FROM MOTION TO DATA TO KNOWLEDGE

Application Note

Image Processing: Brightness, Contrast, Gamma, and Exponential/Logarithmic Settings in ProAnalyst®

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Abstract

This application note discusses Brightness, Contrast, Gamma and the Exponential/Logarithmic (Exp. /Log.) function settings in relation to image processing with Xcitex ProAnalyst software. This application note details how to control light and dark in images and how these factors relate to video analysis. Also included are explanations of these LUT settings, image palette options and how they affect tracking and building a histogram in relation to image processing.

LUT Settings

In image processing, LUT stands for Look-Up-Table. LUT settings are the overall controls including Brightness, Contrast, Gamma and Exp./Log. function settings.. Manipulation of the various controls transforms an input image into a more useful composition for analysis. By manipulating the LUT settings of a video image, the best overall contrast, for analysis, between various images in a video can be achieved. A good contrast between images allows for proper tracking of necessary objects. For example, a color picture of a tree can be transformed into gray scale and the contrast heightened to emphasize the difference in the tree's leaves.

Image Processing

In ProAnalyst, the Image Processing Control panel can be shown by clicking the Image Processing button  located on the side toolbar of the Measurement Window.

The Image Processing control panel allows for setting all the parameters of an image, saving settings and restoring them for later use. Note that there are the same sets of sliders for color and monochrome (black and white) images as there are for color (red, green and blue). For color settings, the red, green and blue channels are modified as a group when the slider is the default black color. By double-clicking on the slider control, the slider bars separate into red, green and blue channel sliders that can be adjusted

independently. For greater flexibility, all images are treated as RGB color. This simplifies image processing and affords the ability to add color to a grayscale image by separating the channels and moving the individual red, green and blue sliders.

The Image Processing Control panel is shown in Figure 1 below.

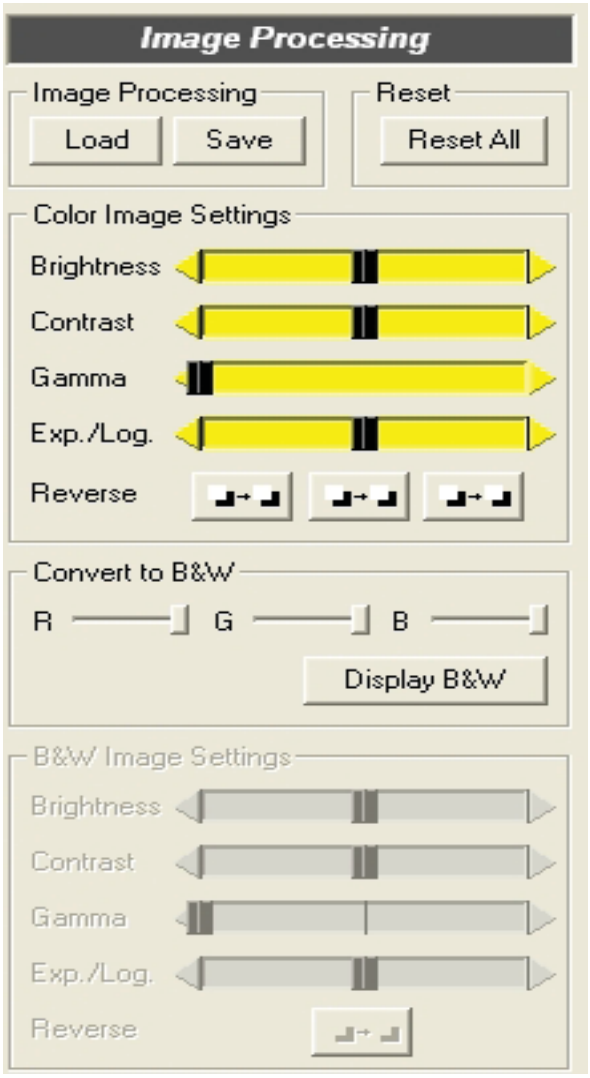


Figure 1. Image Processing Panel

Brightness

Brightness is an attribute of visual perception in which a source seems to be radiating or reflecting a specific amount of light. Brightness often dictates whether an object is able to be tracked or not due to the exposure (amount of light) levels - what can be seen and what cannot. The proper brightness levels are of the utmost importance when capturing a video image so the object is properly shown and can be tracked.

Contrast

Contrast is the visual property of an object that separates it from other objects in a video image. The contrast of objects against the background of a video image is important for two functions: identifying an object and later tracking it. In order to have discernible objects that can each be properly recorded and tracked, correct contrast levels must be utilized to distinguish one object from another.

Gamma

The idea of gamma is more complicated than the previous two forms of manipulating color in a video image. Gamma correction, gamma non-linearity, gamma encoding, or simply, gamma, is the name of a non-linear operation used to code and decode light and dark values in video images. In the simplest terms, gamma is used to quantify contrast and keep images “linear” which allows for objects to be defined more easily and generally made more uniform and therefore easier to track.

