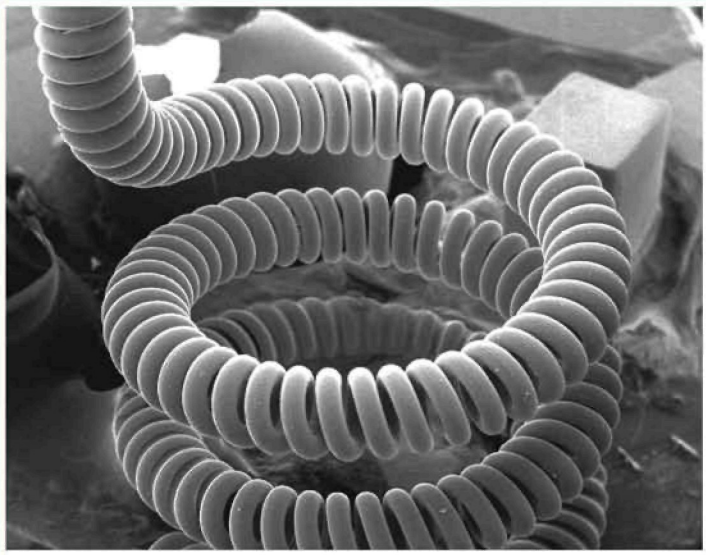


Flicker Stereo: Digital 3D Viewing for PC & Presentation

Nathan R. Greenhut* and Victor A. Greenhut**

** Industrial & Systems Engineering, Rutgers University, 96 Frelinghuysen Road, Piscataway, NJ and ** Ceramic & Materials Engineering, Rutgers University, 607 Taylor Road, Piscataway*
flickerstereo@comcast.net

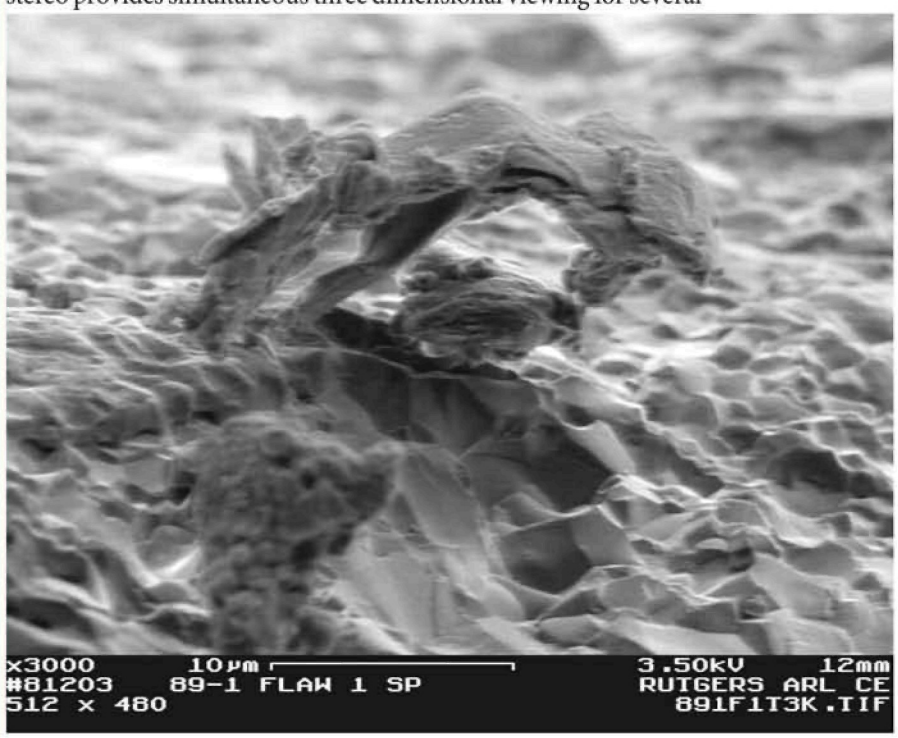
Summary

Flicker stereo alternates two pictures (~ 1 frame/sec.) of the same structure with views tilted 6° ± 1° about a vertical axis--Natural appearing stereo visualization results. A flicker stereo program to be used for viewing with a personal computer (PC) was developed by the authors. The two images are installed, adjusted for superposition and then alternated on the computer monitor or computer projection system. Flicker stereo can be applied to micrographs from the optical microscope, SEM, TEM, pictures or line drawings. Flicker stereo provides simultaneous three dimensional viewing for several individuals without special viewers, projection systems and/or glasses. Different flicker images may be retrieved and viewed on a PC in rapid succession. Flicker stereo facilitates technical discussion between collaborators and provides a convenient approach for 3D visualization by audiences using a digital LCD projection. The program is available to readers.*

Background

Natural human stereo vision normally relies on binocular vision or parallax view. Two images of an object, one per eye, are combined in the brain. True stereo is ordinarily best perceived with an intraocular angle of about 5° to 7°. This is convenient because for a usual human (or ape) eye separation this is the comfortable working distance at about 30 to 50 cm from the eyes - within easy grasp for manipulation of tools. Very close to the eyes and beyond our reach binocular 3D vision does not operate. Size, relative size, topographic contrast (light and shadow), relative position, *etc.* are used to judge three dimensional aspects of distant objects.

