## Image processing with lookup tables (LUT):
Make the (almost) invisible visible

The IDS Software Suite allows you to apply characteristic curves to digital images for all uEye camera models. This is done in the software by using lookup tables. Additionally the lookup tables can be used in the camera hardware for camera models of the GigE and USB 3 uEye series and the USB 2.0 CCD models rev. 3.

Background

With a lookup table it is easy to apply characteristic curves to digital images. A LUT is a table which assigns an output value to every possible input value. Using LUTs has the advantage that calculations can be done very fast. This is most advantageous for evaluating and correcting color spaces.

The figure below shows a LUT which would binarize an image: For an 8 bit image, for example, this LUT would replace all pixels with gray values 0...127 with value 0 and all pixels with gray values 128...255 with value 255.
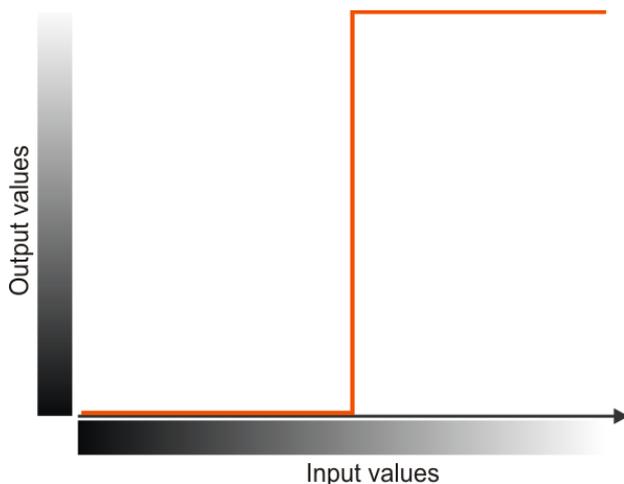
LUT characteristic for binarizing

So you can use a LUT, for example, to make even slight shading clearly visible.
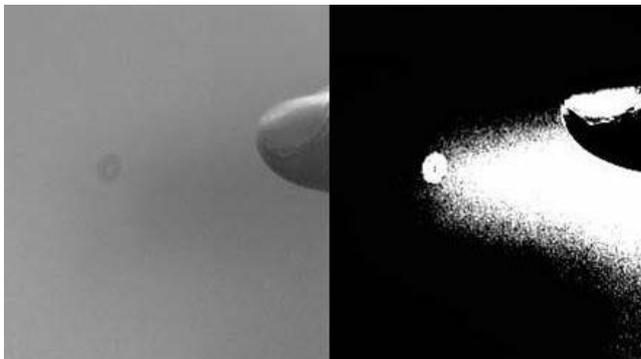
Example image before and after using a LUT characteristic

TechTip

The use of a LUT has the advantage that image calculation can be done very fast. Typical applications are enhancing gamma or image contrast, brightness changes, gray value spreading, or setting individual gradation curves.

Hardware or software LUT

Depending on the camera model the LUT function can be done in the camera hardware or in the software API. Both methods have advantages and disadvantages.

The hardware LUT is done in the camera and does not increase the PC's CPU load. To get a very good image quality, the image is processed with a bit depth of 12 bits per pixel. But for monochrome image it is not possible to apply a false-color LUT. Also, you cannot define separate LUT characteristics for each RGB color.

With software LUT, it is the other way round: Here, you can apply a false-color LUT to monochrome images and define different LUT for each RGB color. As the software LUT processing is done on the PC, the CPU load increases. There also might be a little loss of quality as software LUT is often done with a bit depth of 8 or 10 bits per pixel.

You can use the software LUT with all uEye camera models. The hardware LUT is only available with GigE and USB 3 uEye models and for USB 2.0 models with CCD sensors rev. 3. These models can be used both with the hardware and the software LUT. Depending on the set LUT the driver automatically selects the better option.

Using LUT

Open the "Properties" dialog in uEye Cockpit. Enable using the LUT in the "LUT" tab. Furthermore, you can configure the LUT characteristic individually or load a predefined LUT. On the top right you can see if the LUT function is done by hardware or software.

