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The influence of depth of field on the appearance of chromatic aberration

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Introduction

Chromatic aberration was chosen as the subject of investigation. Chromatic aberration is an error that occurs due to inadequate use of the camera, inadequate conditions for photography or a constructive imperfection of the lens.

The aim of this research is to examine the influence of depth of field on the appearance of lateral chromatic aberration. For the purposes of the experiment, we used one mirrorless camera (Sony a1), while the lenses were variable. We used Sigma 85mm f/1.4 DG DN and Sigma 40mm f/1.4 to check which type of lens shows the most chromatic aberration and how much the change in f-number affects its appearance.

Theoretical part

Chromatic aberration is an optical defect that causes light rays of different wavelengths to focus at different points along the optical axis of the lens (Figure 1).

Chromatic aberrations are manifested as bands of one color around contrasting edges in the frame (Mehić, 2011).

These imperfections are solved more or less successfully in the lens itself, by installing several different convex and concave lenses (Husić, 2012).

Figure 1
Chromatic aberration

Table 1 shows the categorization of the aberration surface by intensity expressed in pixels.

Table 1

Categorization of the surface of chromatic aberration by intensity expressed in pixels

Chromatic aberration surface	**Intensity**
under 0.5	insignificant
0.5-1	low (hard to see)
1-1.5	moderate (somewise visible in the case of large format printing)
above 1.5	strong (very visible in the case of large format printing)

Scene setting

The test card is placed on a neutral background, a wall, at an angle of 90 degrees.After that, the stand is placed, opposite the test card, on which it is placedthe camera that is used so that there is no blurring of the image due to hand tremors (Figure 6).

Figure 2
Scene setting

Results

The test was performed on the Sigma 85mm f/2.8 DG DN lens at a distance of 180 cm from the test map, where the aperture, and therefore the ISO, is a variable factor while the focal length (85mm) and shutter speed (160) are fixed values.

On Figure 7. a graph is shown with the results for the tested lens at different apertures. The graph shows the X axis, on which the values are aperture, and two Y axes where the chromatic aberration is expressed for the ROI surface on the right and left side of the same image. Based on the obtained results, according to the values from table 1. we conclude that the lens generally makes either insignificant or weak ones at any given aperture chromatic aberrations that are hard to notice or not noticeable. The value of the left side is generally higher than the right side, except at the smallest aperture where the value of the left side is significantly higher compared to the previous point, while the opposite is true for the right side.

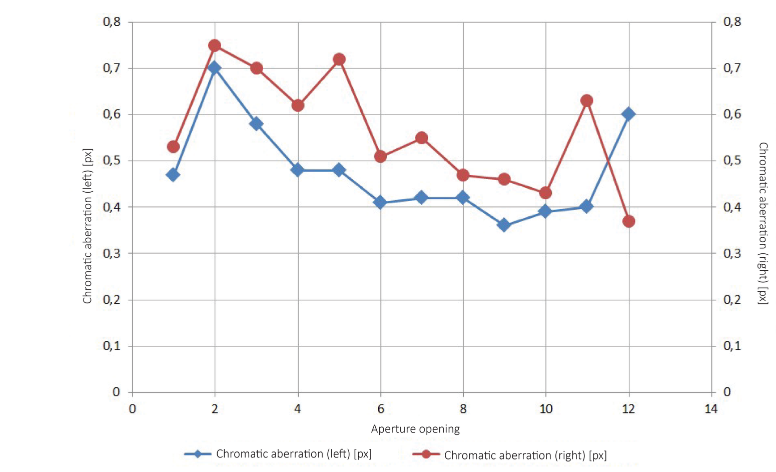

Figure 3
Graphic with the results obtained when photographing with the Sigma 85mm f/1.4 DG DN lens

The second test was performed on the Sigma 40mm f/2.8 lens at a distance of 120 cm from the test map, where the aperture, and therefore the ISO, is a variable factor while the focal length (40mm) and shutter speed (1/80) are fixed values. On Figure 10. a graph is shown with the results for the tested lens at different apertures. The graphic shows the X axis, on which the aperture values are, and two Y axes, on which the chromatic aberration is expressed for the ROI area on the right and left side of the same image. Based on the obtained results, according to the values from table 1. we conclude that the samples taken from the left side showed chromatic aberration below 0.5 at all apertures, which is insignificant chromatic aberration. They are on the right values in the range from 0.35 px to 0.59 px which, according to the table, are values that fall into insignificant chromatic aberrations and minimum values from the range of weak, that is, hard-to-notice chromatic aberrations.

