

Anaglyph image

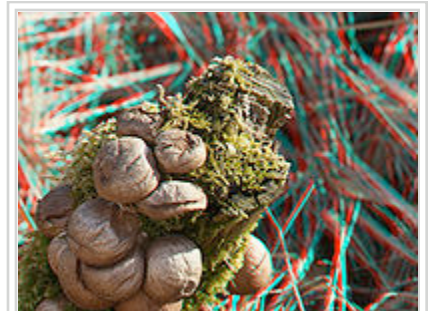
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Stereo monochrome image anaglyphed for red (left eye) and cyan (right eye) filters.



Stereogram source image for the anaglyph above.



Stereoscopic effect used in Macro photography.

Anaglyph images are used to provide a stereoscopic 3D effect, when viewed with 2 color glasses (each lens a chromatically opposite color, usually red and cyan). Images are made up of two color layers, superimposed, but offset with respect to each other to produce a depth effect. Usually the main subject is in the center, while the foreground and background are shifted laterally in opposite directions. The picture contains two differently filtered colored images, one for each eye. When viewed through the "color coded" "anaglyph glasses", they reveal an integrated stereoscopic image. The visual cortex of the brain fuses this into perception of a three dimensional scene or composition.



Anaglyph (3D photograph) of Saguaro National Park at dusk.

Anaglyph images have seen a recent resurgence due to the presentation of images and video on the internet, Blu-ray HD disks, CDs, and even in print. Low cost paper frames or plastic-framed glasses hold accurate color filters, that typically, after 2002 make use of all 3 primary colors. The current norm is red for one channel (usually the left) and a combination of both blue and green in the other filter. That equal combination is called cyan in technical circles, or blue-green. The cheaper filter material used in the monochromatic past, dictated red and blue for convenience and cost. There is a material improvement of full color images, with the cyan filter, especially for accurate skin tones.

Video games, theatrical films, and DVDs can be shown in the anaglyph 3D process. Practical images, for science or design, where depth perception is useful, include the presentation of full scale and microscopic stereographic images. Examples from NASA include Mars Rover imaging, and the solar investigation, called STEREO, which uses two orbital vehicles to obtain the 3D images of the sun. Other applications include geological illustrations by the USGS, and various online museum objects. A recent application is for stereo imaging of the heart using costly 3D ultra-sound with plastic red/cyan glasses.

Anaglyph images are much easier to view than either parallel (diverging) or crossed-view pairs stereograms. However, these side-by-side types offer bright and accurate color rendering, not easily achieved with anaglyphs. Recently, cross-view prismatic glasses with adjustable masking have appeared, that offer a wider image on the new HD video and computer monitors.

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History

The first method to produce anaglyph images was developed 1853 by Wilhelm Rollmann in Leipzig.

Producing anaglyph images

In historical methods using camera filters, on film, two images from the perspective of the left and right eyes were projected or printed together as a single image, one side through a red filter and the other side through a contrasting color such as blue or green or mixed cyan. As outlined below, one may now, typically, use an image processing computer program to simulate the effect of using color filters, using as a source image a pair of either color or monochrome images. Since the 1970s Stephen Gibson offers his patented "Deep Vision" system using cyan instead of green filters. These colors cover the entire visible spectrum, providing more natural color. "Deep Vision"-spectacles have the red filter over the right (!) eye and the cyan over the left. (To bypass Gibson's patent some companies produce red/cyan-glasses with the colors on the wrong side.) Meanwhile there's a third color anaglyph system on the market, named "ColorCode", using yellow (left) and blue (right). Popular professional programs such as Adobe Photoshop provide the basic digital tools for processing of anaglyphs. They do not provide instruction for anaglyph in their basic documentation. Various websites offer free instruction related to 3D for Photoshop. Simple, low cost programs, dedicated to anaglyph creation, are also available. In recent simple practice, the left eye image is filtered to remove blue & green. The right eye image is filtered to remove red. The two images are usually positioned in the compositing phase in close overlay registration (of the main subject). In Photoshop, for example a function called "screen" in the "layers" (F7) option, allows the two filtered layers to be combined transparently, on each other, although the compositing can also be done by pasting into the selected channels. The filtration itself, can easily be done in the "curves" function which allow removal of any RED, GREEN, or BLUE layer, with a simple slider. Experienced Photo-shop users, can sometime process a good cross-view 3D pair into an color anaglyph in 2 to 5 minutes, if little fine tuning is required. Various steps can be added to maximize the quality of the result. These include, size matching of the frames to within a few pixels. Rotation, if needed. Gama leveling, digital sharpening of the softer red image. It should be noted that both the RED layer and the RED filter in the glasses, contain no visible BLUE or GREEN color information, but masked colors do exist, that the eyes can't see through a red filter that can interact with the colors contained in the CYAN image, after compositing and blending.

