Let there be light—evenly!

The Shading-Effect and how it can be dealt with

Brightness and brightness are not the same. This becomes especially visible at brightness distributions on screens. Especially when this illumination is uneven. What can be hardly realized at single monitors has huge effect when multiplied by many screens in a large-scale video wall.

The goal of multi-channel video walls is to give the observer the impression of a single large image. Projection cubes provide an ideal solution for this demand with their very thin bezel between the single modules.

The problem

Even LCDs or plasma screens are equipped with decreasing bezel-widths, so that they are more and more used within such systems. The development of decreasing bezel-widths, introduces, next to the technical problems, also a visual problem: The smaller the gap between two displays, the stronger the differences in color and brightness. In extreme cases there is even something like a “Tile-Effect”.

The solution

With the EYE-ACT eyevis provides an automatic color management system for projection cubes to maintain color and brightness constantly over the entire operation process. eyevis with the EYE-LCD-CAS also has a sensor based calibration system for the LCD series, to be able to adjust the LCDs in color and brightness. Those systems enable the user to regulate color and brightness of individual display units within the video wall.

However, there often is an uneven brightness distribution within the images of the individual devices. This uneven distribution is technical and makes the image areas appear brighter in the center than on the sides.

This effect is called “Shading” and has, as mentioned before, no effects on single displays. On image walls that are composed of several displays, however, it can have negative effects on the overall impression of the image. In order to improve the image impression on large-scale video walls, eyevis developed a special “Shading” correction, to achieve an even color and brightness distribution within the single image areas. The crucial point of this technology is the exact measurement of the color and brightness distribution of the image module. This data is recorded by a color sensor at several points of the module. From this data the Shading-Correction that is applied to the input image, is calculated.

The result is the ideal even brightness and color distribution over the entire monitor.
The correction darkens the areas of the display which seem too bright, providing an even brightness distribution of the display. But not only brightness is corrected. The eyevis Shading-Correction at the same time adjusts possible color irregularities.

Special focus during the development of the eyevis Shading-Correction was put upon the provision of the possibility to adjust the image even after the sensor automatically adjusted the image. If there is a visible variance after the correction, the Shading-Correction can be adjusted through the software afterwards, so that slight variations can be compensated very precisely.

Other than the possibility of refinement the degree of compensation can be determined. 100% compensation would adjust the entire image to the lowest brightness level. In this way the highest homogeneity would be achieved, but at the same time the lowest brightness level. Through the adjustment of the degree of compensation a balance between homogeneity and loss of brightness can be achieved. With those possibilities the video wall is perfectly adjustable to the particular needs on site.

The Shading-Correction is not only applicable to eyevis products. It can be connected to almost any display.

The eyevis Shading-Correction is an integrated component of every eyevis-cube that is equipped with the MSP or SCP option as well as of our omniSHAPES. Other displays can be corrected by the connection of a Pixel-Processor (EYE-PxP) or an openWarp. The recording can be achieved through the eyevis Color Sensor (USB) and Windows software.

With the Shading-Correction eyevis provides the perfect possibility to improve the image quality of large-scale video walls. At any place that has high demands for evenness of color and brightness, this system is a practicable and flexible solution. Through its universal application, it sets new standards in the area of digital image correction.
Test Report: eyevis EC-60-LHD
High-End LED Rear Projection-Cube with accurate optimization for uniform illumination and colour representation

Rear projection systems still have the advantage towards LCD-displays, especially at simulations and control room applications, that they can be used to set up almost seamless video walls comprising several units. Here, “seamless” really describes a gap of less than 1mm between the screens, not 6 mm wide bezels as with LCD screens. In digital signage applications this gap is indeed does not matter, but in simulators, for example, a recognizable structure of the projection area can destroy or reduce the illusion. Projection screens in rear projection system are not illuminated not directly back-lit over the entire area like with LC displays, but more or less illuminated by a spot light source. Thus there have to be different measures to ensure a steady illumination of the image area and to avoid hot-spots. eyevis, manufacturer from Reutlingen, Germany, developed a very powerful image processing derived from its EYE-PxP pixel processor, which is capable to optimize video walls made of rear projection systems as well as LCD screens. The device at hand for this test report was an LED-lit full HD rear projection cube type EC-60-LHD with 60” screen diagonal. The cube additionally features an integrated system for automatic colour calibration, in order to maintain stable image representation on a combined video wall in terms of colour and brightness even in continuous operation.

