

Acutance

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In photography, **acutance** is the edge contrast of an image. Acutance is related to the amplitude of the derivative of brightness with respect to space. Due to the nature of the human visual system, an image with higher acutance appears sharper even though an increase in acutance does not increase real resolution.

In the example image, two light gray lines were drawn on a gray background. As the transition is instantaneous, the line is as sharp as can be represented at this resolution. Acutance in the left line was artificially increased by adding a 1 pixel wide darker border on the outside of the line and a 1 pixel wide brighter border on the inside of the line. The actual sharpness of the image has been decreased because the transition takes place across 4 pixels, but the apparent sharpness is increased because of the greater acutance.

Artificially increased acutance has drawbacks. In this somewhat overdone example most viewers will also be able to see the borders separately from the line, which create two halos around the line, one dark and one shimmering bright.



Another illustration, where overshoot caused by using unsharp masking to sharpen the image (bottom half) increases acutance.

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Tools

Several image processing techniques, such as unsharp masking, can increase the acutance in real images.



Unprocessed, slight unsharp masking, then strong unsharp masking.

Resampling

Low-pass filtering and resampling often cause overshoot, which increases acutance, but can also reduce absolute gradient, which reduces acutance. Filtering and resampling can also cause clipping and ringing artifacts. An example is bicubic interpolation, widely used in image processing for resizing images.^[*citation needed*]

Definition

One definition of acutance is determined by imaging a sharp "knife-edge", producing an S-shaped distribution over a width W between maximum density D_1 and minimum density D_2 – steeper transitions yield higher acutance.

Summing the slope G_n of the curve at N points within W gives the acutance value A ,

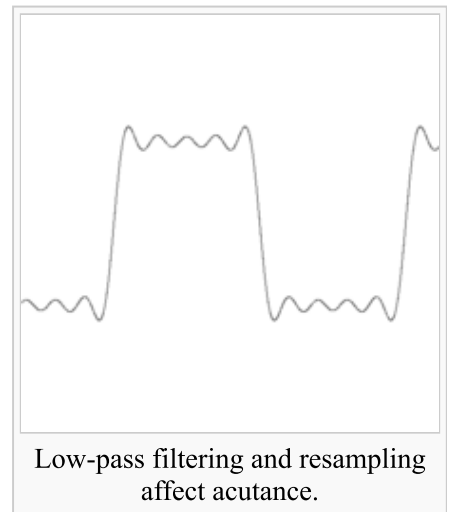
$$A = \frac{1}{N} \sum_{n=1}^N (G_n)^2 \times (D_1 - D_2)$$

Sharpness

Perceived sharpness is a combination of both resolution and acutance: it is thus a combination of the captured resolution, which cannot be changed in processing, and of acutance, which can be so changed.

Properly, perceived sharpness is the steepness of transitions (slope), which is change in output value divided by change in position – hence it is maximized for large changes in output value (as in sharpening filters) and small changes in position (high resolution).

Coarse grain or noise can, like sharpening filters, increase acutance, hence increasing the perception of sharpness, even though they degrade the signal-to-noise ratio.



Low-pass filtering and resampling affect acutance.

The term *critical sharpness* is sometimes heard (by analogy with critical focus) for "obtaining maximal optical resolution", as limited by the sensor/film and lens, and in practice means minimizing camera shake – using a tripod or alternative support, mirror lock-up, a cable release or timer, image stabilizing lenses – and optimal aperture for the lens and scene, usually 2–3 stops down from wide-open (more for deeper scenes: balances off diffraction blur with defocus blur or lens limits at wide-open).

See also

- Contrast (vision)
- Cornsweet illusion
- Edge enhancement
- Mach bands
- Ringing artifact

References

- The Focal Encyclopedia of Photography*, Focal Press, 1956, Ed. Frederick Purves

External links

- Tutorials: Sharpness (<https://web.archive.org/web/20101102045925/http://www.cambridgeincolour.com/tutorials/sharpness.htm>) , at Cambridge in Colour
- Understanding Sharpness (<https://web.archive.org/web/20101102045925/http://www.luminous-landscape.com/tutorials/sharpness.shtml>) , at The Luminous Landscape (<https://web.archive.org/web/20101102045925/http://www.luminous-landscape.com/>)
- Lens Sharpness: The Never-Ending Quest (<https://web.archive.org/web/20101102045925/http://www.luminous-landscape.com/tutorials/sharp.shtml>) , at The Luminous Landscape (<https://web.archive.org/web/20101102045925/http://www.luminous-landscape.com/>)

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