Lecture 1

Fourth stage

Medical Imaging Processing II

Introductory of Image Analysis

By

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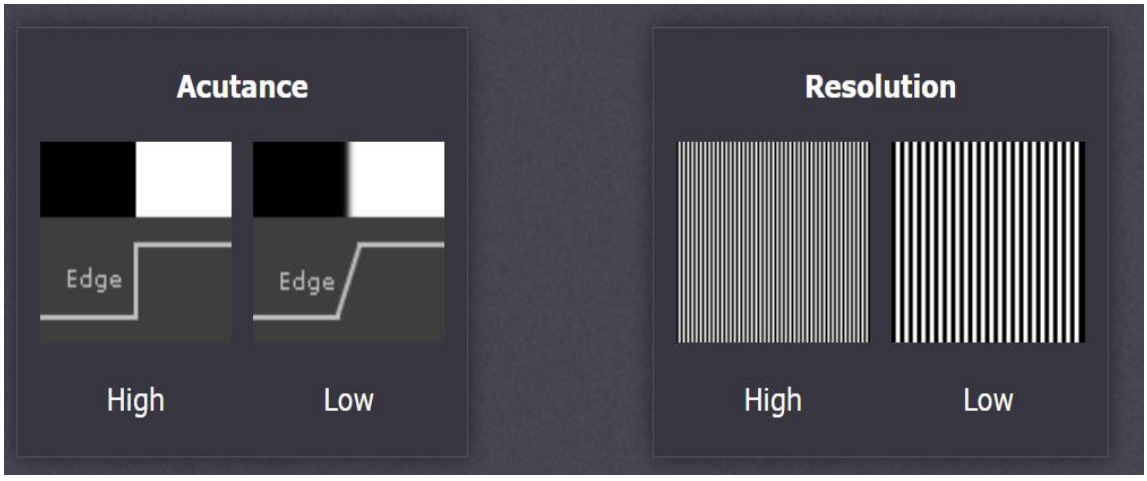
Image Sharpness

'sharpness' refers to an image's overall clarity in terms of both focus and contrast. When the subject of an image is sharp the image appears clear and lifelike, with detail, contrast and texture rendered in high detail. Images which lack sharpness or are 'soft' can appear blurry and lacking in detail, although experienced photographers are able to manipulate sharpness to allow a feeling of warmth or movement within an image. Image sharpness is extremely reliant on achieving accurate focus on a desired subject, especially challenging when shooting scenes which require a narrow depth of field, or shooting in low light situations which require large apertures.

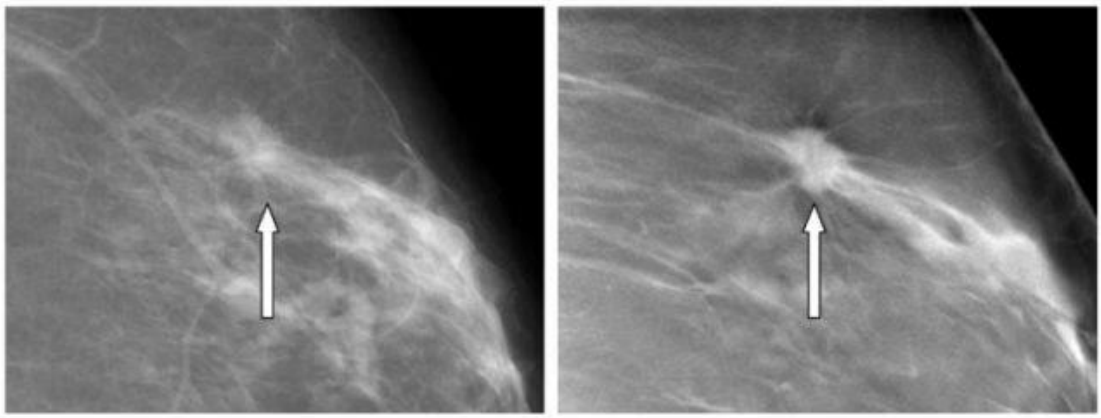
Sharpness describes the clarity of detail in a photo, and can be a valuable creative tool for emphasizing texture. Proper photographic and post-processing technique can go a long way towards improving sharpness, although sharpness is ultimately limited by your camera equipment, image magnification and viewing distance. Two fundamental factors contribute to the perceived sharpness of an image: resolution and acutance.



