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Influence of test chart contrast on quantification of photo sharpness

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Introduction



One of the important attributes of image quality is certainly sharpness, i.e. the possibility of reproducing fine high-frequency details. Sharpness (resolution) can be defined as the smallest interval measurable by a scientific (especially optical) instrument. Sharpness can be categorized as a local attribute. The appearance of local attributes depends on the viewing conditions with respect to viewing distance and size of the image (Phillips & Eliasson, 2018). The measurement of sharpness is a measurement of the spatial frequency response (SFR). This function describes how well the system under test can reproduce a range of spatial frequencies (Figure 1) on a scale from 0% (complete loss of information) to 100% (perfect reproduction without data loss) (Image Engineering, 2022).

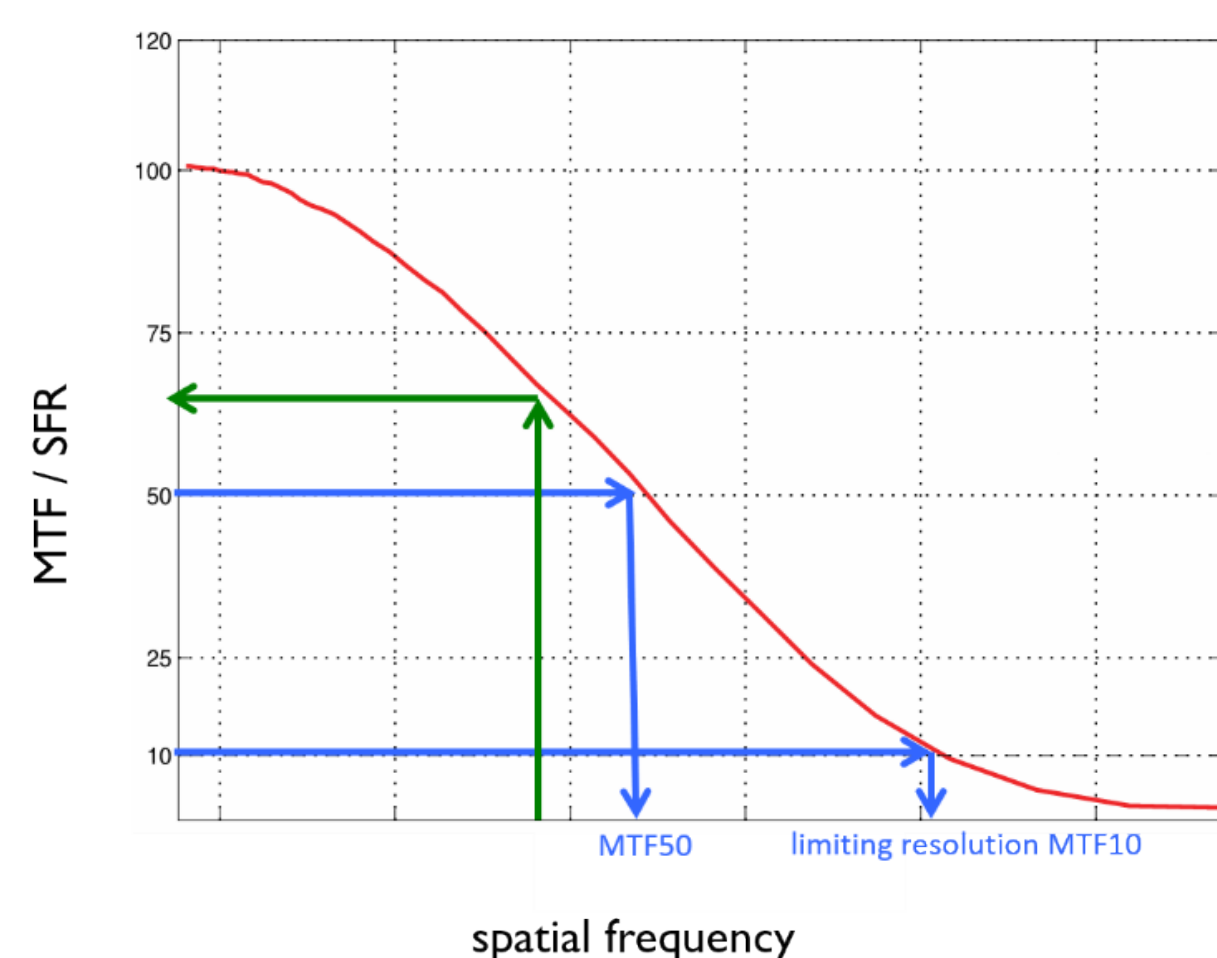


Figure 1

The X-Axis shows the spatial frequencies increasing from left to right, and the Y-Axis depicts the SFR (Image Engineering, 2022)

