Live 3D Video

For An Immersive Experience

We've all seen various forms of 3D images. Magazines seem to regularly print new issues complete with specially printed pictures and red/blue cardboard glasses. Every day, Disney shows thousands of vacationers amazing 3D movies on huge projection screens. In special scientific and research applications, 3D images promote understanding of the real world. And of course there are the laser-produced holographs printed as novelty items or as a security seal to software packages, credit cards, and the like.

But rarely do you see live, high resolution video in three dimensions in conventional settings like corporate boardrooms, trade shows, and public venues.

Using VBrick video network appliances, two ordinary video cameras, and two ordinary projectors, live 3D video with high definition quality is not only possible but also quite easy. This paper will tell you how to do it.

The Eyes Have It

Normal human vision provides depth perception because you have two eyes that are spaced some distance apart. The goal of mechanical and electronic 3D visual systems is to maintain this arrangement over time and distance. There are a number of ways to do this.

- Separate Images – Create an image for the left eye and one for the right eye. Use a separate viewer for each eye. For example, a separate lens as is the case with old "Stereo Viewers", or a separate monitor as is the case with specialized electronic goggles.

- Color – Create an image for the left eye and print it in one color. Create an image for the right eye and print it in another color. Have the viewer wear color filter glasses that only allows the correct color to reach each eye.

- Fool The Brain – By understanding how the human brain perceives depth, one can use a number of techniques to produce the illusion of depth. There are a number of techniques that require the viewer to cross their eyes, stare at some distant object, etc.

- Shutter Glasses – Create a video where every each video frame alternates between left eye and right eye. Use special electronic glasses that can rapidly cause each lens to become opaque or transparent.

Synchronize the video playback with these glasses such that a 30 frame-per-second video shows only 15 frames per second per eye.

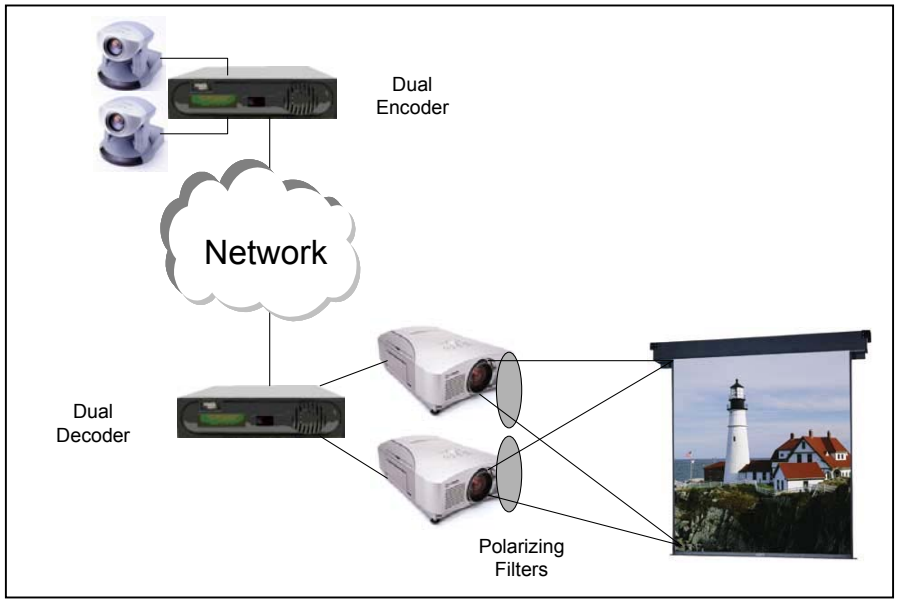
- Polarized Projection – Project two images on a screen, one for the left eye and one for the right eye. Put inexpensive polarizing filters in front of two projectors, one filter placed vertically, and horizontally. Wear inexpensive polarizing filters to view the video.

For live 3D projection, the polarizing solution is by far the best, especially for display to an audience of any appreciable size. There are several reasons for this, including the fact that there is no affect on color, and that the glasses are very inexpensive, available as both disposable cardboard or reusable plastic.

It should be noted that there are special video cameras, adapters, and video projectors that can produce stereo video using polarized light. Unfortunately, these devices only delivery 15 frames per second per eye, producing lower quality and very limited brightness. Because they work with standard NTSC video, they can easily be used with the VBrick system, but you may find the technique described here to be easier, less expensive, and delivering a far superior result.

