Optical aberrations

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Optical Aberration

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An optical aberration occurs when an imperfect optical system wrongly directs some of the rays passing through and thereby creating an imperfect image. This error in the image is a blurring which can be corrected. Even optical systems with the highest quality can be imperfect and therefor create an errors in an image. The higher resolution you want to achieve the more problems there will be with aberration.

There are two different types of optic aberration: monochromatic aberrations and chromatic aberrations. In chromatic aberration at least several wavelengths of electromagnetic radiation are being imaged. Monochromatic aberrations can be divided into several different types such as: coma, spherical, distortion, astigmatism and field curvature. Chromatic aberrations can be divided into longitudinal (which can be further divided into primary or secondary) and transverse aberrations.

Spherical aberration occurs when paraxial rays are focused further away from the lens then the peripheral rays. This means that the paraxial and peripheral rays have different foci and by measuring the distance between there foci you can determine how seveer the spherical aberration is.

Coma aberration happens due to the fact the ray of the off-axis do not completely converge at the focal plane. Coma be subcategorized into positive and negative coma. If it's negative then the rays focus closer to the axis and if it’s a positive coma then the rays focus furthest.

An optical system with astigmatism is one where rays that propagate in two perpendicular planes have different foci.

Field curvature means that the image is not objected on a plane but a sphere/curved surface instead. The image is not blurred but due to the objection of image on a curved surface it creates problems with cameras and slide projectors. This aberration can be simply fixed with using a combination of lenses.

Distortion is a bit similar to the previously mentioned field curvature since this aberration doesn't create a blurred image. Distortion can be further divided into barrel distortion (also called negative) and pincushion distortion (positive). The barrel distortion "shrinks" the image a little bit, especially the corners who are "pushed" towards the centre of the image. This explains why it's negative. While the positive - pincushion distortion stretches the square image at its corners.

Transverse chromatic aberration is when the wavelength causes the image-size to change. The different wavelengths of white light focus in different point on a vertical plane. While the different wavelengths of white light focus on different points on the horizontal axis in longitudinal aberration.

HOW ABOUT SOME DIAGRAMS?

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