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Pushing Stereoscopy: A Unique 3-D Video System

By Ray Zone

Despite the fact that Canon has discontinued production of the 3-D lens for its XL1 camera (see AC Aug. 2001), Jason Goodman of 21st Century 3D has moved forward with stereoscopic video in developing a new system he calls "960p," based on dual Sony DXC-9000 cameras.

"It's a high definition stereoscopic format that takes its name from the HDTV standards it is based on," says Goodman. "By utilizing two 720x480 progressive (480p) video streams, we are able to produce high definition stereoscopic images with low cost standard definition tools."

Goodman also notes that there are certain advantages of dual video recording over the alternating field process used by the Canon XL1 3-D lens. "The XL1 3-D camera lens was unsuitable for blue- or greenscreen composite work," Goodman says. "The compressed video files, the 4:1:1 color space, and sequential recording of the left and right eye images were all limitations."

By utilizing the built-in "feature" of NTSC video, sequential left and right eye images were neatly stored on odd and even fields. "This is great for telling the lens when to photograph each image and telling shutter glasses when to open and shut," says Goodman. "but it can be bad for stereo photography. Because the images are recorded sequentially, there is a 1/60-second time differential between the capture of left and right eye images. In many cases, this causes stereo pairs to be mismatched. Photographing anything with a relatively high degree of motion (the movement of fingers on a hand for example) may exhibit temporal artifacts and a breakdown in stereoscopy. By switching to a two channel system, this problem is eliminated."

The DXC-9000 camera uses three 1/2" CCDs. With progressive scan technology, the camera can capture objects moving at high speeds and produces clear images with high horizontal (720 TV lines) and vertical (480 TV lines) resolution. A built-in frame memory provides three types of output signals, including a non-interlaced signal.

"I got the DXC 9000s because they were the only camera that fit the qualifications for progressive scan and broadcast quality," says Goodman. "They also allow us to do component video uncompressed with 4:2:2 color space with the option for 4:4:4"

While maintaining the benefits of progressive scan acquisition, the output signals provide system compatibility with existing video equipment. The DXC-9000 uses square pixels for minimum distortion of the image

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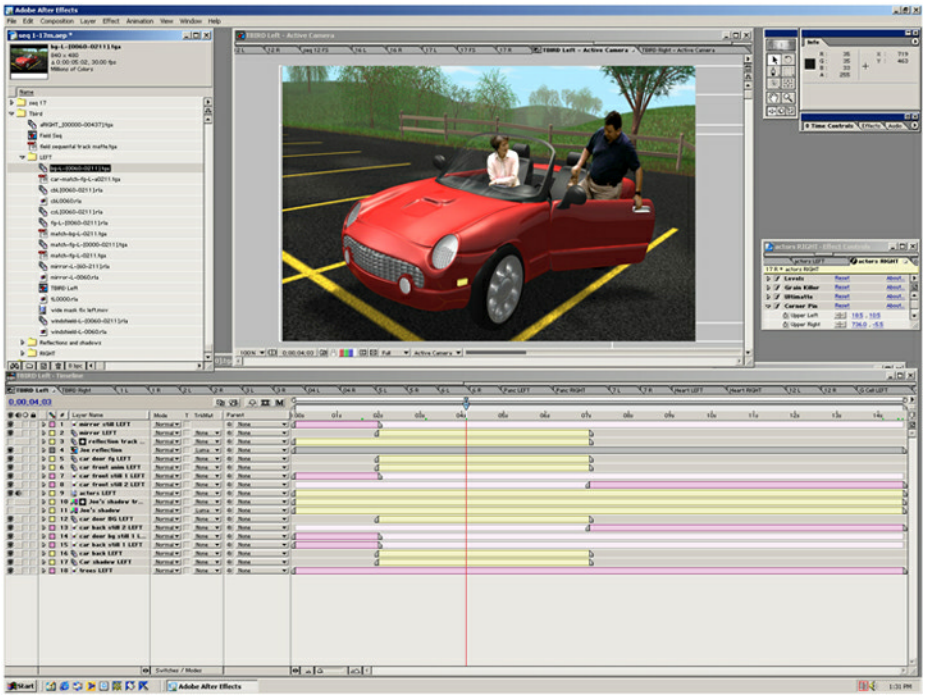


and is ideal for computerized image processing applications. The individual cameras weigh in at 1.68 pounds each, and Goodman has assembled a system to record to Beta SP.

"The DXC-9000 outputs RGB component video which is not suitable for recording to Beta SP in this particular case," says Goodman. "So we used two Sigma Electronics black boxes to convert the RBG component video into YUV component video and then recorded to the two separate Beta decks." Using "video out/video in" external sync on the two Beta decks, field accuracy was maintained.

"We have one of the beta decks sending time code to the other so the in and out points for each shot match," says Goodman. "This makes editing much easier. We log all the footage from the left eye tape and then just re-save the batch capture list, changing the file names to include a right eye suffix." A Horita mini-portable blackburst generator is used to provide external sync to the two cameras to ensure simultaneous image capture for left and right eye channels. The camera adapter unit provides AC power as well as a multi-pin cable that allows for external sync input. A camera remote control unit also provides easy access to various camera functions.