How anaglyph works

Viewing anaglyphs through appropriately colored glasses results in each eye seeing a slightly different picture. In a red-blue anaglyph, for instance, the eye covered by the red filter sees the red parts of the image as "white", and the blue parts as "black" (with the brain providing some adaption for color); the eye covered by the blue filter perceives the opposite effect. True white or true black areas are perceived the same by each eye. The brain blends together the image it receives from each eye, and interprets the differences as being the result of different distances. This creates a normal stereograph image without requiring the viewer to cross his or her eyes.

Viewing

A pair of eyeglasses with two filters of the same colors, once used on the cameras (or now simulated by image processing software manipulations) is worn by the viewer. In the case above, the red lens over the left eye allows only the red part of the anaglyph image through to that eye, while the cyan (blue/green) lens over the right eye allows only the blue and green parts of the image through to that eye. Portions of the image that are red will appear dark through the cyan filter, while portions of colors composed only of green and blue will appear dark through the red filter. Each eye therefore sees only the perspective it is supposed to see.



Paper anaglyph filters produce an acceptable image at low cost and are suitable for inclusion in magazines

Red sharpened anaglyph glasses

Simple paper, uncorrected gel glasses, cannot compensate for the 250 nanometer difference in the wave lengths of the red-cyan filters. With simple glasses, the red filtered image is somewhat blurry, when viewing a close computer screen or printed image. The (RED) retinal focus differs from the image through the (CYAN) filter, which dominates the eyes' focusing. Better quality, molded acrylic glasses frequently employ a compensating differential diopter power to balance the red filter focus shift relative to the cyan, which reduces the innate softness, and diffraction of red filtered light. Low power reading glasses worn along with the paper glasses, also sharpen the image noticeably.

The correction is only about 1/2 + diopter on the red lens. However, some people with corrective glasses are bothered by difference in lens diopters, as one image is a slightly larger magnification than the other. Though endorsed by many 3D websites, the diopter "fix" effect is still somewhat controversial. Some, especially the nearsighted, find it uncomfortable. There is about a 400% improvement in acuity with a molded diopter filter, and a noticeable improvement of contrast and blackness. The American Amblyopia Foundation uses this feature in their plastic glasses for school screening of children's vision, judging the greater clarity as a significant plus factor.

Anachrome filters

Plastic glasses, developed in recent years, provide both the diopter "fix" noted above, and a change in the (CYAN) filter. The formula provides intentional "leakage" of a minimal (2%) percentage of red light with the conventional (BLUE/GREEN) range of the filter. This assigns, two eyed, "redness cues" to objects and details, such as lip color, and red clothing that are fused in the brain. Care must be taken, however, to closely overlay these (RED) areas into near-perfect registration, or "ghosting" will be annoying. Anachrome formula lenses work well with black & white, but can provide excellent results when the glasses are used with conforming, "anachrome friendly" images. The US Geological Survey, has thousands of these "conforming", full-color images, which depicts the geology and scenic features of the U.S. National Park system. By convention, anachrome images try to avoid excess separation of the cameras, and parallax, thereby reducing the ghosting that the extra color bandwidth introduces to the images.



