



SightLine

APPLICATIONS

EAN-Enhancement

PN: EAN-Enhancement

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1 Overview

This document describes an overview of how to use the various enhancement techniques to improve the contrast and defined edges in streaming video.

1.1 Additional Support Documentation

Additional Engineering Application Notes (EANs) can be found on the [Documentation](#) page of the SightLine Applications website.

The [Panel Plus User Guide](#) provides a complete overview of settings and dialog windows located in the Help menu of the Panel Plus application.

The Interface Command and Control ([IDD](#)) describes the native communications protocol used by the SightLine Applications product line. The IDD is also available as a PDF download on the [Documentation](#) page under Software Support Documentation.

1.2 SightLine Software Requirements

ⓘ IMPORTANT: The Panel Plus software version should match the firmware version running on the board. Firmware and Panel Plus software versions are available on the [Software Download](#) page.

1.3 Application Bit Requirements

The functions described in this EAN require Application Bits (app bits) purchased from SightLine. App bits are enabled with a license file provided by SightLine at initial unit purchase or during a license upgrade process. License files use a hardware ID that is applicable to a specific hardware serial number. For questions and upgrade support contact [Sales](#).

Table 1: Application Bits Requirement Table

Function	Initial Software Release	Required Application Bit(s) v7 License
Enhancement - CLAHE, LAP, Denoise, etc.	2.22.xx	Enhancement 0x0000 0080
Enhancement Advanced - Masked Denoise	3.1.x	Enhancement Advanced 0x0080 0000



2 Rendering Video

2.1 Overview

Rendering is the process of generating output video from one or more camera sources and generating output video suitable for encoding. The analysis process is composed of comprised of registration, tracking, detection, etc. The rendering process is initiated after the analysis process is complete. Each stage of the rendering process may be disabled by the appropriate selection of parameters.

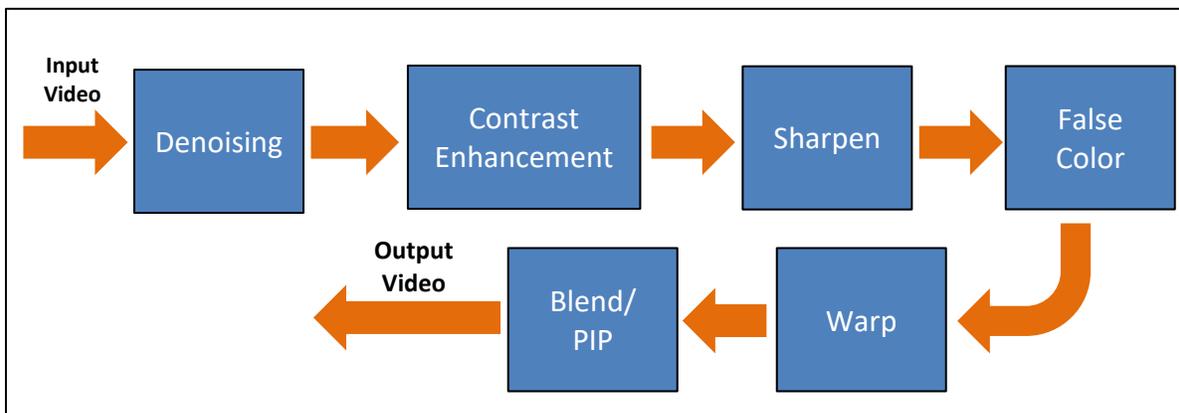


Figure 1: Rendering Video Process

Each frame of analyzed video is passed through the rendering process before encoding to network video output, digital display, or analog display.

Denoising, the first stage of the process, reduces video noise by computing a weighted average of the current frame of video with previous frames.

Contrast enhancement applies one of several different contrast enhancement algorithms to optimize the overall contrast of the image.

Sharpen applies a small sharpening kernel to the image to enhance small details in the video.

False color replaces each pixel with a colored pixel selected from a lookup table.

Warp scales, rotates, and shifts video for stabilization and user-commanded effects.

Blend/PIP combines the processed video streams taken from two different sources in a variety of ways.