To measure sharpness in photos, we must first select a test chart. Quality control of photography devices, especially mobile phones, is in daily development, so test charts are also changing and developing constantly. One option is to use the Slanted Edge SFR measurement developed by Burns and Williams (2002) and standardized in ISO 12233. In addition to the slanted edge, a method based on a Sinusoidal Siemens Star is also used which is evaluated on a radius by radius or frequency by frequency basis. The old high-contrast ISO 12233 chart (Version 2000) is referenced in the ISO 12233:2000 standard but is no longer a part of the standard. It should only be used when results need to be compared with older work (Imatest, 2022). The obsolete ISO 12233:2000 standard defines a resolution test target with a high contrast ratio. These are typically produced at the maximum dynamic range, which can be anywhere from 40:1 to 80:1. The high contrast can lead to clipping of the signal which leads to overstated invalid MTF values. Some camera manufacturers who want better MTF results may take advantage of this anomaly to overstate the quality of the cameras they produce (Imatest, 2021). The revision of the standard resulted in a new test card where the contrast was reduced to the level of ratio 4:1. New version of test chart should contain minimum 9 slanted squares for slanted edge measurements. The mentioned test charts are shown in the Method section, Figure 2. The aim of this work is to measure the sharpness of the

photo obtained with the rear camera on commercially available mobile phones, and to use two test chart (a high-contrast and a low-contrast), during the measurement. In the continuation of the paper, the experiment and the devices used are described in detail, after which the obtained results are presented and discussed.

Methods



For the purposes of the experiment, 5 different phones were used. In order to check the effect of contrast on the measured sharpness values, two test charts were chosen. The old high-contrast ISO 12233 chart (Figure 2 a) and low-contrast ISO 12233:2017 Edge SFR, eSFR (Figure 2 b). The experiment is carried out under suitable conditions in a darkened room. The only light source used was made for the purposes of the experiment. The stand on which the mobile phone is positioned in the middle, and on both sides at an angle of 45 degrees, there are LED lamps that simulate daylight (5000 K). The camera sensor is placed flush with the center of the test chart, while the distance of the stand is 70 cm from the chart. Photographed test charts were tested in Imatest software, module SFR. The ROI (Region of interest) area was the same for all phones (80 x 160 px). On the high-contrast test chart, 8 possible fields were measured, while on the low-contrast map it was possible to measure 15 different fields.