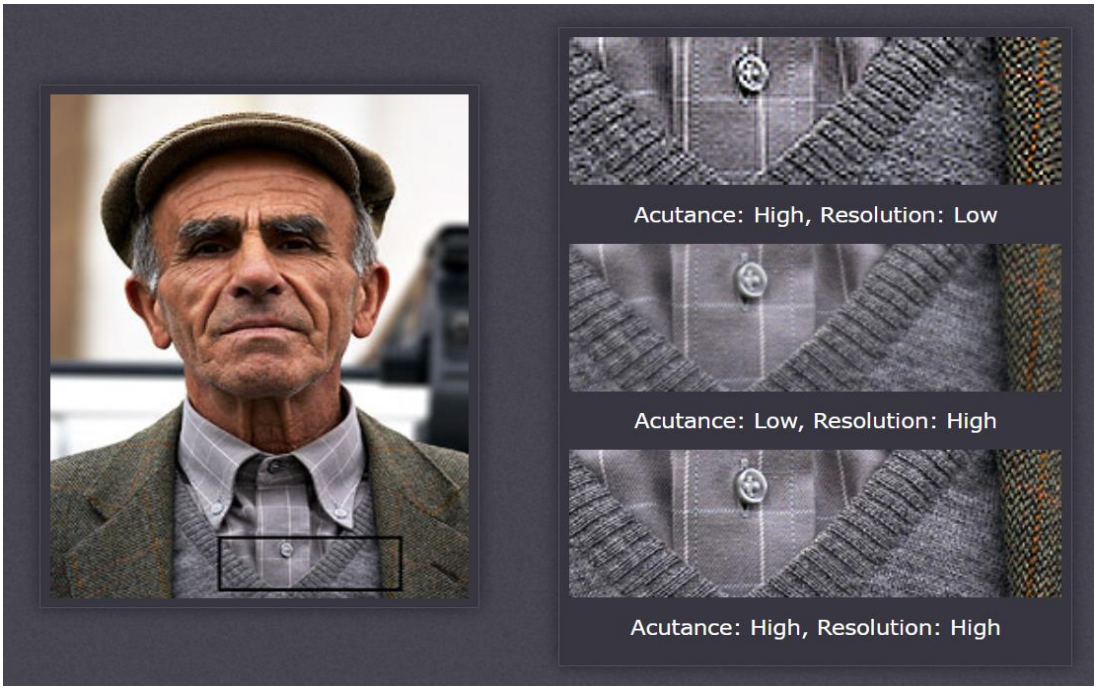
Acutance describes how quickly image information transitions at an edge, and so high acutance results in sharp transitions and detail with clearly defined borders.

Resolution describes the camera's ability to distinguish between closely spaced elements of detail, such as the two sets of lines shown above.
For digital cameras, resolution is limited by your digital sensor, whereas acutance depends on both the quality of your lens and the type of post-processing. Acutance is the only aspect of sharpness which is still under your control after the shot has been taken, so acutance is what is enhanced when you digitally sharpen an image (see Sharpening using an "Unsharp Mask").