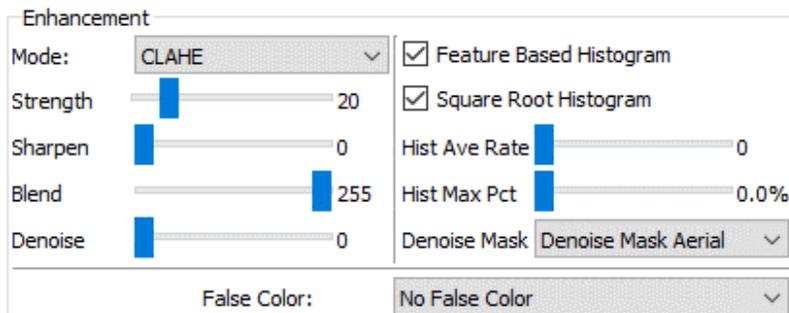


Figure 2: Video Tab Enhancement Controls - Panel Plus



2.2 Denoise

Denoising is accomplished by registered frame averaging. In a system with a moving camera it averages each frame of video after adjusting for frame offset motions, preventing the image from blurring out when the camera moves. This algorithm is most useful for uncooled IR sensors and in low visible light situations. The *Denoise* slider control in Panel Plus specifies the amount of averaging that is applied each frame:

- 0 = no denoising
- 64 = add 25% from the new frame / 75% from previous frames
- 128 = add 50% from each new frame / 50% from previous frames
- Suggested maximum value: ~240

Denoising is especially helpful when using contrast enhancement or sharpen. The algorithms in these stages tend to amplify image noise that denoising can suppress (see [Figure 5](#)).

As a side effect of denoising, motion of foreground objects in the scene that are not captured by frame-to-frame registration will become blurry.

Set using the SVP command **Set Video Enhancement Parameters command (0x21)**.

 *Denoising requires the Enhancement App Bit. The Stabilization App Bit is needed for registered denoising (for moving cameras).*

 **IMPORTANT:** In cameras with full 16-bit pixel depth, sparkle-pixel wrap artifacts can appear when running denoise and contrast enhancement. Please contact [Support](#) to discuss your application and potential solutions.

2.2.1 Denoise Mask

The *Denoise Mask* function has two options: *Denoise Mask* and *Denoise Aerial*. Applying mask denoising works by first detecting regions of motion in the scene. Portions of the scene with motion are then excluded from the averaging process used by denoise. Masked denoising removes image noise and scintillation effects without blurring moving objects. Masked denoising is also helpful in conjunction with CLAHE, LAP and edge sharpening. These algorithms amplify image noise that masked denoising can suppress without blurring moving objects.

Set this function with the SVP command **Set Video Enhancement Parameters command (0x21)**.

 *Denoise Mask requires Enhancement and Enhancement Advanced App Bits. The Stabilization App Bit is needed for registered denoising (for moving cameras).*

2.2.1.1 Denoise Mask Aerial

This mode works from a moving platform and can find small slow-moving objects. It is capable of handling frame-to-frame perspective changes, which makes it well suited for airborne applications. This method takes more processing time than *Staring Denoise Mask*.

 *Parameters for this feature can be found by clicking the Advanced button in the Detect tab.*

The *NframesBack* setting determines how far back in time to search. A larger value allows the system to mask slower moving objects, but slightly increases processing time.

Downsampling: More downsampling (4X or 8X) runs faster but may miss very small objects that would get masked with 2X.



2.2.1.2 Denoise Mask Staring

This is a new beta feature in 3.2.x software. It works best from a ground camera that is either stationary or moves, and then stares for an extended time at a scene while a background model builds. It prevents blurring for objects that are small and move slow or fast, move at varying rates, or that temporarily stop. This method takes less processing time than the *Aerial Denoise Mask* option.

The Aerial Denoise Mask option does not work well if the camera is moving.

Parameters for this feature can be found by clicking the Advanced button in the Detect tab.

Average Time Constant determines the approximate amount of time to fully replace the background model. A larger time constant produces a model that is less affected by slow moving objects but will take longer to initialize when the camera is moved (for a PTZ).

Downsampling: More downsampling (4X or 8X) runs faster but may miss very small objects that would get masked with 2X.