Setting Up Live 3D MPEG-2 using VBrick

The VBrick Video Network Appliance is available as a two-channel MPEG-2 encoder and a two-channel MPEG-2 decoder. With an IP or ATM (or both) network connecting the two VBricks, two synchronized video channels are delivered from anywhere to anywhere. Because the video is live, there are no synchronization issues to worry about, and virtually any cameras may be used.



The VBricks

A dual-channel encoder and a dual-channel decoder are used. The encoder may be set to multicast each video on a different address, or it might Unicast the video directly to the decoders. Both the encoders and decoders support composite and S-Video, and both support CD-quality stereo audio.

The Cameras
Two identical cameras are used. They are mounted on a fixed plate and placed the "ocular distance" apart from each other (approx 3-4 inches) and focused on the same object. As with any video camera, the quality of the image is largely dependent on the quality of the camera and the lighting of the subject. In this case in particular, because the image will be projected on a large screen, high-resolution cameras (>400 lines) should be used if possible, although any camera can be used. It is important that both cameras keep a stable, fixed relationship. Typically, the cameras are mounted on a two-camera bar and the bar attached to a tripod. Very high precision is not necessary (the human brain is very good at processing visual errors).

Each camera is connected to the VBrick encoder, one into channel 1 and the other into channel 2. Audio may or may not be used. If it is used, four CD-quality audio channels are available.

The Projectors
Two identical projectors are used. The projectors must be of the DLP type, and must not use LCD's to produce the video image. This is because LCD projectors often produce polarized light images, making it impossible to further control the light with external polarizing filters.

The projectors are adjusted so that each image overlaps on the screen and should be adjusted for minimal keystone. You will find it impossible to get it perfect, but again, the human brain is quite good a adjusting for errors. A polarizing filter, one horizontal and one vertical, is simply placed in front of the lens of each projector.

The Screen
The projection screen must be of the "metalized" type. Flat surface, glass bead, and other screen types will scatter the polarized light and will not work! The correct type of screen usually is manufactured with a thin aluminum layer. This type of screen is available from virtually all projection screen manufacturers.

Resolution
The 3D setup calls for two cameras and two video projectors. It should be obvious that such a setup produces twice the resolution as one camera and one projector. Because each eye only sees one camera at a time, the truth is that the real resolution is the same as with a single camera. However, experience has shown that the human perception is that the resolution is indeed much higher. Polarizing is not "perfect", and both eyes do see some of the image intended for the other eye. This slight "blending" may be reason why the resolution appears to be similar to high definition television.

Brightness
Projecting two images on a screen obviously is twice as bright as one image. However, the polarizing filters reduce the brightness by approximately 30%. Because there are two projector images, the apparent brightness is quite good. Still, it is important to account for this reduction in brightness when selecting projectors. Projectors with high light output ("lumens") are best, but your selection will depend on room lighting, size of the projected image, screen efficiency, etc.

Adjustments
Without polarizing filters in place, focus the cameras on the most distant object such as a tree seen on the horizon. Adjust the cameras and/or projectors to cause that object to exactly overlap. When correctly adjusted, that distant object will appear as one object with minimal "ghosting". Objects in the field of view that are closer will appear with severe "ghosting", or as a "double image".

Put your filters in place. To determine which filter is which, put on a pair of polarizing glasses and close your right eye. Hold up a filter and rotate it until it is clear. This is the correct filter orientation for the left-eye image. Mark the filter "Left" and put an arrow or other mark indicating "up". Close your left eye and hold a filter up and rotate it until it is clear. This is the filter orientation for the right-eye image. Mark it "Right" and also mark the orientation.

Place each filter in front of the correct projector. With your polarized glasses and projector filters in place, you are viewing live 3D video!

Advantages
The VBrick system has many advantages for live 3D video, including:

- Simplicity
- Network Performance and flexibility
- Low cost
- Any number of simultaneous viewers, anywhere via multicasting
- High resolution D1 MPEG-2, DVD-quality video scales to large screens
- NTSC or PAL Interlaced video
- Full 30 frames per second for each eye, 60 frames per second total (60 fields per second for each eye, 120 fields per second total)
- Excellent brightness

Applications
There are many applications for live 3D video, including:

- Trade Show Displays
- Event Promotion
- Retail advertising and public display
- Museums and Aquariums
- Remote visualization of physical models for manufacturing and design
- Boardroom presentations
- Military visualizations
- Scientific investigations

Sources

VBrick Encoders/Decoders – VBrick Systems, Inc.
Polarizing Filters – Edmond Scientific
Projection Screens – Da-Lite "Silver Vision" screen fabric; Stewart Filmscreen Corp
Projectors – virtually any DLP projector
Glasses – Try Rainbow, Berezin, and many other sources