



# LARGE DISPLAY REPORT

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## Anaglyph 3D: Problems and Solutions

Major Hollywood studios have over 60 3D movies in the current production pipeline. When these eventually make their way to home release, many will be provided in one of the anaglyph formats. The reason for this and the reason that there are several types of anaglyph 3D are the subject of this article.

Here are several important pieces of background information.

- Anaglyph-based approaches generally produce a lower quality 3D image than do the time-sequential (shutter glasses) and polarization-based (passive polarizing glasses) stereoscopic 3D technologies.
- At this time, the installed base of 3D-capable televisions is small, and the number set up to actually present 3D is even smaller.
- Conventional televisions have the capability of displaying several of the anaglyph presentation modes. Anaglyph is also compatible with current DVD technology.

Considering these factors, if studios want to offer 3D videos in the home in the near term, there is little alternative to anaglyph.

### *Some Common Anaglyph Modes*

Color and Optimized anaglyph are two common methods, and there are pros and cons to each.

#### **Color Anaglyph**

All of the red information of the left image is presented to the left eye and all of the blue and green information is presented to the right eye. Color reproduction can be quite good, but the 3D image is prone to retinal rivalry. Strongly saturated colors are

#### **Why Are There Many Anaglyph Modes?**

So-called retinal rivalry occurs if the brightness of the two images is not the same in each eye. (This contribution is separate from retinal rivalry caused by the different color channels perceived by the left and right eye.) The effect is unpleasant – it is perceived as an abnormal luster in parts of the picture, or it may make the image flicker.

Some anaglyph glasses have lenses in which the transmission of one colored filter is less than that of the other. Such anaglyph glasses routinely cause retinal rivalry.

Since retinal rivalry is undesirable, many attempts have been made to fix the problem. The challenge is to adjust the colors in a way that minimizes retinal rivalry while still keeping the new colors as true to the original colors as possible.

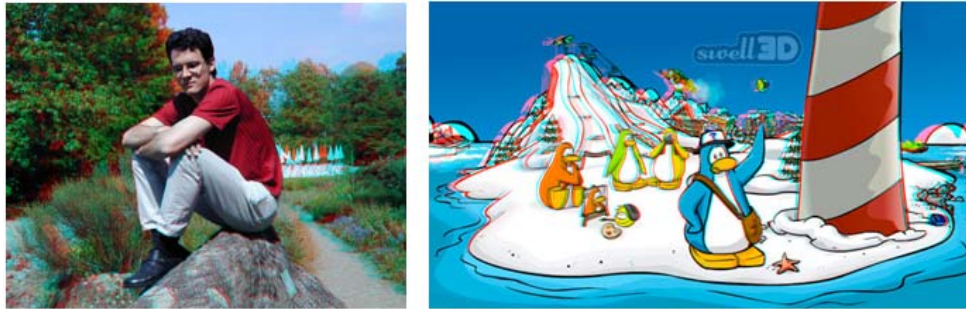
There are several methods by which to calculate the anaglyph r,g,b values  $r_a$ ,  $g_a$  and  $b_a$  from the r,g,b values of the original left ( $r_1$ ,  $g_1$ ,  $b_1$ ) and right images ( $r_2$ ,  $g_2$ ,  $b_2$ ). The formulas must be applied to each pixel.



particularly susceptible. A mathematical expression for the color transformation expressed in matrix algebra is as follows.

$$\begin{pmatrix} r_a \\ g_a \\ b_a \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \cdot \begin{pmatrix} r_1 \\ g_1 \\ b_1 \end{pmatrix} + \begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} r_2 \\ g_2 \\ b_2 \end{pmatrix}$$

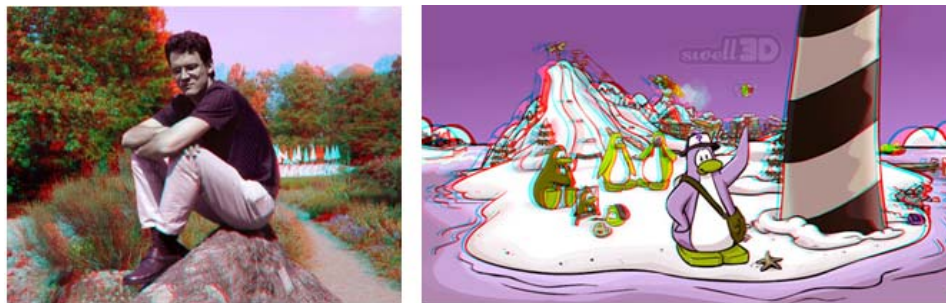
Examples of two images in the Color Anaglyph mode are presented below.



### Optimized Anaglyph

In Optimized Anaglyph all of the blue and green information is transmitted to the right eye. None of the left-image red color data has been used in deriving the output red channel. Instead, 30% of the green channel and 70% of the blue channel are used, and both are brightened by 50%. This eliminates rivalry caused by the red component of the image, but color reproduction is obviously not accurate.

$$\begin{pmatrix} r_a \\ g_a \\ b_a \end{pmatrix} = \begin{pmatrix} 0 & 0,7 & 0,3 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \cdot \begin{pmatrix} r_1 \\ g_1 \\ b_1 \end{pmatrix} + \begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} r_2 \\ g_2 \\ b_2 \end{pmatrix}$$



Do not be misled by the “poor” color appearance of the printed images of the Optimized Anaglyph image as compared with those of the Color Anaglyph. Put on a pair of proper anaglyph glasses and the two look almost identical, with the Optimized Anaglyph producing less retinal rivalry.

Other anaglyph modes include:

- Red/Blue Monochrome Mode
- Red/Cyan Monochrome Mode
- Color Anaglyph Half-Color Mode
- Akumira Anaglyph Mode
- Dubois Anaglyph Mode
- Magenta/Green (Trioscopic)

Additional illustrations and further explanations of the mathematics of the various [anaglyph modes](#) can be found at several sites online.

### ***Recent Developments***

[Lightspeed Design](#) (Bellevue, WA) has developed a flash technology for anaglyph delivery. In an email exchange with Chris Ward, the president of Lightspeed, we learned that this is not an ordinary red/blue or red/cyan mix but, rather, an improved mix that the company has been working on for about a year. Both the flash delivery container and anaglyph process are reported to be special. A video containing a demonstration of images presented in the new anaglyph mode is available online. The password: [depthq.NVIDIA](#) (Santa Clara, CA) is marketing its new [3D Vision Discover System](#), which has been optimized for 3D monitors and utilizes red/cyan passive glasses. (See related story in this issue.) In a recent telephone interview Andrew Fear, product marketing manager for NVIDIA GeForce 3D, and Michael Lim, the nForce product manager, said the strategy is to provide users with an inexpensive, “sneak preview” of 3D imagery. The system is represented as producing good (not great) stereoscopic 3D. If this anaglyph 3D capability suits the customer’s needs, fine. NVIDIA hopes, though, that it will serve to whet the users’ desire for better quality 3D and encourage them to purchase the shutter glasses-based [G Force](#) system, a product capable of providing much improved 3D imagery.

YouTube is now offering videos in various [3D modes](#). When you click on that link, you’ll find a drop-down box that allows you to select the form of anaglyph in which the 3D video is presented. - *Arthur Berman*

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