

MITRE Computer Program: *sinemtf*¹

Website: <http://www.mitre.org/tech/mtf>

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Code Supplied:

C source code (external TIFF library required)
executable for Microsoft Windows operating systems (compiled Windows7)
executable for Mac OS-X operating system (Mac/Intel, compiled on Mavericks)

Documentation:

| | |
|--------------|--|
| Quick_Guide | this file |
| What's New | code revisions |
| BarTgt_Guide | bar target processing |
| MTF_Noise | "Enhanced Noise Suppression in MITRE's <i>Sinemtf</i> Algorithm" |
| Rescale | "Rescaling Digital Fingerprints: Techniques & Image Quality Effects" |
| MTF_TechRpt | "Computer Program to Determine the Sine Wave MTF of Imaging Devices" |
| CTF_MTF | "Conversion Between Sine Wave and Square Wave Spatial Frequency Response of an Imaging System" |

Target Data Files:

Sinemtf input data files are supplied for several commercially available sinewave targets, two MITRE-constructed digital sinewave targets for printer MTF evaluation, several bar target designs, and for the FBI's Scanner Image Quality Test (SIQT) target.

Image File Formats & Bit Depth:

Sinemtf processes uncompressed gray level images having 8 to 16 bits per pixel (bpp). For 8bpp, the image can be in raw, PGM, or TIFF format; for 16bpp, the image must be in TIFF format. To evaluate a color imaging device, the user can either convert the color image to grayscale, or separate the color layers and process each layer separately; e.g., for 24 bit full color capture, separate the 3 color layers (R,G,B) into 3 separate images, then process each 8bpp layer image. The resulting 3 MTFs can be weighted to arrive at a single system MTF, or just use the 'most important' MTF (e.g., green layer MTF).

¹ This MITRE computer program is variously called *sinemtf* or just *mtf*, depending on the document.

Target Orientation:

The sine target can be input to *sinemtf* in any orientation: horizontal (landscape), vertical (portrait), or any angle. However, if the image has been mirrored, with respect to the original target, then the image must be un-mirrored before processing (i.e., left/right or top/bottom reversed).

Printer MTF:

The supplied digital sine targets: A6sine.tif and A7sine.tif, are used for evaluation of a printer MTF. Print this target using the printer under evaluation, then digitize the print using a scanner with a resolution about twice as high as the print resolution. For use in *sinemtf*, ppi print resolution is assumed to be the same in vertical and horizontal directions, and is strictly defined as follows; do not use any other definition!

$$\text{print resolution} = (\text{digital target width in pixels}) / (\text{width of printed target in inches})$$

At a print resolution of 500 ppi, the A6 target size on the print will be 46 x 24 mm; the A7 size will be 23 x 12 mm. Process the scanned print through *sinemtf*, selecting option "P" and the A6sine.txt or A7sine.txt target data file. It will be necessary to independently measure the MTF of the scanner, e.g. ,with sine target M13-1X, and then divide the "P" printer run output MTF of *sinemtf* by the scanner MTF. Note that although the combination of the digital target and the associated target data file are scaled for printing at print resolution = 500 ppi, *sinemtf* will automatically compensate for printing the target at any other resolution, using the same target data file.

!!Note!! Printing the A6sine or A7sine digital target to hardcopy, and then attempting to use that hardcopy print as a target to evaluate a scanner, will lead to erratic, inaccurate MTFs!!

Bar Target:

Sinemtf will also process a bar target and compute the 'square wave transfer function', also known as the 'contrast transfer function' (CTF). For the same imaging device, the CTF computed from a bar target is higher than the MTF computed from a sine wave target, but the two are mathematically related. See separate "BarTgt_Guide.pdf" document for detailed processing instructions.

Target Availability:

Following is a partial list of some of the vendors that sell sine wave and/or bar targets; these are in no particular order and do not imply any endorsement of one vendor over any other vendor:

<http://www.sinepatterns.com>
<http://appliedimage.com>
<http://www.edmundoptics.com>
<http://www.jmloptical.com>

BRIEF INSTRUCTIONS TO RUN *SINEMTF* (example)

(a test case is included in *sinemtf* package)

1) Capture a digital image of sine target model M13-1X using the imaging device under test (this target has a maximum frequency of 12 cy/mm so the capture device resolution should be no more than 610 ppi).

2) Prepare input data file.

For a sine wave target, the input data file must contain the dimensions and locations of the density patches and sine patterns corresponding to the target manufacturer's target model. The input data file must also contain the manufacturer-supplied gray patch density values and sine pattern modulations which are unique to each specific serial number target. Make certain that the target patch densities are matched to their corresponding correct locations in the target; the patch locations are given in the data file in x, y millimeters from upper left corner origin [see figure C-1 in MTF_TechRpt.pdf]. The dimensional data in our supplied M13-1X.txt file can be used as is; however, caution, this assumes that the target manufacturer has not changed the target layout.