To preview the 3-D material during production, a field sequential 3-D multiplexer is used to mix composite video output from the two Beta SP decks into a single 3-D video stream. This is very useful for comparing output of the two cameras and ensuring video input at the Beta decks. A head-mounted display (HMD) or liquid crystal shutter (LCS) glasses and a variety of other means can be used for preview.

"Both cameras ran composite video into a 3-D multiplexer provided by Andrew Woods at Curtin University of Technology in Australia," says Goodman. "This allowed us to preview 3-D in real time and compare focus, brightness and other characteristics on screen as we shot."

The first 960p project that Goodman has completed with his new stereoscopic video system is Avandia 3D, a seven-minute movie produced for the pharmaceutical company GlaxoSmithKline and recently shown at the American Diabetes Association convention. Avandia 3D combines live-action footage of actors shot in front of a green-screen and composited with computer generated (CG) imagery depicting the bloodstream and hypoglycemia at a cellular level. It's a computer-generated fantastic voyage in 3-D into the human heart and bloodstream that's a bit like a traditional "ride film" usually seen in the Imax format.

"The analog component footage was captured with the NewTek Video Toaster via analog component, uncompressed and brought right into Adobe After Effects," says Goodman. "I wanted to stay in component color space to preserve as much image quality and color fidelity as possible. While the Sigma transcoder box is not necessarily an ideal solution, it seems like the best available choice for the present time."

Working in the realm of computer imagery provided great flexibility for manipulation of the stereoscopic image. "We manipulated the stereo window with After

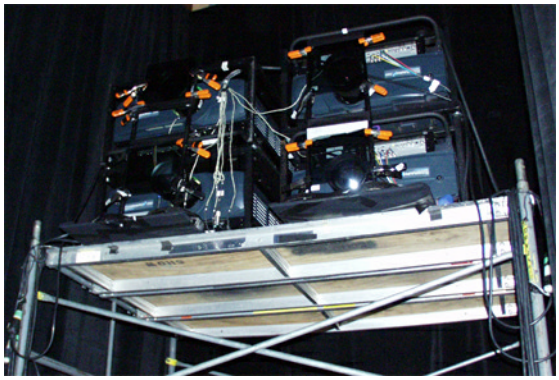
Effects by moving left and right eye images closer together or further apart depending on the need," says Goodman. "We were compositing the live actors into a CG world, so we set up the CG shots with convergence or camera toe-in. Once we got the CG world looking the way we wanted, we integrated the actors in a way that made them appear to be at the proper depth relative to their surroundings."

To project Avandia 3D at the convention, two independent DVDs were encoded progressive scan. The DVDs played in two off-the-shelf DVD players controlled by a Dave Jones-designed sync box. Each DVD player was hooked up to a separate Christie Digital Vistagraphics 5000 projector through a component video connection. The Christie DLP projectors each have 5,000 lumens of light and project through properly oriented linear polarizers onto a 10'8" x 6' silver screen. Projected in the 16x9 aspect ratio, Avandia 3D was watched by the audience using paper polarizing glasses.

"The projected 3-D images were pretty bright," says Goodman. "DVD is important in this system. The disc-based format allows us to easily synchronize the two 480p streams and presents a very high quality image. By sidestepping NTSC interlacing, we are achieving a digital projection format using inexpensive DLP projectors that produce SVGA resolution, which can represent every pixel in our image without scaling. By mating two DLPs to two computer-controlled genlocked DVD players, we are able to present 480 horizontal lines of data to each eye.

"Unlike the XL1 3-D which takes a 720x480 frame and cuts it in half for each eye," continues Goodman, "this system gives you four times the resolution because it's a full frame per eye. The brain interpolates the dual 480p signals into a 960-line display because all that data is there, merging the two independent channels. That's the key to the system."

Modification of the DXC-9000 cameras was not without its challenges. To get the stereo base between the two cameras down to a workable 2 3/8 inches apart, Goodman found he had to use the Sony VCL-707BXM lenses because of its smaller lens barrel. "This is actually a macro lens, designed to photograph objects no more that 17 inches from the camera," says Goodman. John Merritt, chair of the Stereoscopic Displays and Applications conference and senior consultant with The Merritt Group in Williamsburg, Massachusetts, consulted with Goodman to find a solution.



Custom optics were created for the lenses by Steve Manos, formerly of Century Precision Optics. "Originally, the lens was a 7.5mm to 52.5mm zoom," says Goodman. "The modifications created a need to lock the focal length and lose the zoom capability. The focal lengths were matched by our optical engineer and locked in place at 7.7mm. Currently, aperture and focus functions are not linked. For the first shoot, we were just very careful to match them as closely as possible."

Goodman isn't the only one assembling a stereoscopic video rig. Paradise FX in Hollywood has tested two Sony CineAlta 24p HD camcorders mounted at right angles in a housing frame. James Cameron has been using a similar rig for underwater filming of Ghosts of the Abyss, which is destined for the large-format Imax screen. With digital processing of the HD footage, extra definition is added and recorded out to film for projection in the 15/70 format.

"Imax is the obvious king in this arena," says Goodman, "but without Sony's budget, who could afford to make a film in that format? Eventually, however, our eyes are on HD." For now, 21st Century Media will service the pharmaceutical and medical industries with 960p 3-D movies to showcase at trade shows and conventions.