Exponential/Logarithmic (Exp./Log.) Non-Linear

Exp./Log. function settings control the overall color palette of an image in terms of light and dark in a non-linear function. Having an Exp./Log. function setting value of zero (0) moves the image towards the darkest it can be (absolute black). Conversely, having an Exp./Log. function setting at the other end of the spectrum, that of two-hundred fifty-five (255), moves the image towards the lightest it can be (absolute white). The Exp./Log. function settings provide non-linear control over the light and dark of an image.

Detailed Input/Output Mapping

Detailed Input/Output Mapping is a feature in ProAnalyst’s image processing that allows for improvement to the image’s contrast to enhance tracking success. The tracking tools typically acquire objects that have high contrast (white-on-black or black-on-white). Changing the Look-Up-Table (LUT) settings adjusts the image palette to improve image contrast.

Image Palette Options

Figure 2 is a graphical representation of how the image palette functions. A pixel value of X (180) is given on the horizontal axis. By moving vertically until the line in the image palette is reached, and then moving horizontally to the left, we reach value Y (75), the new pixel value for the manipulated image. Examining the picture to the right, a reverse palette is identified because the new Y value (75) becomes the inverse of the original X value (180). Each image palette affects images differently: Normal, Reverse, Brightness, Contrast, Exponential/Logarithmic and Gamma.

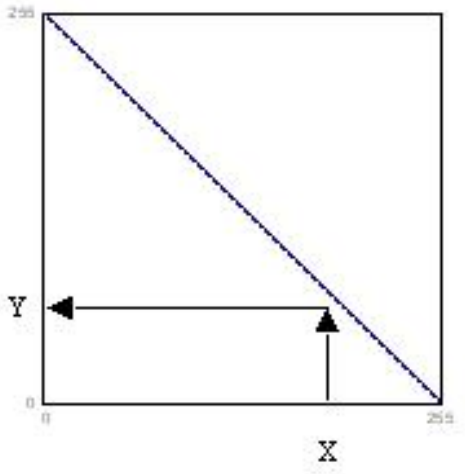


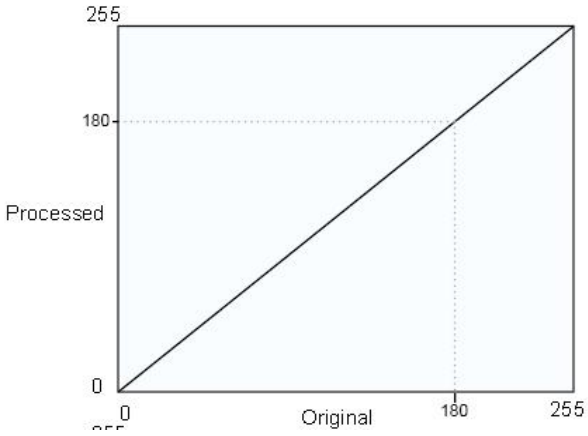
Figure 2. Image Palette

A description and representational graphic of the image palette options available in ProAnalyst are shown below. The text explains the effects of each of the palette options. The images are graphical representations of the various functions and how they affect the pixel intensity values from the original (horizontal axis) to the processed (vertical axis) image after applying the palette.

Note: the values represented on the left side of the graphs are approximations.

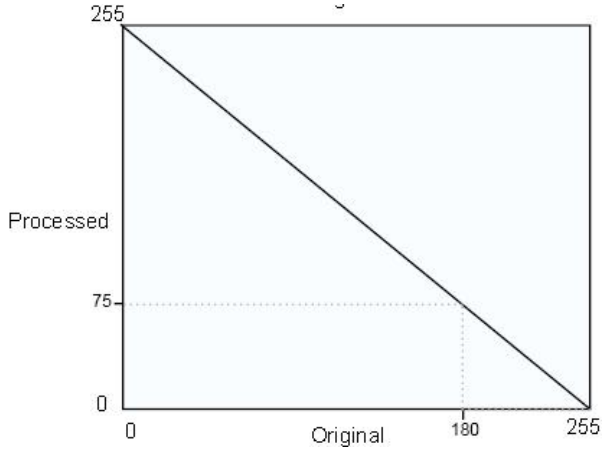
Normal

This is the default and standard palette with no processing occurring. The processed pixels are identical to the original pixels.



