

See more details:

3 ways to an HDR image

The abbreviation HDR (sometimes HDR!) stands for High Dynamic Range (Imaging or Imager) and refers to recording or generation of digital images with a high dynamic range.

IDS offers various camera models that allow HDR pictures to be taken. This TechTip presents the different HDR methods and compares them with one another.

Background

The dynamic range (also known as contrast) in images refers to the ratio of the highest brightness value to the lowest brightness value. In other words, a subject has a high dynamic range if a scene contains very light and very dark areas at the same time (example: taking a picture of a person who has their back to the sun). However, a subject can be very light and have a low dynamic range if it does not contain any dark areas (example: looking directly into the sun).

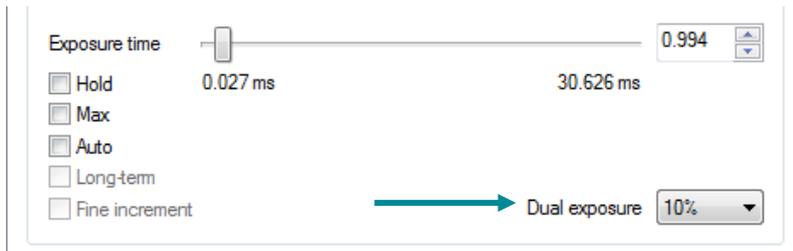
More information about HDR images and dynamic range can be found in our white paper "High Dynamic Range Imaging: Images and Sensors – Principles, Functioning and Applications" at http://en.ids-imaging.com/whitepaper.html?file=tl_files/downloads/whitepaper/IDS_Whitepaper_2009-3_HDR_EN.pdf

The following sections describe the three methods – Interleave HDR, knee point HDR and log mode – which can be used to capture HDR images with particular uEye camera models.

Interleave HDR

With Interleave HDR on the UI-336x/UI-536x and UI-337x/UI-537x models, different exposure times are used for different pixels in a picture. For example, on monochrome models lines 1, 3, 5, etc. are exposed using the full exposure time, while lines 2, 4, 6, etc. use a reduced exposure time. On color models, lines 1, 2, 5, 6, etc. are exposed using the full exposure time and lines 3, 4, 7, 8, etc. using the reduced exposure time. This results in the two images having a vertically halved resolution. You can use external image processing programs to combine the images into an HDR picture.

To set up Interleave HDR: In the uEye Cockpit, go to Properties and open the "Camera" tab. Under Exposure time, in the "Dual exposure" field select the reduced exposure time as a percentage of the full exposure time.



Setting a dual exposure

Example: If you set a full exposure time of 1 ms and then select 10 % under "Dual exposure", the shorter exposure is taken using 0.1 ms.

When you enable dual exposure, you will automatically see two images in the uEye Cockpit. The upper image is produced with the full exposure time and the lower image with the reduced exposure time. Because these images are each only half the height, they appear blurred. You can enable horizontal sub-sampling with a factor of 2x (see "Size" tab) to set the correct aspect ratio for the individual images. A graphics program can be used to stretch and geographically correlate the images and combine them into an HDR image by tone mapping.



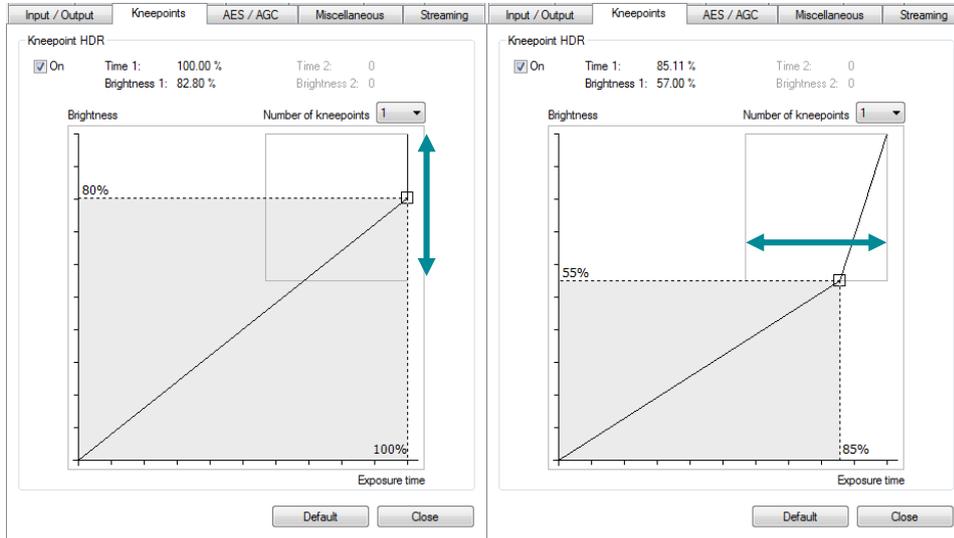
Example of Interleave HDR

Knee point HDR

On the UI-122x, UI-322x and UI-522x models, the HDR mode is created using the knee point. In knee point mode the exposure time is divided into two (or three) sections. After each section, excessively light pixel values are reduced to a limit value and briefly post exposed. This prevents overexposure and increases the dynamics.