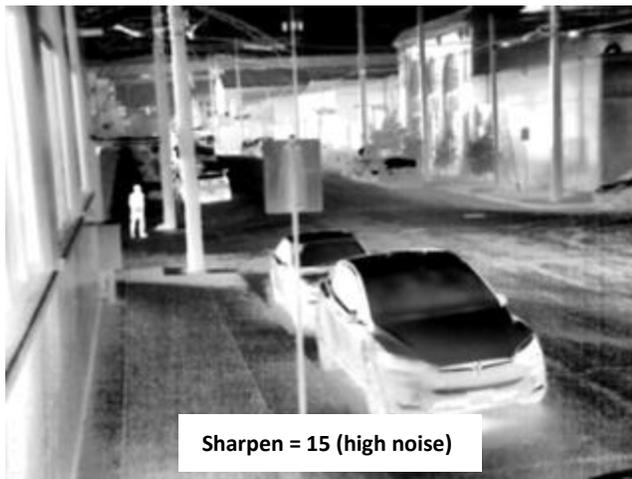


Figure 3: CLAHE and Sharpen Example

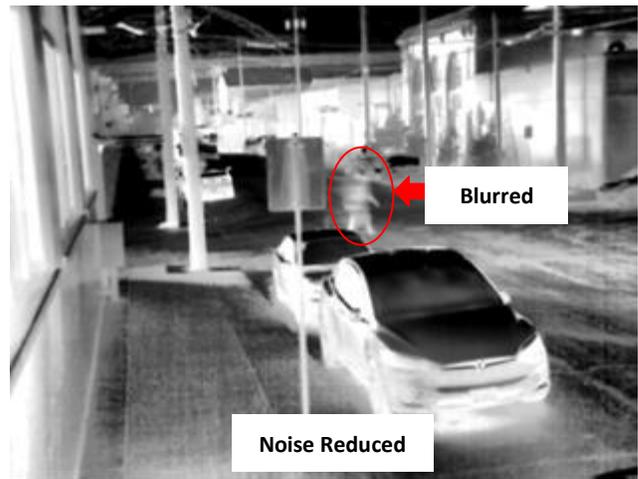


Figure 4: CLAHE and Denoising Example



Figure 5: Masked Denoising Example



2.3 Contrast Enhancement

The contrast enhancement is comprised of one of following basic algorithms: CLAHE, LAP, and Histogram Equalization. Select the desired mode in the *Mode* pulldown or *None* to disable contrast enhancement.

All enhancement modes share the following two parameters:

- *Strength*: Has an effect that differs depending on the specific algorithm selected. See below.
- *Blend*: Allows mixing (alpha blending) of the output of the enhancement algorithm with the input to the Enhance Stage. This allows a user to soften the effects of the contrast enhancement stage.

0 = Show 100% of the original image.

128 = Show 50% of the original image combined with 50% of the enhanced image.

255 = Show 100% of the enhanced image.

Set using the SVP command **Set Video Enhancement Parameters command (0x21)**.