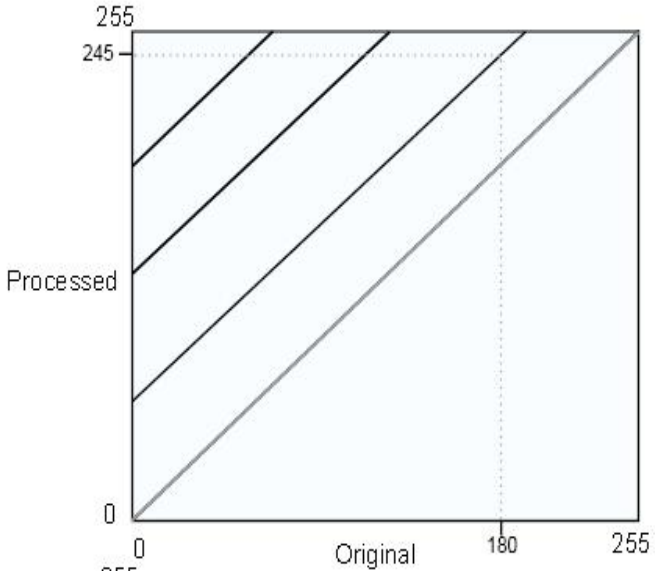
Reverse

This option uses a reverse palette, where 255 is black and 0 is white. This will invert the image so that light regions are dark and dark regions are light. Contrast is not affected.



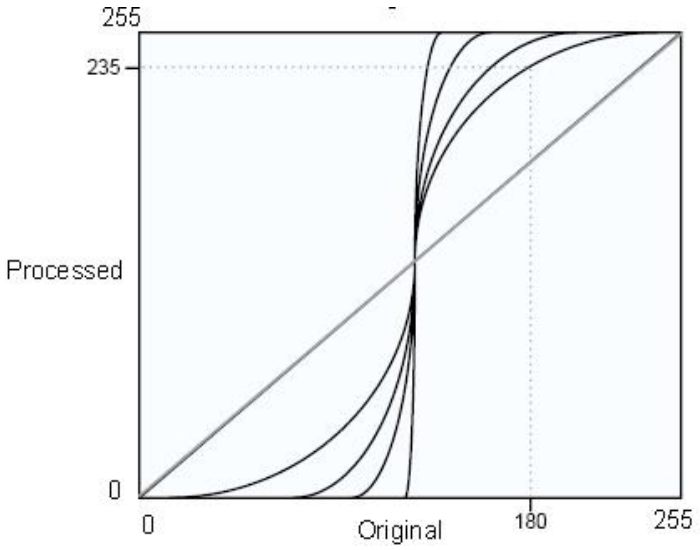
Brightness

Adjusts the brightness of the image. Moving the slider to the right will increase the brightness of the image (moving the diagonal line represents the transition up on the scale) by uniformly increasing the pixel intensity values. Moving the slider to the left will decrease the brightness of the image (moving the diagonal down on the scale) by uniformly decreasing the pixel intensity.



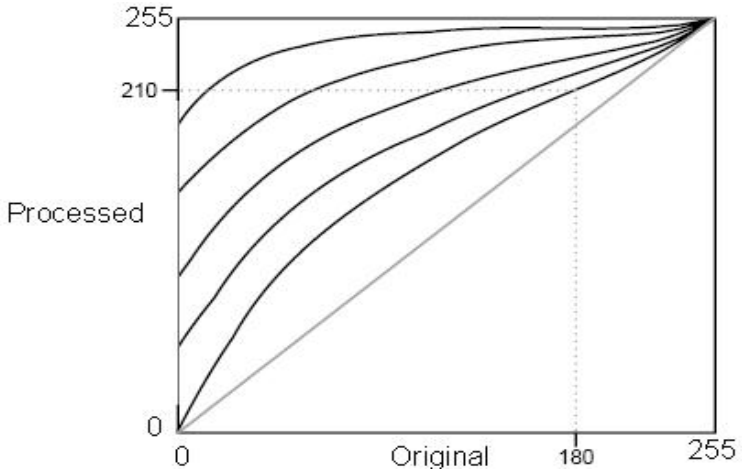
Contrast

Adjusts the contrast of the image. Moving the slider to the right will increase the contrast of the image. This has the effect of moving pixel intensity values towards white (255) or black (0). Moving the slider to the left will decrease the contrast of the image. This has the effect of moving pixel intensity values towards gray (128).



