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Measurement of the Minimum Resolvable Contrast (MRC) at IOSB

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Validity:

1. The MRC applies for well and under sampled imagers. The applicable spectral range is approximately 0.4 µm to 2.5 µm or parts of this range.

   Note 1: The description generally also applies to the measurement of image intensifier based night vision devices.

   Note 2: For imagers with maximum response in the 1 µm to 2.5 µm spectral range the Minimum Temperature Difference Perceived (MTDP) may also be applicable. Which figure of merit should be used may depend on the application and has to be decided beforehand.

Definition of MRC

2. The MRC is the minimum contrast, which allows an observer to resolve a 4-bar-test pattern (Figure 1) in accordance with a given criterion. It depends on the background illumination, the spatial frequency of the test pattern, and on the position and orientation of the test pattern relative to the detector.

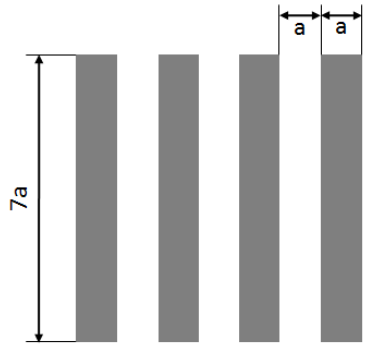

Figure 1: 4-bar-test pattern for MRC measurement.

Measurement Conditions

3. The 4-bar-test pattern seen by the imager under test is created by overlaying a translucent bar target and a background illumination. Illumination of bar target and background can be set and varied independently. The overlay gives positive contrasts between the bars and the background.

4. The bar target is projected on the imager under test using a 2 m focal length, 0.3 m diameter off axis collimator. In doing so optical axis of device under test and projection correspond. The position of the test pattern relative to the detector is adjustable in small steps relative to the imager's instantaneous field of view.

5. Environmental temperature is kept within 22±2 °C unless otherwise specified.

6. Room illumination is set to a level that does not distract the observer from its task. Typically a low level is used to increase the observer's light sensitivity. Alterations according to the observer's demands are allowed.

   Note 3: For night vision device testing no room illumination is allowed.

7. Imager gain is set manually using an as high as possible one for the measurement. Imager brightness is adjusted by the observer to optimise results before and during the measurements.

   Note 4: Measurement of imagers using automatic gain and brightness adjustments are possible as long as linear methods are used. A homogeneous background that forces the automatic to a high gain is used. No changes to this background are allowed during the measurements. Nonlinear automatic settings may be measured but the meaning of the results is unknown at the time of writing.

8. Measurements are performed at the display that belongs to the imager. If no display is belonging to the imager in test, an IOSB standard monitor is used instead. Contrast and brightness of the monitor are adjusted before the measurements to give optimum performance. A suited video generator is used for this purpose. No alterations are allowed during the measurements. The observer is allowed to alter the distance of his eye from the monitor to give optimised results wherever applicable.

Measurement Process

9. The background illumination is set to the level demanded by the customer and kept constant during the measurement. A test pattern is presented to the observer at a contrast that allows a good separation from the background. The observer slightly alters the position of the test pattern relative to the detector (phase) and selects the position where the maximum number of bars is visible. This can be either four, three or two bars (Figure 2). The number of bars visible is recorded and the phase is kept for the measurement of the test pattern.

   Note 5: For a well sampled imager the number of bars that can be resolved is always four.

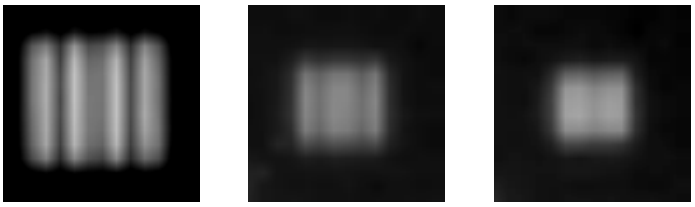

Figure 2: Test patterns as seen by an under sampled imager with four, three, and two bars visible (from left).

Starting from an invisible test pattern, the bar illumination is increased until the test pattern can just be seen in positive contrast. The corresponding modulation contrast ΔC is derived from background L_B and bar (target) L_T radiance according to:

$$\Delta C = \frac{L_T - L_B}{L_T + L_B}$$

This measurement is typically repeated four times. The whole procedure is repeated with bar targets of increasing spatial frequencies until the observer is not able to resolve any bars in the first step of the measurement process. Spatial frequency and contrast used for the decision are recorded.

10. The criterion for resolving the bar target is to see the bars and not just some modulation on the display, although it is not necessary that each of the bars be visible at the same time.

11. The MRC is measured with the bar target orientated horizontal and vertical relative to the detector of the imager.

12. Measurements typically are taken at a minimum of six spatial frequencies distributed approximately uniformly over the useful range of the imager.

Exploitation of Results

13. The MRC for a given spatial frequency is the average value of the typically four measured contrasts ΔC.

14. The MRC results are be tabulated for each orientation, containing also the spatial frequency of the bar pattern not resolved by the observer. The number of bars resolved is given in the table when different from four. Additionally, the MRC results are plotted on a graph containing the two orientations measured.