Stereoscopic 3D Image Parameters

The quality of a Stereoscopic 3D presentation can be judged by two attributes. First is the presentation's image quality based on the same factors one would judge a 2D image. These include brightness, contrast, sharpness, color accuracy, and so on. However 3D also as its own parameters unique to the medium. These include crosstalk and flicker performance.

3D Crosstalk

3D Crosstalk is the phenomenon of an image supposed to be seen by one eye is inadvertently seen by another eye. There are many causes of crosstalk in stereoscopic 3D hardware whether the system is active or passive 3D. However, crosstalk is more complicated than just a double image effect. Here are common issues with 3D Crosstalk

1. Both eyes seeing a "ghost" of the other eye's image"
2. One eye seeing a "ghost" of the other eye's image
3. Discoloration of a ghost of the other eye's image
4. Reverse Crosstalk: Phenomenon where the dark image

Reverse Crosstalk

Reverse Crosstalk is a term coined by HDF Services to describe a phenomenon of crosstalk in 3D displays that shows a visual anomaly that one would not expect from typical 3D crosstalk. In normal 3D crosstalk we get the ghosting phenomenon where a bright image on a dark background will show up in the other eye as a faint "ghost" image. This is caused by high contrast imagery and high brightness of an object.

However we have encountered a phenomenon that we call "reverse crosstalk" where a dark object instead of a bright object is the source of the 3D crosstalk and "ghost" image. We have encountered this phenomenon on two displays. First is a JVC DLA-X35B projector which exhibited this phenomenon. The second is a demo unit of the Samsung autostereoscopic display.

The topic of "reverse crosstalk" is rarely talked about in 3D and is something of key interest of HDF Services. We still do not know the cause of this phenomenon, with our present thinking being it is the result of software attempting to compensate to reduce crosstalk or inherent limitations in the display technology itself.

Traditional Ghosting on the Left, Reverse Crosstalk on the Right

3D Flicker

3D Flicker is another phenomenon that is a unique image quality parameter of stereoscopic 3D. it is true that flicker used to be a metric of study for 2D displays when there were CRT monitors, Plasma displays, and early LCD monitors. However flicker is mostly a thing of the past for 2D displays yet it can be a problem in 3D Displays.

Flicker is an artifact that is only generated by a frame sequential stereoscopic 3D presentation. This includes typical active shutter glasses solutions found in 3D projectors at home and cinema and 3D monitors, but it also includes systems that use 3D modulators to create a passive image such as those used by RealD, DepthQ, Xpand, and many others.

The perceptibility of flicker is based off the frequency of the flicker and the brightness of the image. Many projectors often used 96hz flicker for their 3D presentation which was found to be acceptable for home viewing due to the low brightness of the projected image. However upon higher brightness levels a 96hz flicker would be too noticeable and distracting. The standard for cinema is 144hz however we know that the human eye can perceive higher refresh rates than this and thus 144hz, although acceptable for casual viewing in a dark cinema, might not be acceptable when your display is exhibiting a high brightness. Long term comfort tests still need to be conducted to draw valid conclusions from this topic.

Left/Right Eye Color Matching

The last metric of 3D image parameter has to do with the left and right eye being color matched. This is often not an issue for most 3D systems because they often use a single display with a 3D modulator or active shutter glasses. Unless the active shutter glasses has a defect in which both lenses have different optical properties (which I have not come across), you will not have a color mismatch between the left and right eye.

However, there are other methods of achieving 3D that use two displays which send their own unique image to the left and right eye. Because they are two different displays or projectors they will have their own unique characteristics due to variance off the assembly line, aging, and so on. This is often an issue with dual projection 3D using both polarization and the Color Bandpass System most often associated with Dolby.

It is very important that the colors and brightness of the left and right eye are mostly matched, or else the viewer can exhibit visual discomfort. Research still needs to be done on this topic, as we have found that some color mismatches are more noticeable than others. For some reason the Dolby Cinema system, despite having a color mismatch, doesn't cause visual discomfort compared to testing done on our own dual projection system.

Conclusion

In order to analyze a stereoscopic 3D display one has to analyze the image quality characteristics used to evaluate 2D displays and unique parameters to analyze the 3D display. Thus, when testing, designing, evaluating, and reviewing 3D displays you must also analyze crosstalk, flicker, and color matching.