New: in v6.6. The 4 corner density patch dimensions can be altered to trim away stray background illumination. Label the corner density patches with 'c' instead of 'd' before making such an alteration. (Backward compatibility remains with old input data files.)

3) Obtain information on image to run *sinemtf*.

- View the softcopy image of your scanned sine target (using your image display software).
- Locate the column and row of the inner corner of the top left, top right, and lower left gray patches (see illustration), i.e.,
 - lower right corner of top left patch
 - lower left corner of top right patch
 - upper right corner of bottom left patch

Coordinate reference point is upper left corner of entire image, denoted column=0, row=0, then column values increase to right and row values increase downward. These column,row coordinate values must be in digital image PIXEL UNITS.

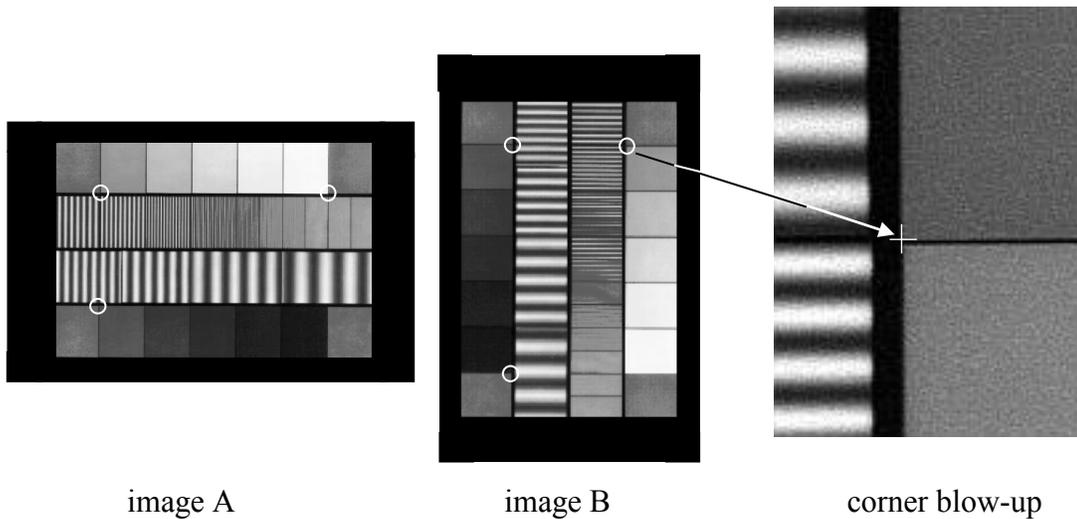
Starting with v5.0 the user has the option of letting *sinemtf* automatically refine the input coordinates.

- Note orientation of sine image:
 - Horizontal - sinusoidal brightness varies in horizontal direction (image A)
 - Vertical - sinusoidal brightness varies in vertical direction (image B)

3) Run *sinemtf*.

Multiple options can be selected from runtime menu display; separate selected option letters by spaces or no space, but not by commas.

4) The output file is named MTFOUT, data is always appended to this output file.



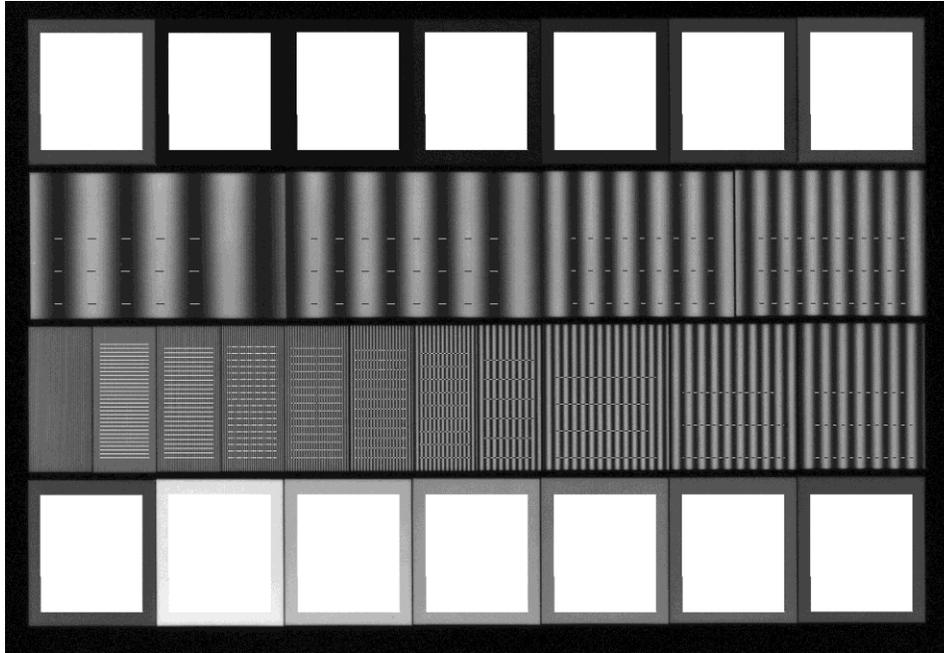
Illustrating locations of 3 Input Corner Coordinates for:
 image A - horizontal, landscape orientation
 image B - vertical, portrait orientation