Comparison between Acutance and resolution
Photos require both high acutance and resolution to be perceived as critically sharp. The following example is designed to give you a feel for how each influences your image:

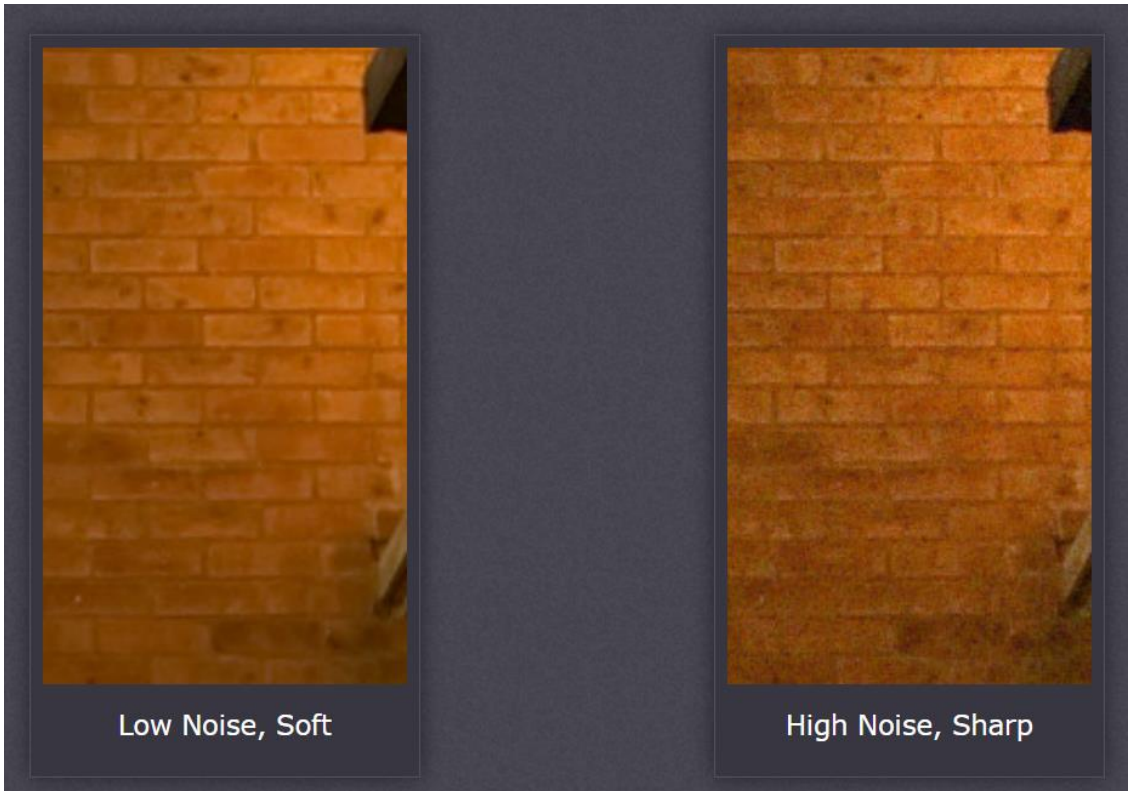


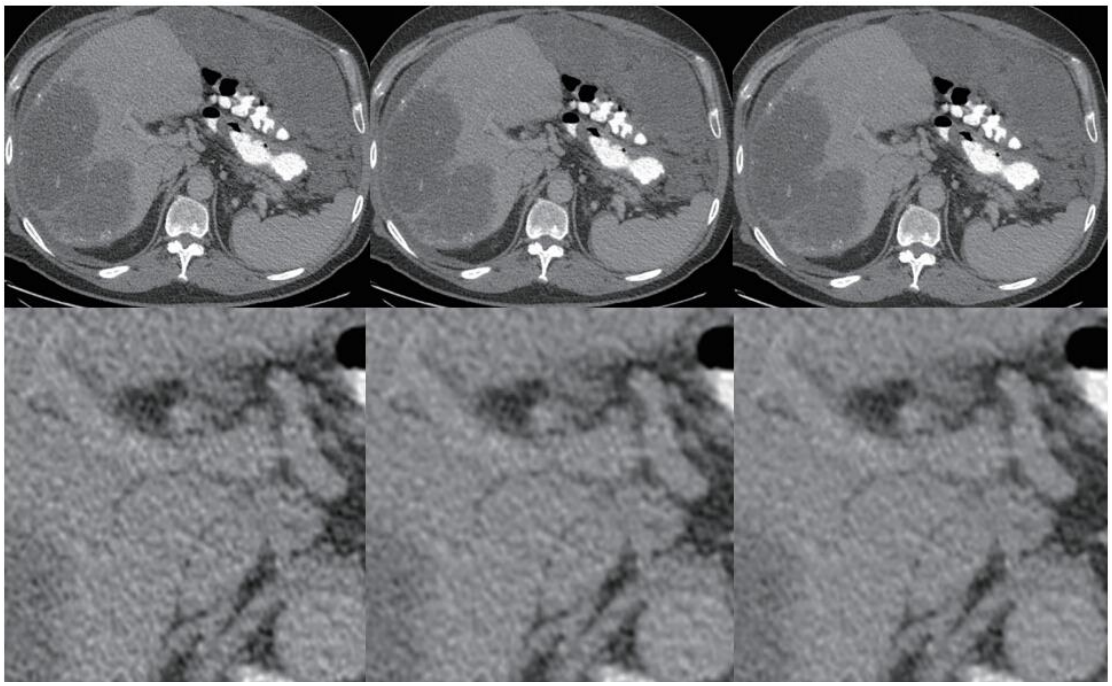
A B

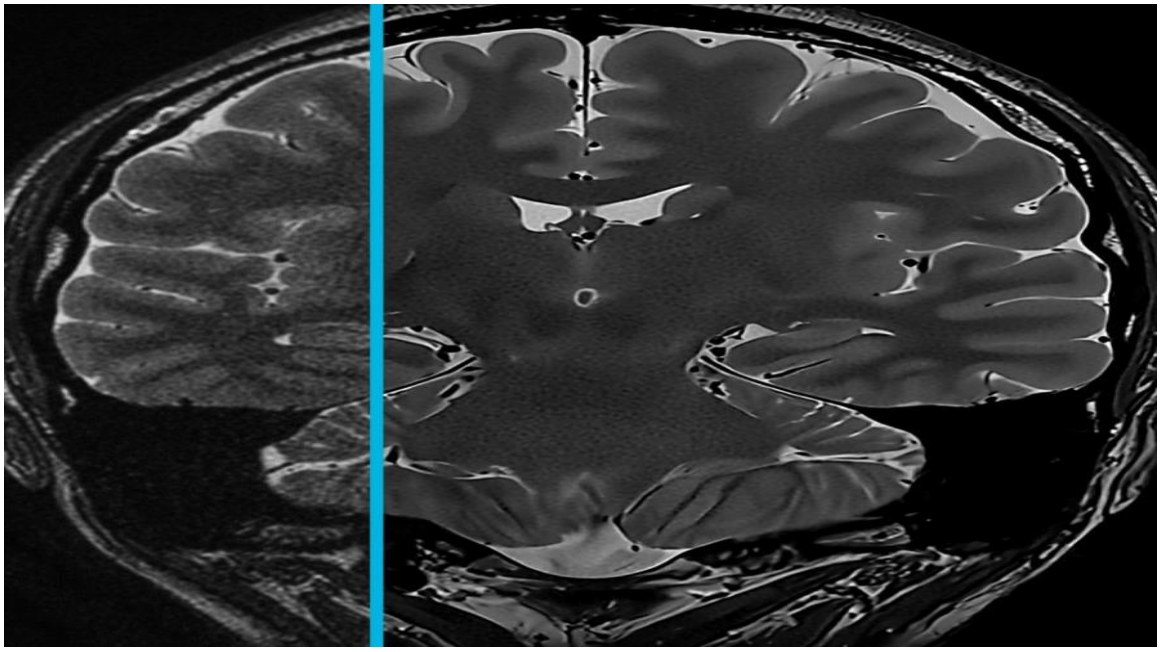


PROPERTIES OF SHARPNESS

Sharpness also depends on other factors which influence our perception of resolution and acutance. Image noise (or film grain) is usually detrimental to an image, however small amounts can actually increase the appearance of sharpness. Consider the following example:


Low Noise, Soft
High Noise, Sharp





Although both images have not been sharpened, the image to the left appears softer and less detailed. Image noise can be both very fine and have a very high acutance — tricking the eye into thinking sharp detail is present.