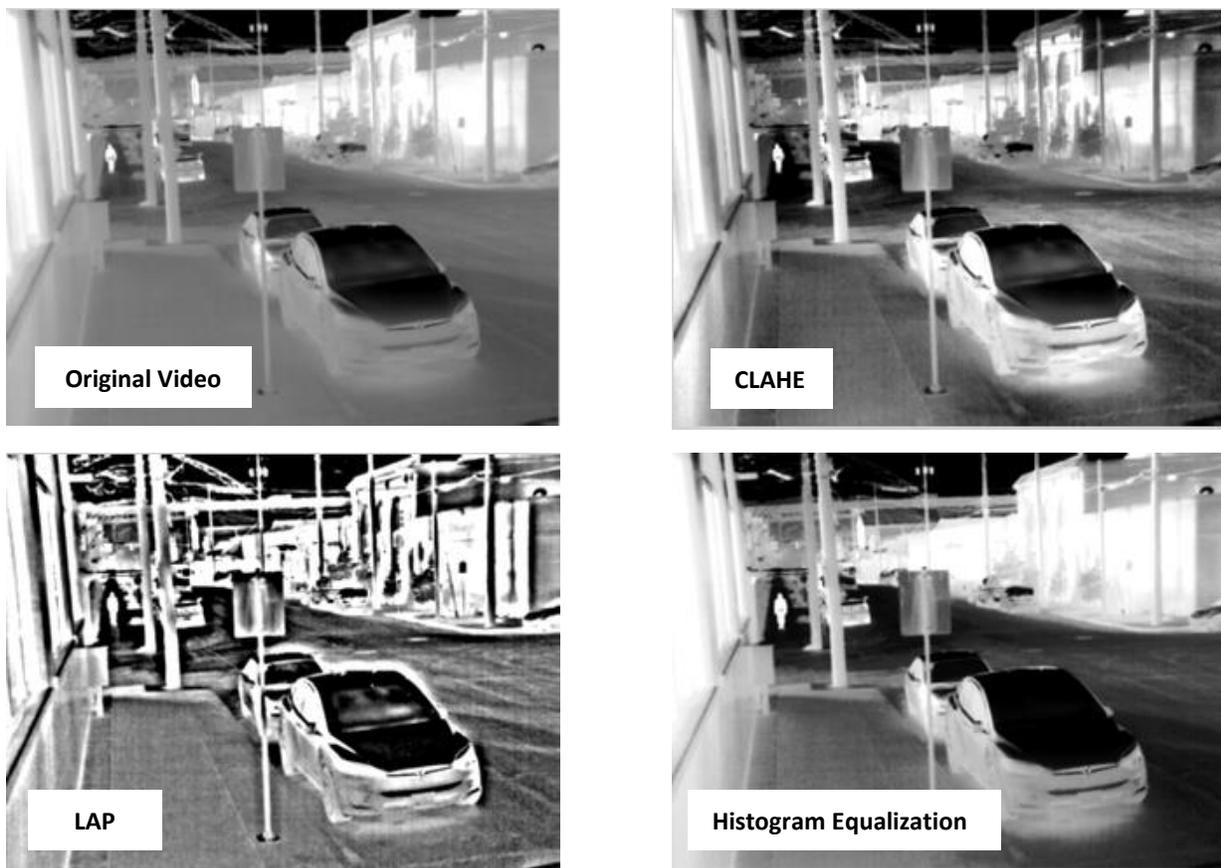


Figure 6: CLAHE, LAP, and Histogram Equalization Examples



2.3.1 CLAHE

Contrast Limited Adaptive Histogram Equalization (CLAHE) brings out hard to see (low contrast) features in video including video that contains brighter and darker areas (Figure 6).

Adaptive Histogram Equalization (AHE) is a computer [image processing](#) technique used to improve [contrast](#) in images. It differs from ordinary [histogram equalization](#) in the respect that the adaptive method computes several [histograms](#), each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image. It is therefore suitable for improving the local contrast and enhancing the definitions of edges in each region of an image.¹

Contrast Limited AHE: Ordinary AHE tends to overamplify the contrast in near-constant regions of the image, since the histogram in such regions is highly concentrated. As a result, AHE may cause noise to be amplified in near-constant regions. Contrast Limited AHE (CLAHE) is a variant of adaptive histogram equalization in which the contrast amplification is limited, so as to reduce this problem of noise amplification.¹

CLAHE: Standard CLAHE works with an 8-bit image input. For a 16-bit camera this will be the 8-bit image after autogain is applied.

CLAHE9 and CLAHE10: These versions use either 9 or 10-bits of a 16-bit input image as the input for the CLAHE operation. This can allow for improved contrast in the result image at the expense of slightly more processing time. CLAHE9 and CLAHE10 can also be applied to an 8-bit image input that has been denoised into a >8 bit per pixel intermediate image.

The *Strength* parameter controls the contrast limit of CLAHE. A larger value allows the algorithm to map a larger contrast but can also tend to bring out more noise.

Set using the SVP command **Set Video Enhancement Parameters command (0x21)**.

 *CLAHE requires the Enhancement App Bit. CLAHE9 and CLAHE10 requires both the Enhancement and High Bit Depth App Bits.*

2.3.2 Local Area Processing

Local Area Processing (LAP) brings out hard to see (low contrast) features (Figure 6). LAP emphasizes differences from the local image average to provide an increased amount of detail in low contrast areas of a video or image. The algorithm makes details visible in underexposed or overexposed portions of the image.

The *Strength* parameter controls the size of the kernel used in the processing and a larger value provides more enhancement. Values are between 0 (minimal enhancement) and 18 (maximum enhancement). For LAP mode there is no additional enhancement benefits after 18.

Set using the SVP command **Set Video Enhancement Parameters command (0x21)**.

 *LAP requires the Enhancement App Bit.*

¹Wikipedia contributors, "Adaptive histogram equalization," *Wikipedia, The Free Encyclopedia*, https://en.wikipedia.org/w/index.php?title=Adaptive_histogram_equalization&oldid=936814673 (accessed May 7, 2020).



