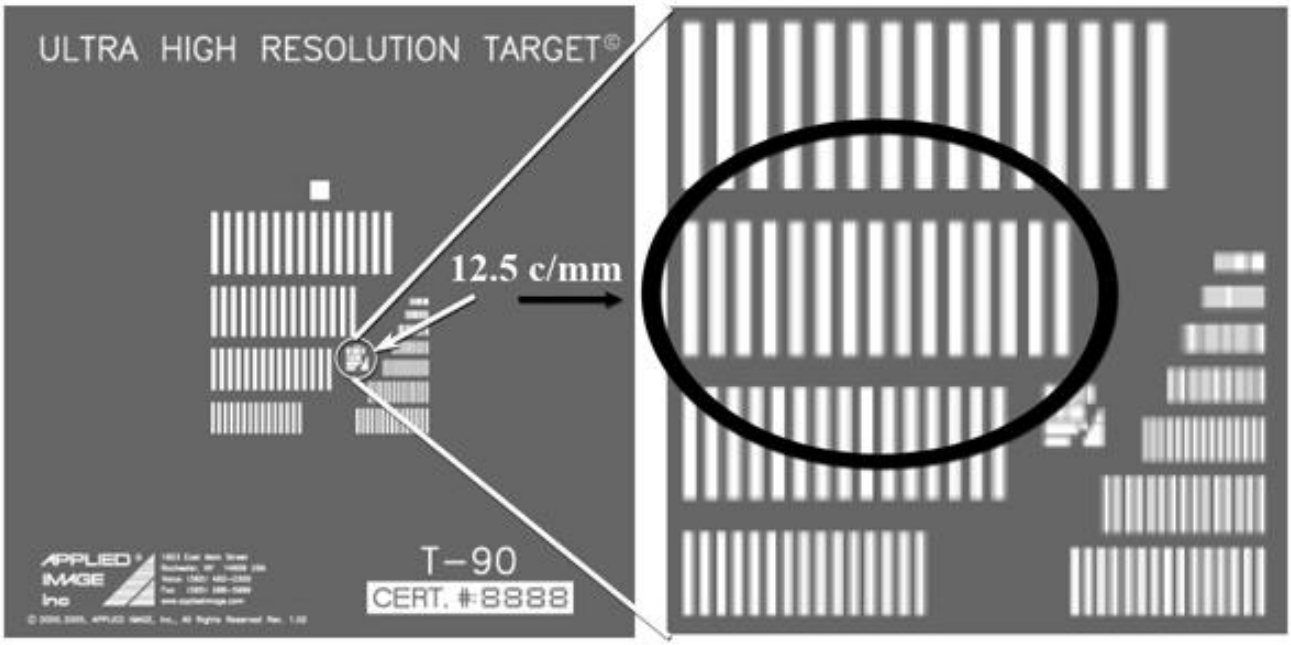
As an example, a set of line pairs in which the width of each individual line is 0.1 millimeter (i.e., dark line width = 0.1 mm and light line width = 0.1 mm) would have a combined line pair width of 0.2 mm, and would be described as having 5 cycles per mm (1/0.2 = 5).

1000 ppi RESOLUTION AS MEASURED IN CYCLES PER MM

Because a nominal resolution of 1000 ppi corresponds to an achievable resolution of approximately 9.8-13 cycles per millimeter. Any test target within this range would be sufficient; the 12.5 cycle per millimeter region of the T-90-N-CG chart is demonstrated.

PROCEDURE

1. Locate the portion of the test chart which depicts 12.5 cycles per millimeter (See Figure below).



2. Visually verify (count) the number of dark and light lines and record each (e.g., 15 light and 14 dark – See figure below). It is recommended that a magnifier or loupe be used in the counting process.

3. Ensure scanner is on and set operational parameters to those normally used for scanning of latent print evidence, as appropriate.

4. If not already done in Step 3, set scanner to 1000 pixels per inch.

5. Place test chart on scanner platen with top of chart at top of scanning region. This will allow the user to measure the resolution in the horizontal aspect (as depicted in figures above).

6. Activate scanner.

7. Save file using either lossless compression or no compression (such as TIFF or Bitmap).

8. Open file in image processing application.

9. View region which depicts 12.5 cycles per mm.

10. Zoom image so that individual pixels are visible. If the scanner has accurately captured 12.5 cycles per mm, then it should be possible to distinguish the dark and light line pairs in this region. It should not be necessary to use image post processing to improve the visibility of the line pairs.

11. To confirm accurate capture, it is necessary to verify that the correct number of dark and light line pairs per mm have been recorded by counting them and checking this number against the number recorded in step 2 (e.g., 15 light and 14 dark).

12. If the number counted in step 11 matches the number counted in Step 2, then you have verified that your scanner can sample at 12.5 cycles per millimeter in the horizontal direction and exceed the 1000 ppi standard. If not, then your scanner does not meet the 1000 ppi standard and the scanner should be set to a higher nominal resolution and retested. Note that some scanners exhibit higher achievable resolution in the center of the scan area. Thus, it may be appropriate to retest at different locations on the scanner.

13. Rotate the chart 90° either to the right or left and repeat steps 6 through 12 to measure vertical resolution.

It is recommended that this process be documented in accordance with agency policy.

It is further recommended that this procedure be repeated on a regular basis (e.g., annually) in accordance with agency quality assurance and quality control practices. Likewise, if the scanner requires repairs, then this procedure should be performed prior to use in case work.