

A White Paper on Passive Stereo

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Purpose

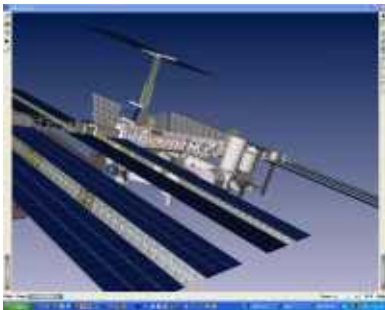
There are infinite configurations for VIZ systems ranging from a single projector or monitor, showing 3D but not stereo, to multiple projectors showing 3D stereo and blended to produce an infinite size of image.

This White paper shall focus on stereo enabled systems only. It will also focus on three main configurations.

What is 3D?

3D is simple to understand. The model created with a 3D drawing program provides depth as one of its parameters. Thus a 3D image has width, height and depth. Items drawn using 3D programs can be rotated to view the item from any angle. Samples of 3D programs are AutoCAD 3D, Solidworks, Maya and many more.

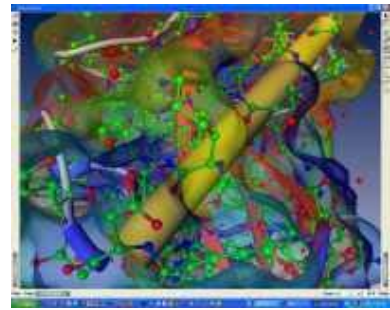
Exhibits 1-3, below are samples of 3D models for various vertical applications



1 - Modelling



2 – Oil and Gas exploration



3 – Molecular Physics

While stereo offers 3 dimensions of viewing angle, the image is generally viewed on a 2D plan. The third dimension (depth) is implied rather than exhibited. To visualize the third dimension, we turn to 3D stereo techniques.

What is 3D Stereo?

Humans see in stereo. That is what gives us “depth perception”. The key to seeing in stereo is the fact that we have two eyes and that they are separated by our nose. The difference in viewing angle is about 5 degrees. If you look at an object with both eyes and then close one eye, then the other eye, you will see that the object being seen by each eye is slightly different. (see Exhibit 4, below)



4 – 3D model showing right eye and left eye images

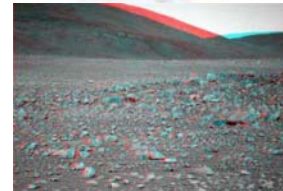
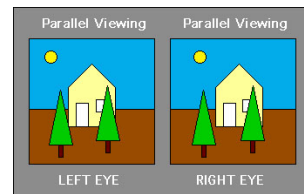
This model shows two “views of the same scene. Especially note the positions of the logs on the lower right and upper left.

When these two images are viewed as one, depth is “experienced”.

3D stereo can be enabled in a few ways including:

- **Eye-forcing (Free-view)** A technique wherein you force your eyes to cross while staring “between” two images. It might be fun – but not very practical.
- **Stereoscopic** This technique goes back to the time of our grandparents.
- **Anaglyph** Very popular with Playboy magazine, this technique uses red and blue colour shift to get stereo.

The image to the right is of the surface of Mars
- **Active** This stereo technique uses very expensive projectors which alternate the right-eye and left-eye images sequentially at a very high rate of refresh. To view and active stereo model requires a very expensive set of active liquid crystal glasses
- **Passive** This stereo technique uses two inexpensive projectors (when compared to active stereo) which sends overlapping images to the screen. The images are polarized using special filters. The images are viewed with a set of inexpensive polarizing glasses.



Passive 3D Stereo

As was mentioned in the opening of this white paper, we shall be putting our focus on passive 3D stereo systems.