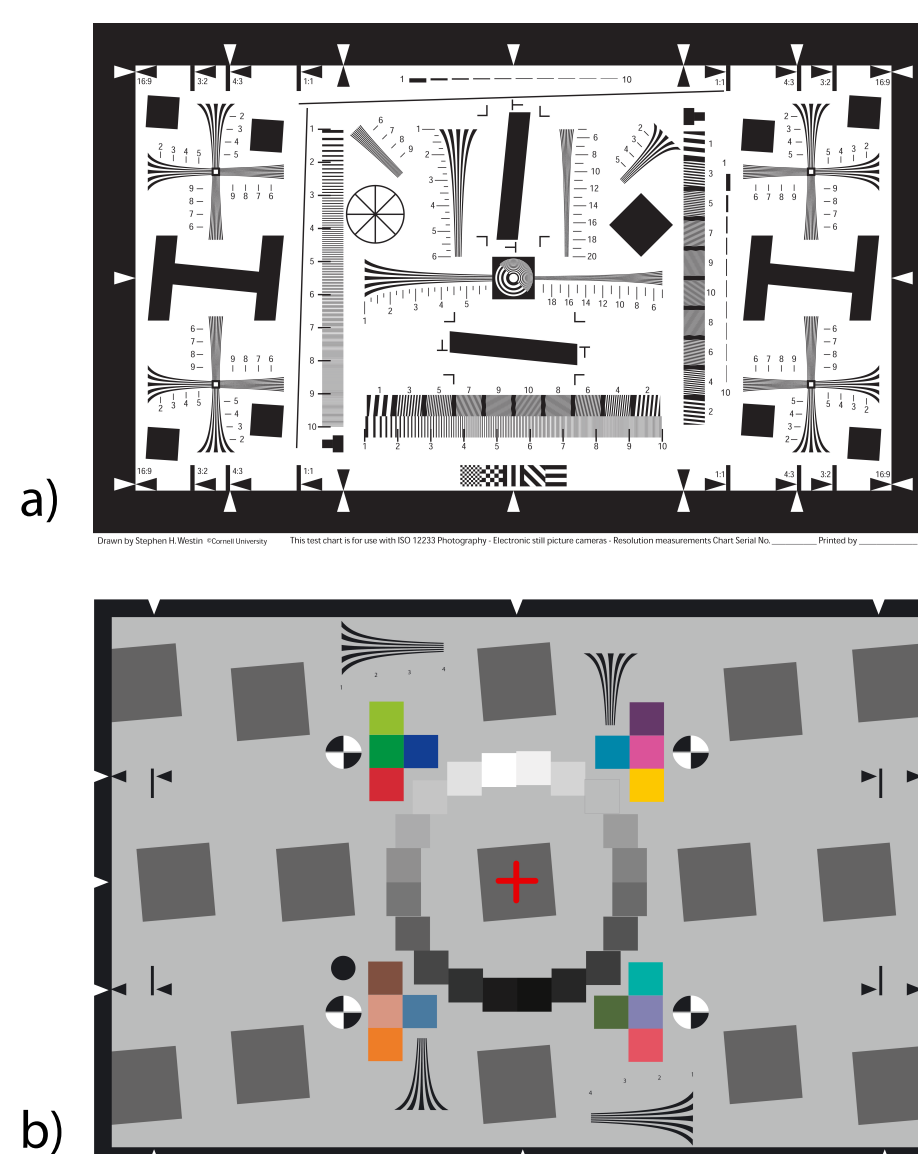


Figure 2

Test charts used in the experiment, a) high-contrast and b) low-contrast

Results



The obtained results are shown in Figures 3 and 4. The graph shows the mean values, as well as the minimum and maximum values for each phone. Based on the results, it can be concluded that the number of megapixels, i.e. the resolution of the camera certainly does not affect the quality of the obtained photo, in this case specifically the tested quality attribute - sharpness. Image processing has a much greater influence on the sharpness of the photo. The fourth phone with 12 MP has the highest sharpness when measured on the low-contrast test chart. The MTF50 value for that phone is much higher compared to phone 1 (64 MP) and phone 5 (48 MP). When measuring the old test card (high-contrast), slightly different results were obtained.

In that case, the phone with the highest resolution (64 MP) has the highest MTF50 value. Higher values were also obtained during the control of phone 3, while similar results were obtained with the other phones when the test chart was changed.

