

Vignetting

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In photography and optics, **vignetting** is a reduction in image brightness in the image periphery compared to the image center.

Although vignetting is normally unintended and undesired, it is sometimes purposely introduced for creative effect, such as to draw attention to the center of the frame. A photographer may deliberately choose a lens which is known to produce vignetting. It can also be produced with the use of special filters or post-processing procedures.

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Causes

There are several causes of vignetting. Sid Ray^[1] distinguishes the following types:

- Mechanical vignetting
- Optical vignetting
- Natural vignetting

A fourth cause is unique to digital imaging:

- Pixel vignetting

Mechanical vignetting

Mechanical vignetting occurs when light beams emanating from object points located off-axis are partially blocked by external objects such as thick or stacked filters, secondary lenses, and improper lens hoods. The corner darkening can be gradual or abrupt, depending on the lens aperture. Complete blackening is possible with mechanical vignetting.

Optical vignetting

This type of vignetting is caused by the physical dimensions of a multiple element lens. Rear elements are shaded by elements in front of them, which reduces the effective lens opening for off-axis incident light. The result is a gradual decrease of the light intensity towards the image periphery. Optical vignetting is sensitive to the aperture and can be completely cured by stopping down the lens. Two or three stops are usually sufficient.

Natural vignetting



An example of vignetting in a photograph



Vignetting is a common feature of photographs produced by toy cameras such as this shot taken with a Holga

Unlike the previous types, natural vignetting (also known as natural illumination falloff) is not due to the blocking of light rays. The falloff is approximated by the \cos^4 or "cosine fourth" law of illumination falloff. Here, the light falloff is proportional to the fourth power of the cosine of the angle at which the light impinges on the film or sensor array. Wideangle rangefinder designs and the lens designs used in compact cameras are particularly prone to natural vignetting. Telephoto lenses, retrofocus wideangle lenses used on SLR cameras, and telecentric designs in general are less troubled by natural vignetting. A gradual grey filter or postprocessing techniques may be used to compensate for natural vignetting, as it cannot be cured by stopping down the lens.

Pixel vignetting

Pixel vignetting only affects digital cameras and is caused by the physical depth of the photon wells that capture light in today's digital cameras. Just like more light reaches the bottom of a well when the sun is in zenith, light hitting a photon well at a right angle will have greater impact than light hitting it at an oblique angle. Most digital cameras use built-in image processing to compensate for optical vignetting and pixel vignetting when converting raw sensor data to standard image formats such as JPEG or TIFF.



Vignetting can be used to artistic effect, as demonstrated in this panorama

References

- [^] Sidney F. Ray, Applied photographic optics, 3rd ed., Focal Press (2002).
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