2.3.3 Histogram Equalization

Histogram equalization brings out hard to see (low contrast) features. It is similar to CLAHE but operates on the entire image rather than on subregions. It may not bring out some image features that CLAHE does if there are large shadows or uneven lighting.

This method usually increases the global [contrast](#) of many images, especially when the usable [data](#) of the image is represented by close contrast values. Through this adjustment, the [intensities](#) can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values.²

The *Strength* parameter controls the contrast limit of Histogram Equalization. A larger value allows the algorithm to map a larger contrast but can also tend to bring out more noise.

The *Brightness* parameter shifts the resulting histogram to be either brighter/darker.

Set using the SVP command **Set Video Enhancement Parameters command (0x21)**.

 *Histogram Equalization requires the Enhancement App Bit.*

2.3.4 Feature Based Histogram Equalization

Emphasizes image areas with features and edges over flat background. In scenes comprised of a small number of foreground objects on a relatively flat background, the background pixels will tend to dominate the histogram. The resulting map will skew towards bringing out noise in the background, not showing the features. This method the histogram for pixel values that have a strong response to a high pass filter are weighted higher. This emphasizes image features over background areas.

Works with CLAHE/9/10 and Histogram Equalization, not with LAP.

Set using the SVP command **Set Video Enhancement Parameters command (0x21)**.

2.3.5 Square Root Histogram Equalization

Applies a square root to the image histogram bins before applying histogram equalization. This technique can prevent large constant background or foreground areas in the image from dominating the histogram map.

Works with CLAHE/9/10 and Histogram Equalization, not with LAP.

Set using the SVP command **Set Video Enhancement Parameters command (0x21)**.

In [Figure 7](#) background features are not visible in the original. With Histogram Equalization the background is visible, but the person is saturated. Both Feature Based and Square Root Histogram Equalization improve this by bringing the hot areas in the image out of saturation.

² Wikipedia contributors, "Histogram equalization," *Wikipedia, The Free Encyclopedia*, https://en.wikipedia.org/w/index.php?title=Histogram_equalization&oldid=953270501 (accessed May 7, 2020).

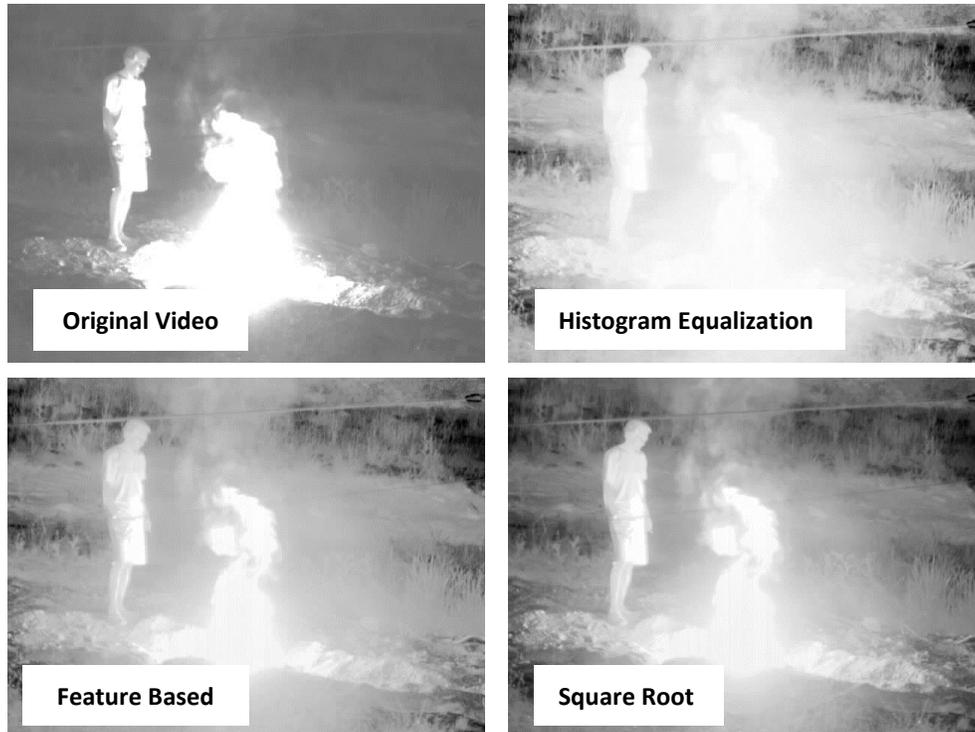


Figure 7: Histogram Equalization with Feature Based and Square Root Modifications Examples

