SHADOW CONSISTENCY

OPTIMIZING 3D LUT DARK DETAIL

By Joel Barsotti and Tom Schulte

In some displays, a D65 grayscale point cannot be achieved at the lowest luminance levels, because D65 is outside the display's native color gamut. If ultimate grayscale accuracy is targeted at those lowest luminance levels during 3D LUT calibration, inconsistent color transitions will be created, causing color artifacts in shadow detail.

This paper presents a method of achieving the most accurate and consistent color possible for all displays at low luminance levels, assuring the best possible display performance, with no shadow color artifacts.

Low Luminance Color Gamut

If you were to plot an LCD display's native color gamut at different luminance levels, you would see that, at luminance levels typically below about 25-30%, the display has reduced color gamut area. In other words, the display doesn't achieve 100% saturation at those lower luminance levels.

You would also see that the display's native black point is almost never at D65. That means that at lower luminance levels (typically below 5-10%) D65 will surely be outside the display's reduced gamut area.

Therefore, when trying to correct neutral gray to D65 below about 5-10% while calibrating an LCD display with a 3D LUT, the grayscale point is naturally going to go to the edge of the display's RGB signal cube.

At the luminance levels where the grayscale point transitions to or from the edge of the signal cube, inconsistent color and grayscale transitions will be created, causing shadow color artifacts. Because a display's black point is usually bluer than D65, the color artifacts tend to be some red/green combination.

Therefore, trying to correct neutral gray as closely as possible to D65 is a problem at low luminance levels where D65 is outside the display's gamut, because it creates inconsistent color artifacts in the display's shadow details.

Shadow Consistency

CalMAN's core calibration algorithms are the best in the industry, and they are constantly being fine-tuned to deal with the peculiarities of the real world physics of electronic displays. One such peculiarity is that, at the low luminance levels associated with shadow detail, a display's native color gamut may not contain the D65 grayscale point.

As described above, if ultimate grayscale accuracy is targeted at all luminance levels during 3D LUT calibration, inconsistent color and grayscale transitions will often be created in the display's shadow detail. Instead, at a display's lowest luminance levels where D65 is outside the display's color gamut and can't be achieved, the target needs to be maintaining consistent color transitions in the shadow detail, avoiding color artifacts.

To accomplish this, when CalMAN renders 3D LUT calibration data from a display's profile data, it determines the lowest luminance level at which D65 is still within the display's color gamut. CalMAN's 3D LUT rendering engine then calculates consistent color transitions for all gamut colors from that level down to the black point.

This automatic switch to targeting color consistency avoids color or grayscale discontinuities and keeps the grayscale point inside the display's achievable gamut at the lowest luminance levels.

Conclusion

CalMAN's advanced 3D LUT calibration algorithm avoids creating color artifacts at a display's lowest luminance levels where D65 is unachievable by automatically switching its correction target from ultimate color accuracy to ultimate color consistency. This shadow consistency feature of CalMAN's 3D LUT algorithm assures the most accurate images possible on any display, with no shadow color artifacts.

About SpectraCal:

SpectraCal specializes in the tools and training necessary to achieve images representative of the content creator's intent for environments from low to high ambient light while achieving the colorimetry, contrast, and dynamic range necessary for the image to have the proper impact on the viewer.

SpectraCal CalMAN software was developed to support the display calibrator in the step by step process of screen optimization. The foundation of screen optimization through display calibration is to understand the elements in a display that require adjustment and how each element inter-relates to the others. From its inception, CalMAN has earned rave reviews and has become the preeminent display calibration software package on the market, compatible with virtually all color meters available today. As display technology evolves, CalMAN will continue to provide the first choice for display calibration solutions.

More Information:

For more information on CalMAN professional quality solutions for your displays:

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Joel Barsotti is Head of Advanced Color Research at SpectraCal. He has been the primary architect of every version of CalMAN since version 4.0. Joel has designed several iterations of 3D LUT profiling code, each of which has significantly advanced the state of the art. His innovations include: CalMAN AutoCube technology, CalMAN Dynamic Profiling process, Dynamic Linearity Correction, Intelligent Resolution Profiling, Lightning LUT, 3D LUT Retargeting, the adaptation of volumetric interpolation to color science, grayscale priority interpolation, and grayscale tint reduction, making CalMAN one of the most sophisticated color management packages available.

Tom Schulte is Product Development Manager at SpectraCal. Tom has extensive experience in electronic systems test, calibration and service, as well as electronics test instrument design and usage and has authored numerous technical white papers. Tom was previously an Application Engineer at Sencore for over twenty years, where he was involved in video, audio, and RF test instrument design, plus training and support for electronic test equipment users.