Interpreting the Debug Image:

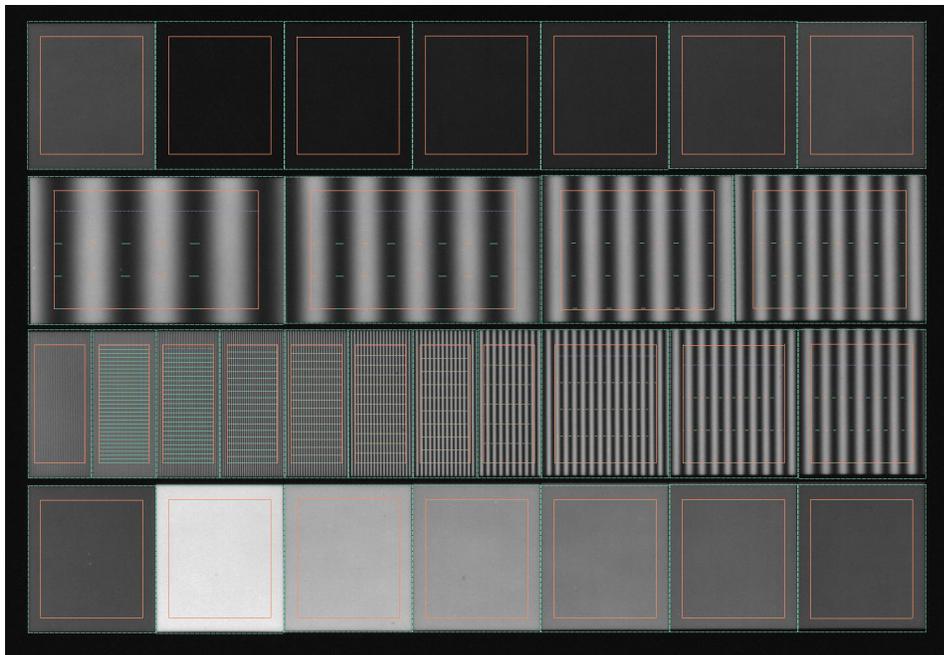
The debug image contains the original image with markings indicating processing locations and where the areas in the target reference file are expected to be located within the image. Specific marking are:

1. Reference patch borders: Dashed light green rectangles show the full extent of each density, sine, and bar pattern patch.
2. Processing rectangle: Solid orange line rectangles outline the patch area that is analyzed. This box is designed to be inside the reference patch border by a fixed percentage.
 - a. For the density patch this is the area from which statistics are collected. [Formerly indicated a solid filled rectangle.]
 - b. For the sine/bar patches, all peak/valley searches will occur inside this box.
3. Peaks and valleys: Peaks are orange and valleys are light green. The markings show the location at the first of several averaged lines.
4. Last line included in the peak/valley analysis: Dotted light blue line. Data beyond this line is not processed since too few lines remain for the averaging operation.
5. 3 Corner Dots: Single orange pixels. These are the 3 corner positions chosen manually by the user (or automatically refined by the software.)

In version 6.5 debug markings were colorized as indicated. Prior to 6.5 the debug markings were gray and only included as solid density processing block (2a), peaks and valleys (3), and the corner indicators (5). Both types of debug image are shown below.



Pre version 6.5



Version 6.5

Notice

This "sinemtf" software was developed by The MITRE Corporation and was produced for the U.S. Government under Contract numbers J-FBI-12-128, J-FBI-86-028, J-FBI-93-039, DAAB07-99-C-C201, DAAB07-00-C-C201, DAAB07-01-C-C201, DAAB07-01-C-N200, DAAB07-02-C-N200, W15P7T-04-C-D001, and W15P7T-04-C-D199 and is subject to the Rights in Data-General clause FAR 52.227-14, Alt. IV (DEC 2007).

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