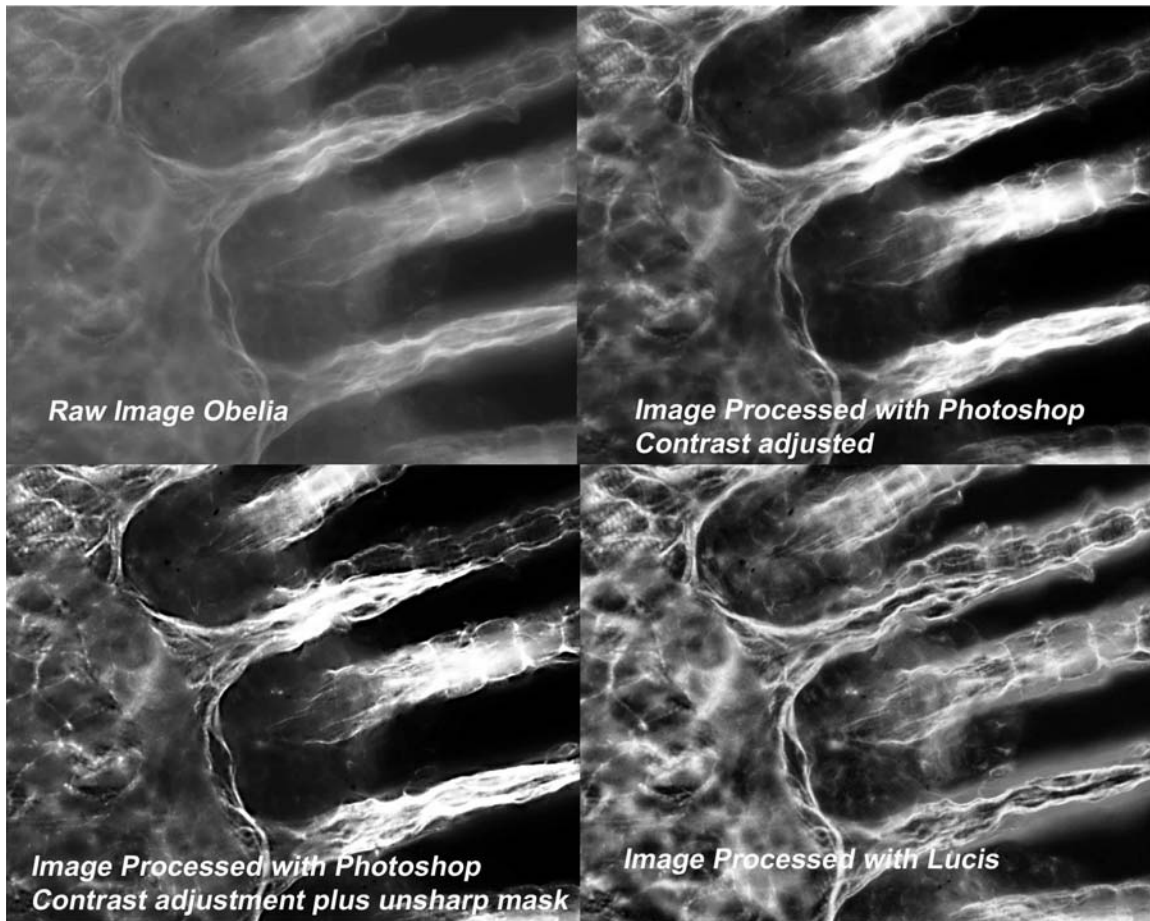


### Lucis Image Processing Competitive Advantages

Lucis is sometimes compared image processing methods unsharp mask and contrast adjust. Unsharp mask is a type of high-pass filter. An algorithm, such as a Gaussian curve, is used to smooth the image. The smoothed image is subtracted from the original, and then the results are contrast-stretched. This enhances edges and detail in the image. Using this method can sometimes cause loss of detail in the bright areas. Also, although detail is represented by high frequencies, there are high frequency components in the larger image features. As you enhance the detail you are also enhancing the high frequency components of the large features, creating artifacts.

Contrast adjust involves eliminating ranges of pixel intensities where there is little information, then contrast stretching the remaining intensities to better view image detail. So revealing detail involves discarding some image information. It is impossible to view detail in the bright and dark regions of the image simultaneously.

Below is an image example where unsharp mask and contrast adjust obscured detail in the highlighted areas that Lucis revealed.



Figures 1-4: Images of a fluorescently stained jellyfish, obelia. These organisms are 1 mm in diameter and stained with the fluorescent probe, alexa phalloidin. The montage shows

a raw image taken with the Optronics MagnaFire™ camera, an image processed with Photoshop adjusting the gray scale range, the image further processed by using the Photoshop unsharp mask, and finally a Lucis processed image. The Photoshop image, after contrast adjustment and using the unsharp, mask appears similar to the Lucis processed image. However, the highlights have overwhelmed image detail in the Obelia's tentacles. In contrast Lucis, reveals structural details with the same region of the tentacles. The Lucis image was created with a one step processing command.

Images and the above description courtesy of Brian Matsumoto, Ph.D.  
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Lucis is based on a patented algorithm, Differential Hysteresis Processing. Lucis uses a hysteresis process to create a smoothed image. This smoothed image is subtracted from the original. This result is contrast-stretched to create a Lucis image with enhanced detail. This differential hysteresis process has superior results to unsharp mask because detail is not lost in the highlighted areas. Lucis is superior to contrast adjust because 1) Lucis enhances detail by shifting the relative emphasis of contrast information, not by discarding information and 2) Lucis enhances detail throughout the image simultaneously, in the bright, mid-range and dark areas of the image.

Depending on the contrasts in the image itself, there will always be times when unsharp mask or contrast adjust can produce an image similar to the Lucis image. But in ICT's experience Lucis is always slightly better, and is frequently greatly superior. Here are the key differences between Lucis and other image processing methods.

1) Lucis enhances any image. You don't have to examine the image and determine which image processing method should be used to extract the information you seek.

2) Lucis has superior performance with respect to revealing image detail throughout the image, simultaneously in the dark and highlighted areas. Depending on the image, other methods may come close but Lucis is always a little superior, and is sometimes greatly superior.

3) Lucis reveals accurate image detail. There can sometimes be shadowing around discontinuities that might obscure some detail, but in ICT's experience Lucis does not create artifacts that appear to be image detail. For a mathematical analysis of possible Lucis shading around discontinuities, please read Localized Contrast Enhancement Using Lucis (pdf 556K). For an analysis of possible Lucis artifacts please read Avoiding Lucis Artifact Production (pdf 300K). Both papers are available at [www.imagecontent.com](http://www.imagecontent.com) under "Software Tutorial."

4) Lucis is very easy and intuitive to use. Typically you only have to move the one slider (the big cursor) to get results.

5) As you move the big slider to the left, image detail increasingly emerges. This gives the researcher a "feel" for how the image detail varies in a way that is very different from other methods. This is a very different experience than using an image-processing algorithm where you have to type in several parameters to see a result. Often the effect of varying the parameters on the resulting image is not intuitive. This can result in a long, trial and error process.

6) The Differential Hysteresis Processing algorithm is easy to understand. Users can feel confident with the information they are viewing because the process of enhancing the detail makes sense even to a person without an extensive background in image processing. For more information please read [Lucis Algorithm Description \(pdf 388K\)](#) under "Software Tutorial."

For more information about Lucis please call 508-346-3491 or US Residents can call toll free-866-746-4428 (866-RING-ICT) or e-mail us at [sales@imagecontent.com](mailto:sales@imagecontent.com).