If you want to use knee point mode you should make the following presettings to make optimum use of the mode. On the "Image" tab in the uEye Cockpit, set the gain to the minimum value and disable analog additional gain. On color models, the RGB gain for all colors should be set to the same gain value. Black level control has no effect with knee point HDR.

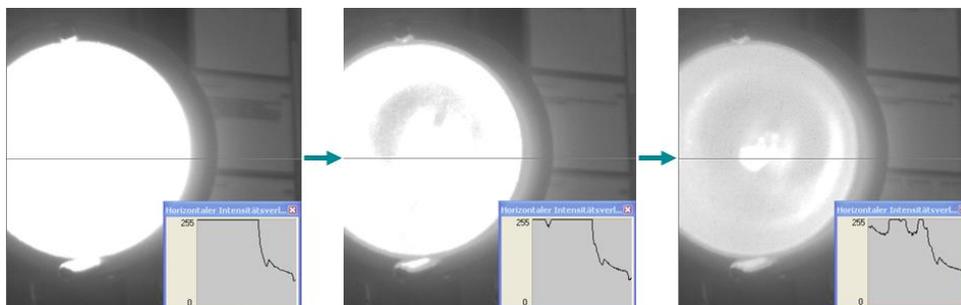
To set up the knee point: In the uEye Cockpit, go to Properties and open the "Knee points" tab. Enable knee point mode by selecting "On". Select "1" under Number of knee points. First set the limiting level and then the post exposure phase.



Setting the knee point

Limiting level and post exposure time: The x value of a knee point specifies the first exposure phase as a percentage of the currently set exposure time. The y value specifies the proportion of the maximum pixel intensity in percent. For example, a setting of $x = 55$, $y = 80$ would have the following effects: The first exposure phase would last for 55 % of the set exposure time. In this first exposure phase, all pixels are exposed to a maximum of 80 % of the maximum pixel intensity and remain at 80 % until the phase is over. In the second exposure phase, they are exposed again and can reach the full pixel intensity.

Because no split is possible with a minimal exposure time, we recommend using at least 5 times the exposure time. Using two knee points gives you a better graduation and increased dynamics, but with some settings increased image noise can occur.



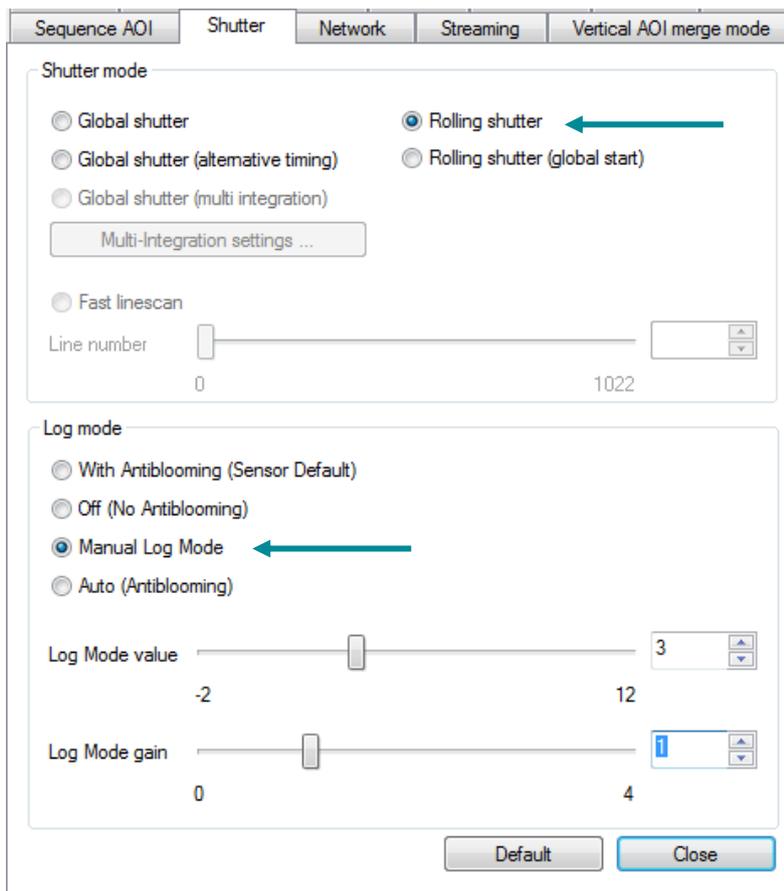
Examples of knee point HDR

Log mode

The UI-124x/UI-324x/UI-524x and UI-125x/UI-325x/UI-525x models have a log mode, which can be used to produce HDR pictures.