2.3.6 Histogram Averaging Rate

Used to prevent the histogram equalization map from changing suddenly due to rapid scene brightness changes. The histogram equalization map is averaged by $\text{histAveRate}/256$ every frame. Setting the *Hist Ave Rate* to 0 fully replaces the histogram equalization map every frame. Setting *Hist Ave Rate* to 128 updates the histogram equalization map by 50% every frame.

Works with CLAHE and Histogram Equalization, not with LAP.

Set this function with the SVP command **Set Video Enhancement Parameters command (0x21)**.

2.3.7 Histogram Maximum Percent Bin

Limits the amount of histogram in a single bin to this percent. This prevents a single background or foreground grey level from dominating the histogram map which can prevent other areas of the image from seeing contrast enhancement.

Works with CLAHE and Histogram Equalization, not with LAP.

Set using the SVP command **Set Video Enhancement Parameters command (0x21)**.

2.4 Sharpen Stage

Edge sharpening is an image filtering technique that brings out edges in an image. The *Sharpen* parameter has a range of 0 (no sharpening) to 15 (maximum sharpening).

Set this function with the SVP command **Set Video Enhancement Parameters command (0x21)**.

 *Edge Sharpening requires the Enhancement App Bit.*



2.5 False Color Stage

To use the *User Palette* mode see the [EAN-False-Color](#) document to setup a custom color user palette.

Set False Color parameters using the SVP command **Set Display Parameters command (0x16)**.

Available in all App Bit configurations.

2.6 Multi-Camera Image Blend Stage (3000 Only)

Blending is described in detail in [EAN-Blending](#).

Blending requires the Blending App Bit.

2.7 Warp Stage

Rotation is useful for gimbal systems where the image may be shown on its side or upside down.

The *Pan/Tilt* controls in the *Manipulate* section of the *Video* tab may be used to bore-sight an image with the lens, or to move the shown area of a larger image in a smaller output frame.

In some cases, a small zoom may be applied to clip off the edges of the image when there are stabilization artifacts.

Set using the SVP command **Set Display Parameters command (0x16)**.

Available in all App Bit configurations.

3 Application Notes

Some video enhancement settings can cause issue when streaming video, See the Troubleshooting section in [EAN-Encoding](#) for more information.

3.1 Mitigating Scintillation Effects

When operating with high magnification imaging systems, atmospheric effects can lead to distracting or disruptive visual effects, e.g., heat shimmer, scintillation, and turbulence. These effects may be reduced or eliminated by setting the following parameters from the *Video* tab in Panel Plus:

- Enable *Denoise* by moving the slider to 240.
 - Check the *Denoise Mask* checkbox.
 - Set *Enhancement Mode* to *CLAHE*.
- Use *CLAHE9* or *CLAHE10* with a high bit-depth camera.
- Set *Sharpen* to 15.
 - Set *Blend* to 255.
 - Adjust the sharpness of the final video with the *Sharpness* slider.
 - Adjust the overall impact of the contrast enhance stage by adjusting the *Blend* parameter.
 - Increase or decrease the averaging effect to dampen scintillation effects by increasing or decreasing the *Denoise* slider.

Small changes to this parameter can have significant impact.



3.2 Replicating Effects of IR Cameras

FLIR camera features and equivalent SightLine parameters for histogram equalization are shown below.

FLIR Camera Features	SightLine Histogram Equalization Parameters
Information-Based Equalization	Feature Based Histogram Equalization (create histogram from high-pass energy)
Adaptive Contrast Enhancement (ACE)	Implement using brightness control
Digital Detail Enhancement (DDE)	Implement via sharpen, LAP, CLAHE
Linear percent	Similar effect to blend %
Tail rejection	Similar effect to contrast
Damping factor	Use Histogram Averaging Rate
Max gain	Strength parameter
Plateau values	Similar effect to Hist Max Percent parameter

4 Questions and Additional Support

For questions and additional support, please contact [Technical Support](#). Additional support documentation and Engineering Application Notes (EANs) can be found on the [Documentation](#) page of the SightLine Applications website.