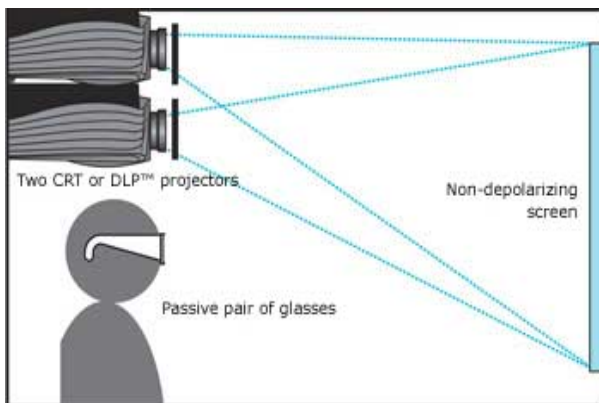
Passive 3D stereo is a relatively inexpensive technique for visualizing 3D data in stereo. For the longest time passive stereo was considered an also-ran, after active stereo, in visualization techniques. Over the past few years, the projectors that can be used in passive stereo have both increased in quality and reduced in size and price. In 2000, a single channel passive 3D stereo system (there are two projectors per channel of passive stereo), would cost \$95,000 and deliver acceptable stereo. However when you tried to drive multiple channels of passive 3D stereo, the result was less than satisfactory. In 2006, a very high quality and bright single channel of passive stereo can be purchased for approximately \$50,000. Modern passive 3D stereo systems can be delivered with multiple channels using image blending technology and even image warping (for curved screens).

For the purposes of this white paper we shall examine two levels of passive 3D stereo system; an entry level single channel (VIZ3D) and multi-channel BIZWALL/VIZWALL for extended view (BIZWALL is a front projected system, while VIZWALL is rear projected).

For purposes of this discussion, we shall be using product names, descriptions and images from CYVIZ, a partner of VIZCAN which specializes in Passive 3D Stereo.

Single Channel VIZ3D

A single channel system consists of two matched projectors, a stereo converter, polarising filter, silver matte projection screen and polarized glasses.



separates the signal into the right eye and left eye components and send them to the two projectors.

One projector displays the left eye information, the other displays the right eye information, both at standard refresh rate. The polarizing filters mounted in the optical light path of each projector ensure that the correct information passes through its corresponding filter in the pair of passive stereo glasses. The data stream that comes from a stereo enabled video card (i.e. nVidia 4500) is sequential with right eye and left eye information. The converter unit

The two-projector passive 3D stereo approach provides for higher brightness than other stereo techniques.

The VIZ3D system can be considered a starting level system. A full system (not including computer or application) will generally cost less than \$US50,000.



The VIZ3D system is designed for front projection but it can be used, also, in rear projection.

Multi-channel Stereo BIZWALL or VIZWALL

A stereo BIZWALL is a front projected wall that is made up of 2 or more channels of passive 3D stereo systems, such as the VIZ3D.

A stereo VIZWALL is a rear projected wall that is made up of 2 or more channels of passive 3D stereo systems, such as the VIZ3D.

For purposes of this paper we shall ignore the projector orientation and refer to the system as a WALL.

Creating a multi-channel WALL is more than just lining up multiple VIZ3D systems side-by-side. Here is where we introduce a new term called “image blending”.

Image blending is fairly simple to understand.

When you produce a 3D model you can split the model across multiple visual outputs. (see image below left). This is done using a computer graphic card with dual outputs (see image below right).



You will note in monitor sample that there is a bezel (hard edge) between the halves of the image.

When you send the same signal to two projectors, the halves of the images can be lined up, without the interference of a bezel, in two ways.

The first is referred to as image matching or butting. This means that the two edges of the split image that correspond to the centre of the image are lined up (or matched) so that they touch but do not overlap. This creates what can be termed a “hard edge”. (see image below)

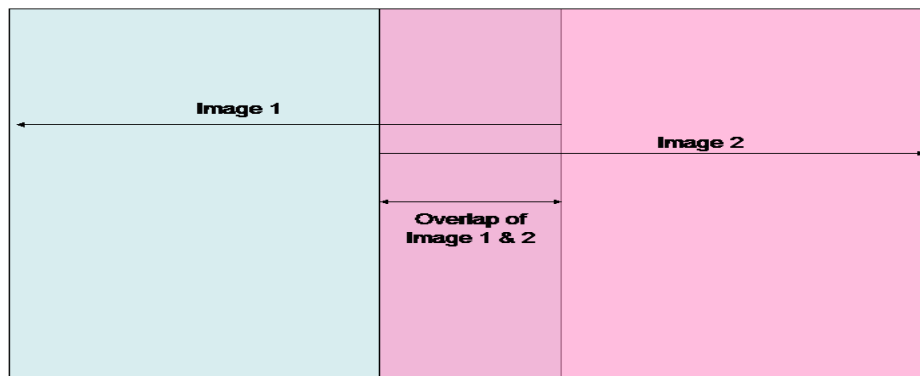


You will note in this image that there are vertical lines corresponding to the matched edges. The key to working with edge matching is to maintain the matching, which can be

a difficult task at times.