Plastic anaglyph glasses can employ diopter correction for improved viewing

Traditional Anaglyph Processing Methods

The following monochromatic method assumes that the stereo pair is available as a digitized image and that access to general purpose image processing software and computer is available.

Starting with a pair of color images, or a sepia (toned) image, first convert each to grayscale (shades varying between black and white). Select the right image and paste it into a new document. Convert the new document to color (it still looks black and white, with all channels identical). Returning to the grayscale stereo pair select only the red channel of the left image and copy that channel to the clipboard. Select new the anaglyph document as the destination window. Using the *channels* window select the red channel and paste in the left image. The images may then be flattened, color adjustments applied as outlined below, and the image saved in an appropriate transmission and viewing format such as JPEG.



Anaglyph from monochrome images.



B&W anaglyph image of Zagreb taken using one camera. Images were taken about 2m (7ft) apart to get the 3D effect.

There are several computer programs that create color anaglyphs without Adobe Photoshop, and a traditional, more complex compositing method can be used with Photo-shop, as explained below. To make an anaglyph containing color information using color images, replace the red channel of the right-eye image with the red channel of the left-eye image. To do this, select the entire right eye image (if the original is a crossed eye stereogram this will be on the left) and make a new document. Paste the right eye image in. Move the selection to the left eye image (with consideration as above for crossed eye stereograms) and using the channels dialog select the red channel. Copy the red channel from this source image. Return to the new document and select the red channel. Paste the left eye image into the red channel. Fine details of the process, can provide many advantages, that space considerations don't allow in this article context.



Color anaglyph taken using two cameras about 40cm (16in) apart for enhanced depth effect.

Using color information, it is possible to obtain reasonable (but not accurate) blue sky, green vegetation, and appropriate skin tones. Color information appears disruptive when used for brightly colored and high contrast objects such as signs, toys, and patterned clothing when these contain colors that are close to red or cyan.

Anaglyphic processes are not always able to reconstruct full-color 3D images. Colors which are combinations of red-green (yellow);and red-blue (magenta) would reproduce. However, to get full-color photos or movies, a polarizing filter system (or an adapted Russian LCD shutter system) must be used. Polarizing filters steer the vibrations of light analogous to a Window blind. Two synchronized projectors are used, overlapping the images into an aluminum screen. The shutter system, on the other hand, switches back and forth rapidly for left- and right-eye images, synchronized to the image input, and alternating so fast that the eye cannot detect the changes. This is similar to how LCD shutter glasses work.

According to entertainment trade papers, 3D movies are now more popular than ever. The modern processes allow maximum comfort and minimum eyestrain. 3D provides an entertainment experience still not possible with television (though certain experimental processes, the quasi-holographic "volumetric displays", have been used, for example, to show real images of cars in a display setting, with no viewing glasses required).

Depth adjustment

(The adjustment suggested in this section is applicable to any type of stereogram but is particularly appropriate when anaglyphed images are to be viewed on a computer screen or on printed matter.)

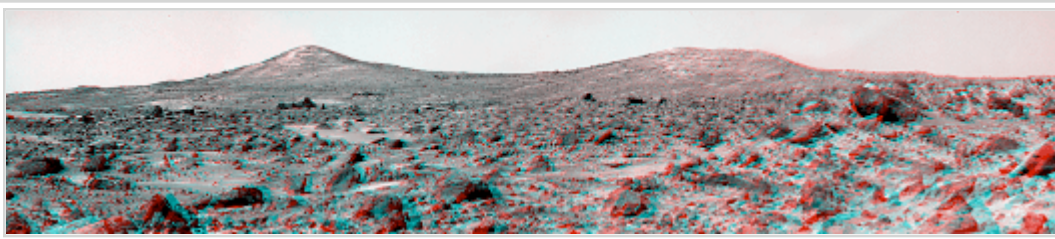


Image as originally presented by NASA with foreground spilling from the frame. This is a two-color (red-cyan) anaglyph from the Mars Pathfinder mission. To view, use a red filter for the left eye and a cyan filter for the right eye. Note that the distant mountain images are aligned, placing them at the screen, and the confusing appearance in the lower right corner.