For color cameras you set via the dropdown box "channel" whether the LUT is applied to all channels or only to a specific channel. In the "Output" area you can edit the LUT characteristic by moving single knee points with the mouse. You can draw a smooth curve for the selected channel by left-clicking on a blank space next to the curve. The LUT has 32 knee points by default. Knee points are used for defining the individual sections of the curve. When you select the "Split points" option, each knee point is split into two separate points. Thus, the start and end points of each curve section can be defined independently of the adjacent sections.
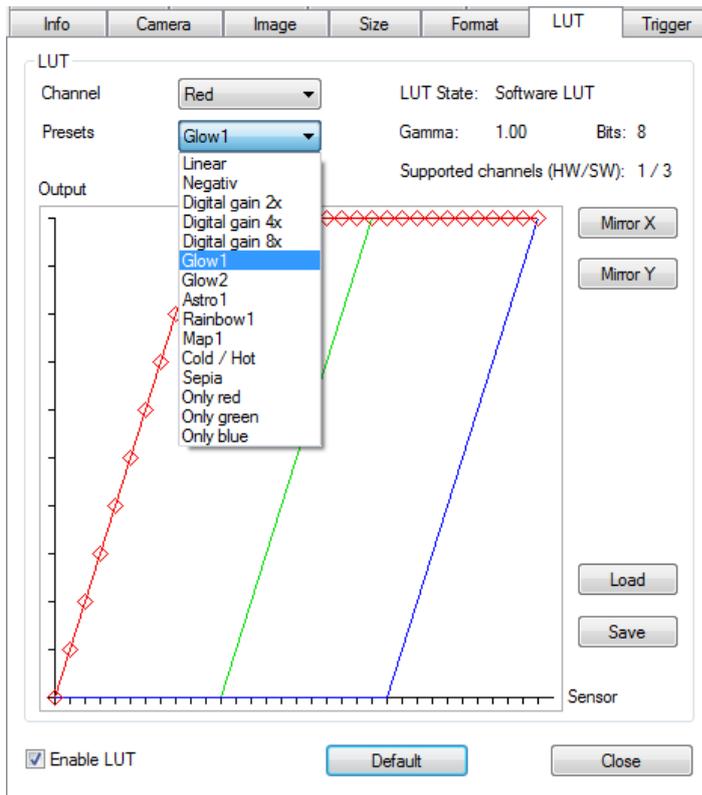
To flip the LUT characteristic along the X or Y axis, use the buttons "Mirror X" and "Mirror Y".

To save a custom LUT characteristic in a file or to load a saved LUT characteristic, click on the buttons „Save" or „Load".

You can select a predefined LUT via the „Presets" dropdown box. The available LUT characteristics differ according to the camera model and the current set color format (see "Format" tab).

The color separation is especially of interest with color cameras. For monochrome camera models different special LUTs for false-color representation offer many possibilities e. g. like "Astro1" for astronomic captures.
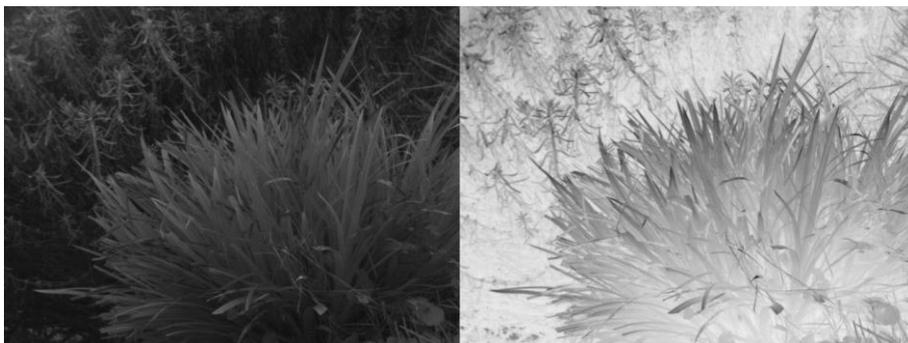
The freely selectable gamma is automatically added to the LUT. If using false color rendering, you should work without active gamma. Please also disable the auto functions.
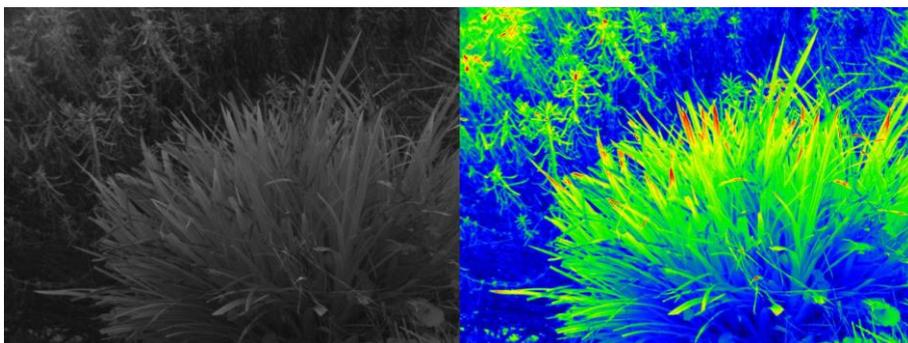
Example: Color separations (LUT "Only green")

Example: Brightness correction (LUT "Digital gain 2x")

Example: Get more details in dark areas (LUT "Negativ")

Example: False-color representation (LUT "Rainbow1")

Application areas

The use of the LUT functions allows to highlight poorly visible areas by increasing the contrast or to edit the image by using gamma correction. So this function is especially interesting if you have to enhance a weak contrast in the image, do gray level spreading or apply a gamma function.

The LUT function is especially useful in the fields of medical technology such as blood analysis or ophthalmology. But there are also suitable applications in the fields of astronomy or thermography.

Summary

Using the LUT function of the IDS Software Suite you can quickly and easily enhance image contrast and gamma, or apply individual gradation characteristics – both in the camera or on the PC. With the software LUT you can apply a LUT characteristic to all cameras even if they do not support this feature in the camera hardware.

For more information on configuring and programming the LUT, refer to the uEye manual at http://en.ids-imaging.com/manuals-ueye.html.

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