As shown in our previous report in issue 3/2009 dealing with eyevis cube version EC-50-LSXT+, rear projections cubes with LED light sources do not have to worry about a comparison with conventional lamp technology. Exactly the opposite is the case. LED-lit cubes provide prolonged service intervals enhanced colours and improved reliability. The hot spot issue however, is less caused by the light source, but more related to the loss of light, related to the design of the optical system, the geometry of the projection and the gain behaviour of the screen. Here is where the EYE-PxP pixel processor comes into play. It provides an internal memory capacity for video signals up to 2048x1200 pixels. The EYE-PxP caches every frame of the input signal and can perform different image processing functions on the cached frame, before it is transmitted to the output of the processor.

Among others, the signal processing functions provided by the EYE-PxP comprise a gamma correction with 24 bit LookUpTable (LUT) in each colour channel, colour correction with 3x3 colour transformation matrix for colour space transformations, colour shading for pixel-wise colour correction for correction of shadings, and alpha masking with pixel-wise transparency correction for hot-spot corrections, blending and masking. These functions enable, for example, a compensation for the hot-spot behaviour of the different rear projection screens which is known by the manufacturer or can be measured. These hot-spot effects can be visibly reduced with a shading correction.
Of course, there was a local inspection at eyevis for this report with extensive measurement activities. The editor’s measurement camera type Radiant Imaging PM-1423-1 was extremely helpful during these tests. Since the camera is able to make spatial measurements of luminance and colour, we had the possibility not only to perform precise measurements of the distribution of colour and brightness, but to extract the measured data to create individual masks for the alpha shading.

But let’s start from the very beginning: The EC-60-LHD is a rear projection cube with a screen diagonal of 60” and a native resolution of 1920x1080 pixels (Full HD). The light sources based on LED technology has a specified lifetime of 60,000 hours. Integrated in the light engine there is a colour sensor with long-time stable filters, as they are used in monitor calibration systems, for example. Because the sensor is not located directly in the light path of the projection, a calibration measurement can even be realised in usual operation, without disturbing the projection.

Our test system included two cubes mounted side by side and was adjusted to a brightness of 170.1 cd/m², measured with the JETI specbos 1211 in the centre of the screen. The black level was at 0,11cd/m², the full screen contrast at 1546:1 – in good accordance with the manufacturer data (1500:1).

The colour measurement shows, that the colour space quite exactly resembles the sRGB-Standard, because the EC-60-LHD was adjusted to it. In principle LED-Systems got a much wider colour space, but a huge colour space is not a value itself, especially when the displayed content was produced for sRGB resp. Rec.709 (HDTV). For the test of the automatic colour calibration (Fig.1) the colour balance of the LED-light source of one cube was changed, so the colour temperature fell from 9000K to approx. 7600K. The last graphic shows that after the accomplishment of the automatic calibration the original condition was de facto recovered.

The most interesting measurements, were obviously those which should which should show the capabilities of the shading correction and the precise correction with the specific alpha mask. For the measurement shown in the top graphic of Figure 2, the factory-set shading correction was switched off first, so that it represents the „raw state“ of the interaction between projector and screen, of course showing a recognisable hot-spot. Activating the shading correction shows a clear improvement, which of course brings a decline of the total brightness, because the light density in the centre of the screen has to be adapted to that of the areas towards the edges.

With an alpha mask calculated from the first measurement, the uniformity of the illumination could again be improved. The control measurement shows a standard variance of only 5.2%, which is already within the margin of the measurement accuracy of light density measurement tools complying with DIN5035 class B. A variance from a perfectly uniform illumination that is not visible to the human eye.

Summary

The detailed research of the image quality of the EC-60-LHD with the measurement camera shows that a specific calibration and illumination correction with the EYE-PxP pixel processor is capable to achieve a distinct and visible improvement of the image quality of a video wall made of these cubes. The automatic calibration for brightness and colour integrated in the EC-60-LHD is capable to maintain the image quality achieved through the calibration of such a system on installation for a long time. This is especially useful for LED-based systems, because the service intervals are obviously longer than with traditional lamp-based systems.

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