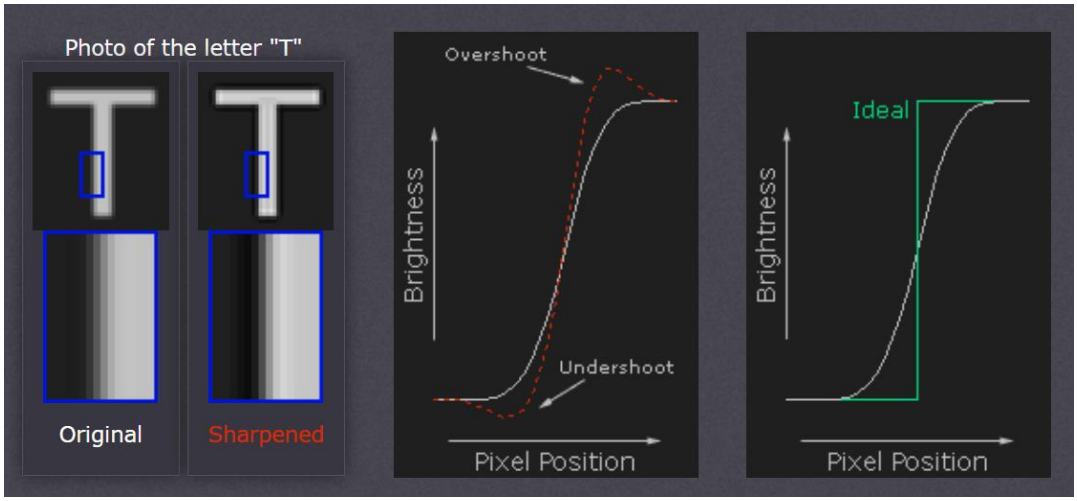
Sharpness also depends on viewing distance. Images which are designed to be viewed from farther away, such as posters or billboards, may have much lower resolution than fine art prints in a gallery, but yet both may be perceived as sharp because of your viewing distance. Keep this property in mind when sharpening your image, as the optimal type of your sharpening may not necessarily be what looks best on your screen.

Sharpness is also significantly affected by your camera technique. Even small amounts of camera shake can dramatically reduce the sharpness of an image. Proper shutter speeds, use of a sturdy camera tripod and mirror lock-up can also significantly impact the sharpness of your prints.