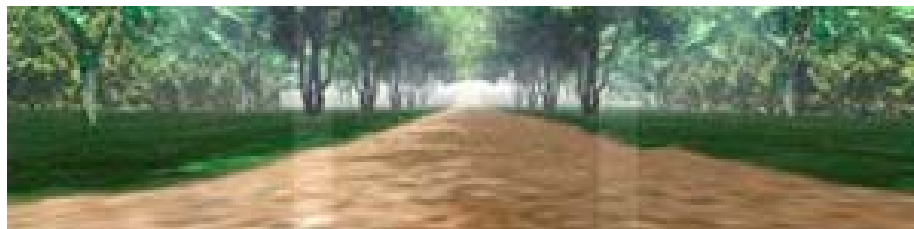
The second technique is to overlap the edges and blend them. This technique is more difficult to explain than it is to do. Essentially when the graphic output system “splits” the image, it does not split it into two separate half images. The system is directed to maintain a certain percentage of the one split image which corresponds to the other split image.

For example, see the diagram below.



Blended image for two channels

When you overlap the image, the overlap area gets images and, therefore, lumens (or light) from both projectors. Consequently the overlapped area looks washed out. (see below example of a 3 channel uncorrected blended image) Note the light bars every one third of the way across the image.



To correct for this extra light, you need to lessen the light outputs to the blended area until they match the rest of the image. (see below for corrected image)



Blending of multiple channels of stereo images is more than a handful for a VIZ rookie (or an Audio Visual technician for that matter). Blending of passive stereo requires that the passive stereo setup and alignment be exact and that the alignment between channels is also exact. Otherwise you end up with vertical bars of light and dark across your image and a fuzzy image when you view with the stereo glasses.

There are a number of other factors that can affect the image of your stereo WALL. One factor, for example, is unmatched projectors. Take a look at the multi-projector screen shown at left. You can tell where each projector is focussed because the image looks like a stacking of boxes.



There are a number of reasons for this view but the one we shall focus on is unmatched projectors.

The light from projectors can be measured in two ways, lumens and wavelength. Lumens are a measure of how much light is being output and wavelength

is a measure of the color of the light. A color mixture with too much red, for example, is a hot color. Too much blue, results in a colder looking light. This is called color temperature. To get a quality multi-projector image you need to match the lumens and color temperature of your projectors. There is no magic way to do this at this time. You have to measure the output of a number of projectors and select the one that are closely matched. The image to the right is an example of a quality six channel image using matched projectors.



You can imagine what the image above left would look like if one were to double the number of projectors for passive stereo.



Well it can be done.

The image to the right is of a six channel Cyviz passive stereo system, with blending, taken on a trade show floor (and there is nothing more dangerous to image quality than a trade show floor).

The secret to this quality system is quality components (especially matched projectors) and meticulous setup.

Conclusion

OK, so what have we learned in this paper?

We now know that a quality passive stereo system is not only possible, it is also affordable.

The fundamental design of a quality passive stereo system must include matched projectors and, in the case of multiple channels, a quality blending algorithm together with quality installation and training.

Notes about the author:



Bruce Ricketts has been in the VIZ game for almost 20 years. He has seen the industry go from DOS based machines to supercomputers and from low light and medium resolution CRT projectors to high resolution and high brightness DLP. He has also seen the cost of a quality system fall from million of dollars to thousands.

He is a consultant to VIZCAN Systems and a business partner with IBM Canada and CYVIZ.

Photo acknowledgments: We acknowledge the property rights of the following companies whose images were used in this paper: Christie, Amira, Barco, nVidia, 9th Systems, VisionMax, Vizbox, IBM and Cyviz.