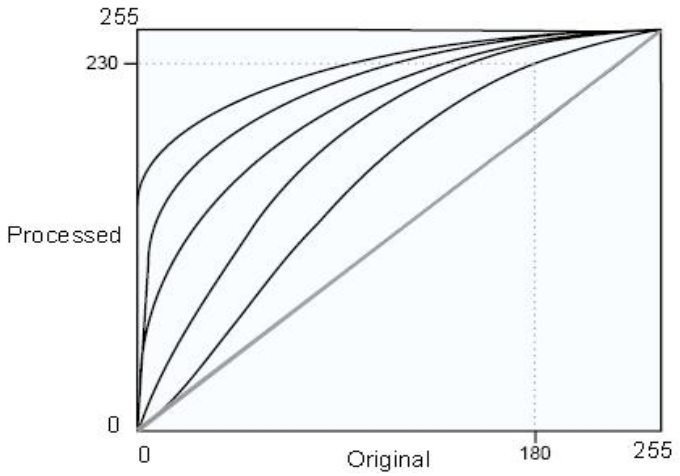
Exponential/Logarithmic

Adjusts the image using non-linear input/output mappings. This slider is a combination of a logarithmic (moving slider to the right) and exponential (moving slider to the left) palette. The logarithmic palette increases the contrast in dark regions and decreases the contrast in light regions. This has the effect of bringing out more detail in the dark regions and making light regions very light. The exponential palette increases the contrast in light regions and decreases the contrast in dark regions. This has the effect of making dark regions darker and bringing out more detail in lighter regions.



Gamma

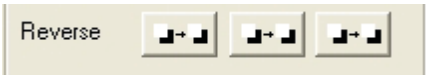
Adjusts the gamma of the image. Gamma correction is typically used to adjust for differences in the way monitors display brightness and colors. Adjusting this slider is similar, although not identical, to adjusting the non-linear slider. Moving the slider to the right will increase the brightness of the image in a non-linear fashion.



Reversing Channels

Images may also be converted between color and monochrome, and then adjusted individually by separate channels (colors) of the image. Note that all of the analysis toolkits use only monochrome representations of images.

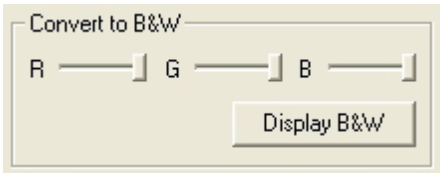
To reverse a monochrome image or individual channels of a color image, click on the **Reverse Buttons** located at the bottom of the color and black and white sections of the panel.



Reversing channels changes the color palette such that whites and blacks are reversed. In addition, for color images, each individual channel of RGB color is reversed. For color reversals, Red is reversed to Cyan, Green is reversed to Magenta and Blue is reversed to Yellow.

Converting between Color and Monochrome

To display a color image as monochrome or to reset a monochrome image to its original color (if recorded in color), use the **Convert to B&W Button** and adjoining sliders for more in-depth manipulation of the separate color channels.



Display B&W

Converts color images to monochrome images using the conversion factors indicated by the R, G, and B sliders.

Color Scale(s) - R Scale, G Scale and B Scale.

The Color Scale(s) represent the amount of a certain color in an image. The R scale represents the amount of red channel included, the G scale the amount of green and the B scale the amount of blue when converted from color to monochrome.

Saving LUT Settings

Once a good set of LUT settings has been established, save the image processing settings to reload them at a later time or apply these saved settings to another video image. Optimizing one image for tracking performance and then applying these same image processing settings to all images in the same experiment or application is very useful. The image processing settings are saved into an LUT (.LUT) file for later use.

Histograms

A histogram is a graphical display of collected data. In image processing, this 'data' equates to an images distribution of light and dark.

In relation to Brightness, Contrast, Gamma and Exp./Log. function settings, histograms are virtual representations of the distribution of every pixel in your image. This representation is horizontally graphed according to light and dark; the darker sections are towards the 0 number (complete black) and the lighter images towards the 255 number (complete white). The vertical spikes represent the quantity of pixels in that range of either light or dark. For example, the image referenced by the histogram shown below has a portion that is almost completely black, indicated by the large spike near the 0 number.

By clicking the **Histogram** button  located on the toolbar at the top of the Measurement window, a histogram of your data is automatically generated as shown in Figure 3. Histograms provide a visual representation of the light and dark contrasts in an image.

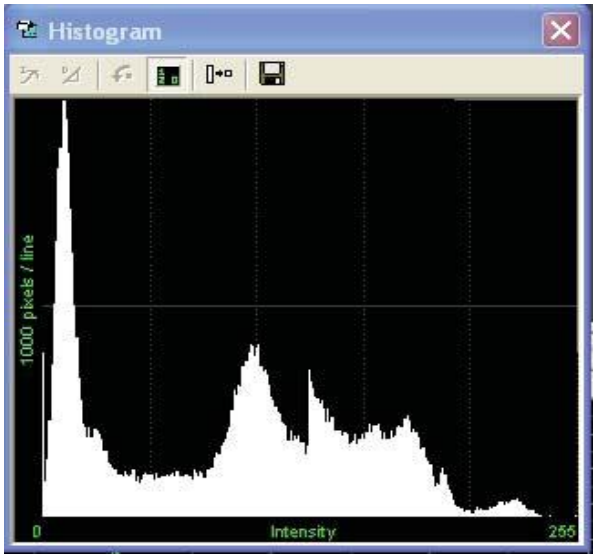


Figure 3. Histogram

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