The more light falls on a pixel the lighter its gray scale value. This is a linear process, which means that above a certain point light points in the image are over exposed. In log mode, the increase is no longer linear above a certain brightness, i.e. due to damping the pixel requires a significantly higher amount of light before it is completely saturated. Thus log mode means that after a linear increase in brightness there is a transition to a non-linear range.

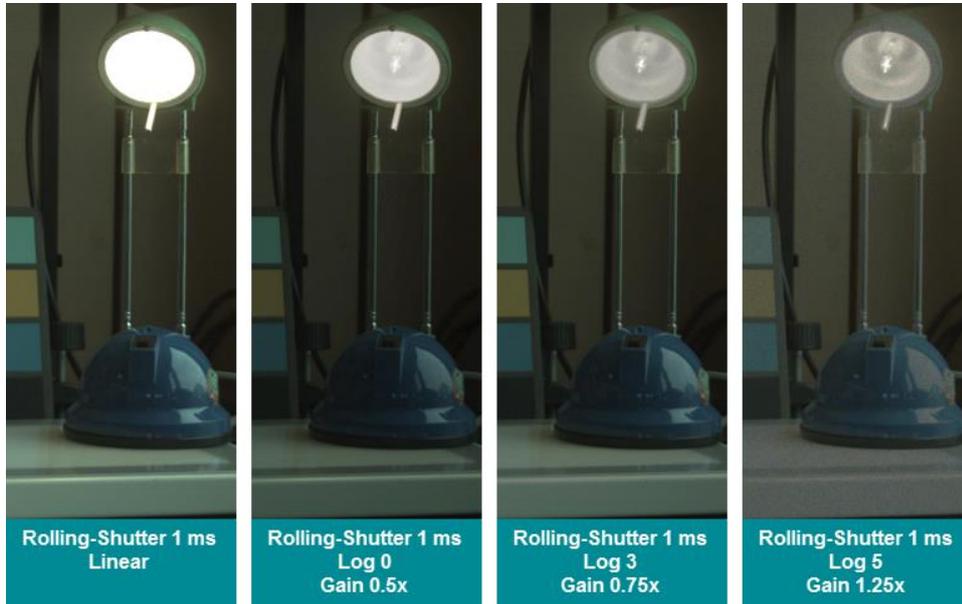
To set up log mode: For color cameras, in the uEye Cockpit go to Properties, open the "Image" tab and set equal values for the RGB gain. When using log mode, the total gain is automatically set to "0". Within certain limits, log mode gain can be used to influence the basic gain.



Setting log mode

When using log mode, we recommend using rolling shutter mode ("Shutter" tab). Set the exposure time on the "Camera" tab such that important parts of the image are over exposed. On the "Shutter" tab, enable the "Manual log mode" option. The settings for "Log mode value" and "Log mode gain" are at the minimum value. Increase the "Log mode value" setting until details are displayed in the over exposed

parts of the image. Adjust the "Log mode gain" value so that the light points in the image turn white.



Examples of log mode

Application areas

HDR pictures are suitable for situations with a high dynamic range, e.g. welding, where the welding arc results in a high level of brightness but the weld seam or the welding object still needs to be detected. With paints or other shiny surfaces, reflections and shiny points may also mean that HDR pictures with an increased dynamic range are required.

In traffic monitoring, situations often occur in which information in dark areas of the image needs to be evaluated, despite the headlights of oncoming vehicles (for example in a tunnel).

HDR pictures can also be used in very dark situations where pictures have to be produced without flash, e.g. in astronomical photography.

Summary

The different methods for HDR pictures have advantages and disadvantages depending on the situation. The following table compares Interleave HDR, knee point HDR and log mode with one another:

	Interleave HDR UI-336x/UI-536x UI-337x/UI-537x	Knee point HDR UI-122x/UI-322x/ UI-522x	Log mode UI-124x/UI-324x/UI-524x UI-125x/UI-325x/UI-525x
Number of pictures	1	1	1
Number of resulting pictures	2	1	1
Ideal exposure time	Any	Medium	Short
Suitability for moving objects	Good	Good	Very good
Image processing necessary?	External	No	No
Resolution	Half	Full	Full
Color capability	Yes	Limited	Limited
Image noise	Low	Medium	Medium
Configuration	Easy	Difficult	Difficult
Automatic exposure	Possible	Possible	No
Dynamics	Very good	Good	Medium

For further information on setting and programming the cameras, refer to the uEye manual at <http://en.ids-imaging.com/manuals-ueye.html>.

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