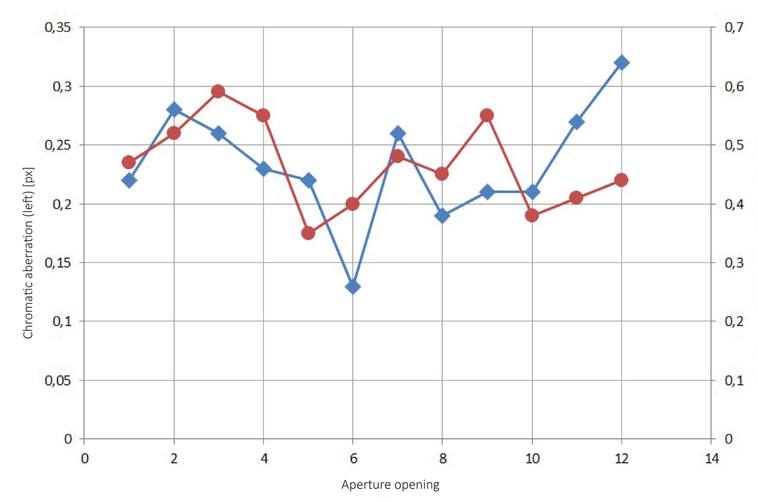

Figure 4
Graphic with the results obtained when photographing with the Sigma 40mm f/1.4

Conclusion

When studying the theoretical foundations of photography itself as well as individual parts of the camera system, we come to the conclusion that the theoretically perfect way of creating a photograph does not exist in practice. Deviations from perfect values the consequence is the imperfection of parts of the photographic system where the construction and quality of the used lenses play a crucial role. In order for the experimental part to be adequately done, it was necessary to study all the characteristics of the camera body as well as the lenses used, which significantly affect the final quality of the image. All the necessary knowledge for understanding the issues dealt with in this paper are clearly summarized and presented in the theoretical part. In order to obtain relevant results, the test card was photographed in accordance with the appropriate standards and recommendations. With the help of Imatest software, analyzes were made that gave results about the quality of the tested lenses. Changing the aperture did not drastically affect the increase in chromatic aberration either in the case of the Sigma 85mm f/1.4 DG DN, or in the case of the Sigma 40 mm f/1.4 lens. In general, at the average value of the examined apertures, the differences in chromatic aberration are the smallest, that is, negligible. Comparing these two lenses, the smallest measured value is for the Sigma 40mm f/1.4 and is 0.13 px at an aperture of f/4.5, and the largest is for the Sigma 85mm f/1.4 DG DN lens at an aperture of f/3.5 and is 0 ,72 px. The camera body as well as the lens that will be used are of great importance because their selection directly affects the results obtained. Also, it is of great importance to choose the appropriate test procedure, properly light the scene, perform the photography itself, analyze the obtained photos for the aforementioned irregularities with specialized software tools, and then choose the best lens by evaluating the results. It should also be borne in mind that for the full use of all the performance of the camera and lens, great knowledge and experience are needed, because otherwise the human factor can affect the degradation of the final quality. By improving the lenses, where recently new materials are used to make the lenses themselves, as well as special coatings that compensate for imperfections, better and better results are obtained. In the future, it can be expected that during the construction and production of the lenses themselves, errors arising due to reduce lens imperfections to a minimum. In addition to the improvement of lens production, software tools for removing lens irregularities are also being improved in parallel.

REFERENCES

Husić A. (2012) Hromatska aberacija. Available from: https://un-ze.ba/am/pzi/2011/HusicAmela/uzroci.html

Mehić, N. (2011) Hromatska aberacija. Available from: https://un-ze.ba/am/pzi/2010/MehicNerma/hromatska%20aberacija%20(CA).html

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