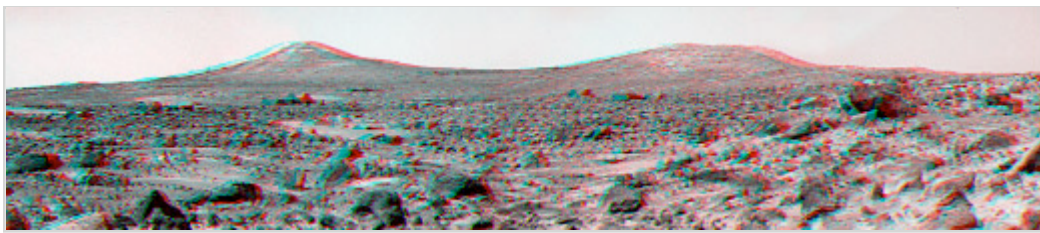
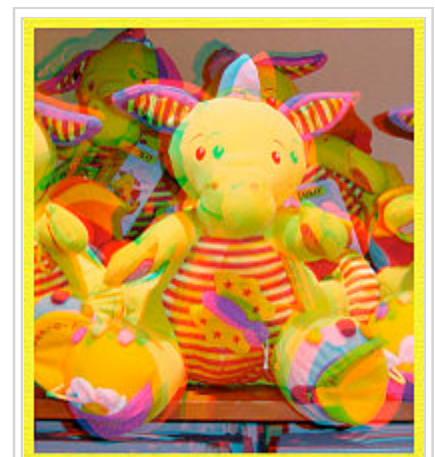


Image adjusted so that most objects appear to be beyond the frame. Note that the mountain images are now separated when viewed without the glasses. This follows the rule for a red left eye filter when distant objects are beyond the image plane: RRR-Red to Right Receding for dark objects on lighter background in the image as it appears without wearing the filters.

Those portions of the left and right images that are coincident will appear to be at the surface of the screen. Depending upon the subject matter and the composition of the image it may be appropriate to make this align to something slightly behind the nearest point of the principal subject (as when imaging a portrait). This will cause the near points of the subject to "pop out" from the screen. For best effect, any portions of a figure to be imaged forward of the screen surface should not intercept the image boundary, as this can lead to a discomforting "amputated" appearance. It is of course possible to create a three-dimensional "pop out" frame surrounding the subject in order to avoid this condition.

If the subject matter is a landscape, you may consider putting the frontmost object at or slightly behind the surface of the screen. This will cause the subject to be framed by the window boundary and recede into the distance. Once the adjustment is made, trim the picture to contain only the portions containing both left and right images. In the example shown above, the upper image appears (in a visually disruptive manner) to spill out from the screen, with the distant mountains appearing at the surface of the screen. In the lower modification of this image the red channel has been translated horizontally to bring the images of the nearest rocks into coincidence (and thus appearing at the surface of the screen) and the distant mountains now appear to recede into the image. This latter adjusted image appears more natural, appearing as a view through a window onto the landscape.



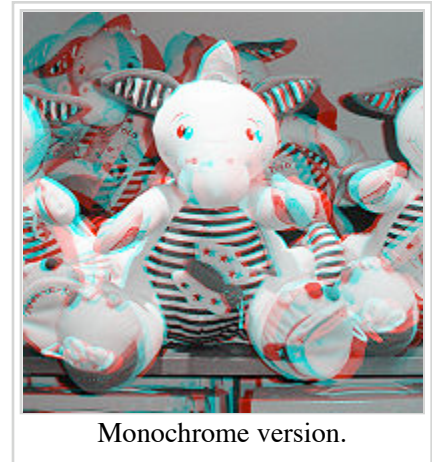
Shelf edge at screen depth.