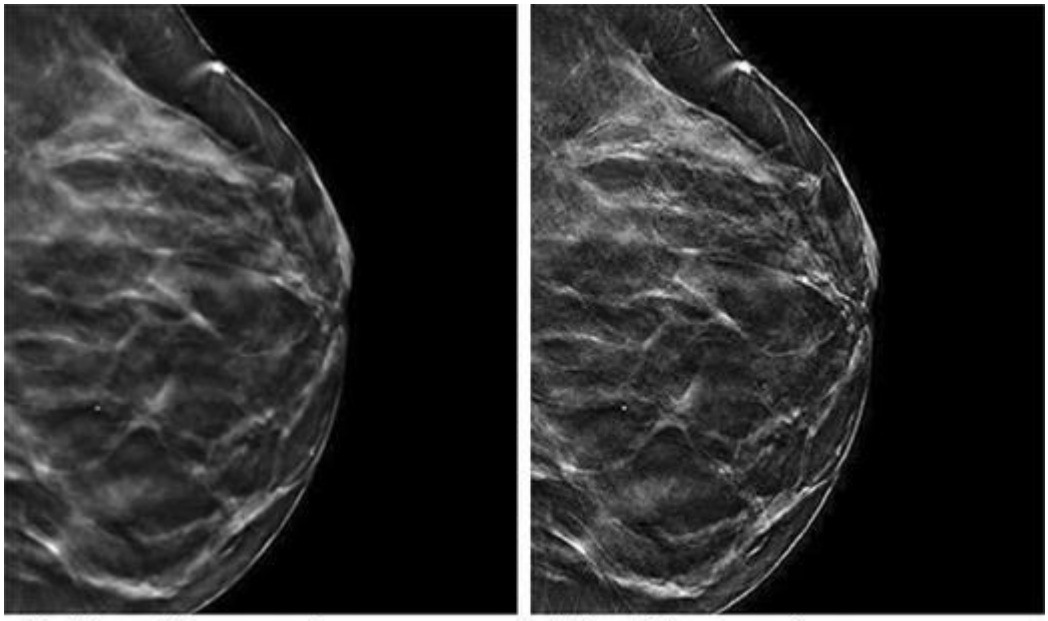
SHARPENING SOFTWARE TOOLS

Most image sharpening software tools work by applying something called an "unsharp mask," which despite its name,

actually acts to sharpen an image. in a it works by exaggerating the brightness difference along edges within an image:

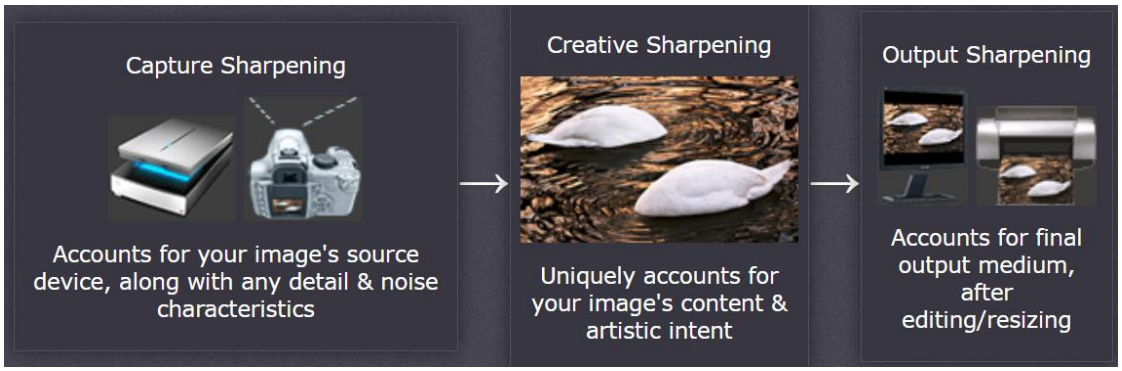


Note that while the sharpening process isn't able to reconstruct the ideal image above, it is able to create the appearance of a more pronounced edge. The key to effective sharpening is walking the delicate balance between making edges appear sufficiently pronounced, while also minimizing visible under and overshoots (called "sharpening halos").



SHARPENING WORKFLOW

Most photographers now agree that sharpening is most effective and flexible when it's applied more than once during image editing. Each stage of the sharpening process can be categorized as follows:



(1) Capture sharpening aims to address any blurring caused by your image's source, while also taking image noise and detail into consideration. With digital cameras, such blurring is caused by the camera sensor's anti-aliasing filter and demosaicing process, in addition to your camera's lens. Capture sharpening is required for virtually all digital images, and may be applied automatically by the camera for photos which are saved as JPEG files. It also ensures the image will respond well to subsequent rounds of sharpening.

(2) Creative sharpening is usually applied selectively, based on artistic intent and/or image content. For example, you might not want to apply additional sharpening to a smooth sky or a person's skin, but you may want to crank up the sharpness in foliage or a person's eye lashes, respectively. Overall though, its use may vary wildly from photo to photo, so creative sharpening is really a "catch all" category. It's also the least used stage since it can also be the most time-consuming.

(3) Output sharpening uses settings customized for a particular output device, and is applied at the very end of the image editing workflow. This may include special considerations based the size, type and viewing distance of a print, but it can also be used to offset any softening caused by resizing an image for the web or e-mail.

Overall, the above sharpening workflow has the convenience of being able to save edited images at a near-final stage. When printing or sharing one of these images, all that is needed is a quick top-off pass of sharpening for the output device.