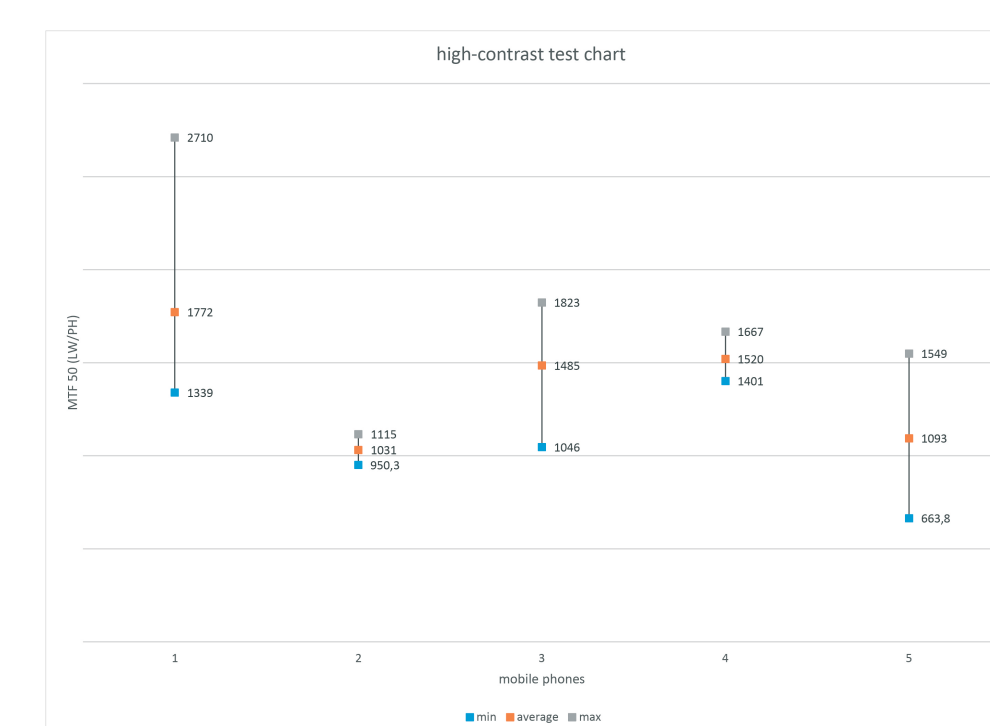


Figure 3

Measured sharpness (MTF50) for high-contrast test chart

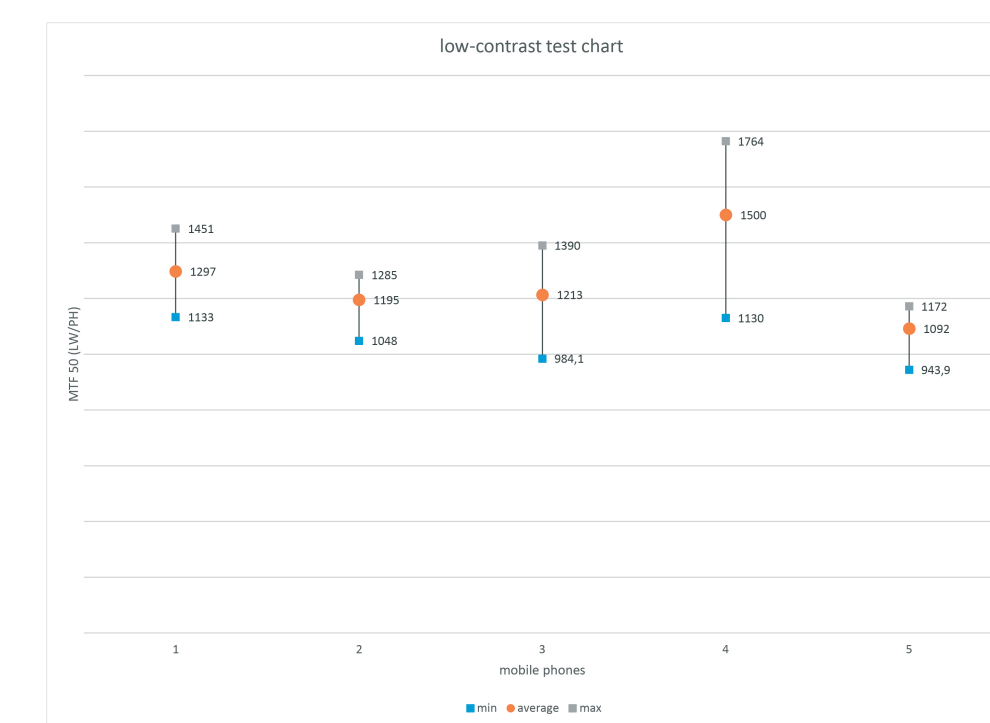


Figure 4

Measured sharpness (MTF50) for low-contrast test chart

Conclusion



One of the important attributes is sharpness, which depends on the viewing distance and therefore belongs to the local group of quality attributes. It is thus vital to properly test and analyze the image sharpness of the camera under test. In this paper, the influence of the contrast of the test chart on the value of the obtained sharpness was examined. Based on the results, it is concluded that the contrast has an impact. Depending on the selected test chart, different values were obtained. However, for more concrete analyses, a suggestion for future research is to consider a larger number of cameras, as well as a larger number of different contrast ratios on the test charts.

REFERENCES

- Burns, P. & Williams, D. (2002) Refined Slanted-Edge Measurement for Practical Camera and Scanner Testing. In: Proc. IS&T 2002 PICS Conference, An International Technical Conference on Digital Image Capture and Associated System, Reproduction and Image Quality Technologies, April 2002, Portland, Oregon, pp. 191-195.
- Image Engineering. (2022) Resolution - Image Quality Factors. Available from: <https://www.image-engineering.de/library/image-quality/factors/1055-resolution> [Accessed 8th september 2022]
- Imatest. (2022) ISO 12233 — Resolution and spatial frequency responses. Available from: <https://www.imatest.com/solutions/iso-12233/> [Accessed 9th september 2022]
- Imatest. (2021) High-contrast edge-SFR test targets produce invalid MTF results. Available from: <https://www.imatest.com/2018/06/high-contrast-edge-sfr-test-targets-produce-invalid-mtf-results/> [Accessed 9th september 2022]
- Phillips, J.-B. & Eliasson, H. (2018) Camera Image Quality Benchmarking. Wiley-IS&T Series in Imaging Science and Technology.

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