Scene composition

In the toy images to the right, the shelf edge was selected as the point where images are to coincide and the toys were arranged so that only the central toy was projecting beyond the shelf. When the image is viewed the shelf edge appears to be at the screen, and the toy's feet and snout project toward the viewer, creating a "pop out" effect.

Dual purpose, 2D or 3D "compatible anaglyph" technique

Since the advent of the internet, a variant technique has developed where the images are specially processed to minimize visible mis-registration of the two layers. This technique is known by various names, the most common, associated with dioptr glasses, and warmer skin tones, is Anachrome. The technique allows most images to be used as large thumbnails, while the 3D information is encoded into the image with less parallax than conventional anaglyphs.



Applications

In DVD & Blu-Ray home release of theatrical 3D films

Disney studios released Hannah Montana & Miley Cyrus: Best of Both Worlds Concert in August 2008, its first Blu-Ray 3D disc. This was shown on the Disney Channel with red-cyan paper glasses in July 2008.

The greater clarity of Blu-Ray, and the learning curve at Disney, has greatly improved red-cyan anaglyph, especially in relation to close overlay of the 3D images, such as they have followed in their animation projects. Most Disney theatrical 3D images show far less mal-registration, compared to old fashioned polarized or anaglyph technique.

In comics



3-D Glasses distributed with special Batman comic books between 1953 and 1964

These techniques have been used to produce 3-dimensional comic books, mostly during the early 1950s, using carefully constructed line drawings printed in colors appropriate to the filter glasses provided. The material presented were typically short graphic novels of a war story, horror, or crime/detective nature - similar in content to some modern Japanese *manga*. These genres were largely

eliminated in the US by the rise of the Comics Code Authority. Anaglyphed images were of little interest for use in the remaining comics, which emphasized bright and colorful images, unsuited for use with the viewing and production methods available at the time, which were usually red-green rather than red-cyan.

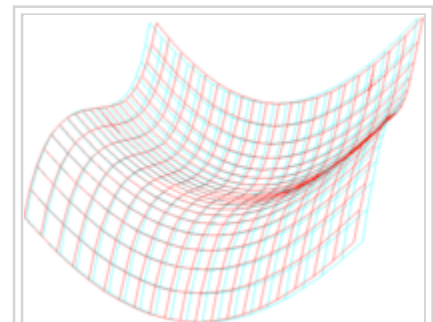
In fine arts

Some maintainers of internet web sites have added depth information to images of famous paintings, further processing these to produce color anaglyph (3D) images.

In science and mathematics

Three dimensional display is useful for the display of various data sets and for illustrating certain mathematical functions. Anaglyph images are useful since they are suitable for both paper presentation and non-moving video display.

Chemical structures, particularly for large systems, can be difficult to represent in two dimensions without omitting certain information. Therefore most chemistry computer software can output anaglyph images, and some chemistry textbooks include them.



The single valued function of two variables $z(x,y) = x^2 + y^3$ with the function value displayed as the height.

See also

- Holography
- Phantogram
- Pulfrich effect
- Stereogram
- Vectograph
- Wheatstone viewer

External links

- How to make Anaglyphs (http://www.opentutorial.com/Make_3d_images) - A step by step tutorial on how to make your own anaglyphs
- Making a 3D anaglyph movie (<http://www.saunalahti.fi/animato/3d/3d2.html>)
- Choose a good screen - glasses pair to visualize anaglyphs (<http://www.david-romeuf.fr/3D/Anaglyphes/BonCoupleEL/GoodCoupleMonitorGlassesAnaglyph.html>)
- 3D Latinamerica See 500 images in 3 Dimensions of Latinamerica - Argentina, Uruguay, Paraguay, Bolivia, Peru, Ecuador and Venezuela (<http://www.3dlatinamerica.com>)

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