The common technique for reconstructing a stereo view involves allowing only one image to enter each eye with the images offset by the required 5° to 7° tilt angle. The tilt axis is positioned vertically, parallel to the body axis. Viewing devices consisting of lenses and/or mirrors provide stereo visualization of photographs. Familiar viewers include the classic Victorian stereopticon and civil engineering, air photograph ground viewers. Some individuals can hold one picture before each eye and obtain stereo without the assistance of such optical devices. Common projection methods require that the two images taken at the requisite tilt be projected such that only one image enters each eye. A two projector system is required. Stereo projection is usually accomplished with crossed projection polarizers (using a special metallized screen) and viewers must all be furnished crossed polarizing glasses. Another viewing approach projects complementary color images (red and green projection filters) with complementary color (red and green) lenses. If the angle is 6°± 1° a natural appearing stereo picture results. Greater angles yield "forced" stereo in which features appear to project unnaturally out of the frame. Smaller angles yield "flat" images.



An alternate approach has been in use since at least the nineteenth century—flicker stereo. This technique simulates the way in which animals such as birds and reptiles, without binocular vision, obtain stereo information. The head is cocked back and forth and the relative movement of objects is mentally integrated to yield three-dimensional information. Frequently, only one eye is focused on the object. Humans use head cocking occasionally to obtain positional information of near distance objects. The head is moved back and forth and the apparent motion of objects is integrated by the mind to yield stereo information. Nineteenth century applications of this projection system involved rapid mechanical alternation of two images taken at tilt angles. Images were switched by a tilting mirror or prism. A similar flicker device is used by astronomers to detect moving objects in multiple astronomical photographs. Flipping two pages by hand, as in this article, may also provide a flicker stereo view.

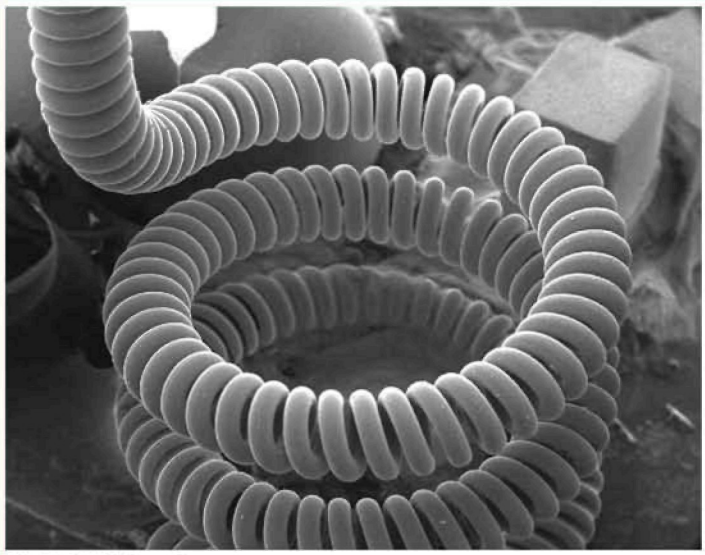


Figure 1 a & b The filament from a slide projector bulb showing the multiple helical windings of the tungsten. Helix wire width 4mm.

Digital Flicker Stereo

Today, flicker stereo can be accomplished conveniently on a personal computer (PC) using a Visual Basic® program developed by the authors.** The program will be provided as freeware upon request.* Two images are installed, aligned and then alternated on the computer monitor or computer projection system. A relatively natural three dimensional view of the object results. Flicker stereo can be applied to micrographs from any optical microscope, SEM, or TEM, *etc.*. A surface or transparent section may be viewed successfully. Stereo images can also be reconstructed from heavy-metal shadowed carbon replicas. Paired line drawings can also yield a stereo image. Macrographs (photographs) may also be used, as can any imaging technique that provides the required parallax views.

The major utility of flicker stereo is the ability to obtain three dimensional views without special viewers, projection systems and glasses. Simultaneous viewing by multiple individuals who can view the same image is particularly convenient. This facilitates technical discussion. Collaborators can point out and discuss features without encountering cumbersome refocusing and interocular distance adjustment for each user. The widespread availability of personal computers and computer projectors makes flicker stereo an ideal way to show audiences important three dimensional information without special, expensive projection systems and glasses.

Images oriented with the tilt axis rotated to the vertical are installed in the program. Care should be taken to spatially match the areas viewed and provide well matched magnification, contrast, and brightness. The program allows limited relative alignment of the two images to optimize the stereoscopic impression. The flicker rate can be varied over a range because different individuals have maximum comfort and best visualization at different flicker rates. After a time using the flicker a static, single image may be worked with while still retaining the stereoscopic understanding of the image.

Often SEM pictures convey misleading information because bright features appear to project out of the image. Thus, higher secondary electron signal from projections, electrical nonconductors and high atomic number material may falsely appear to be at high surface relief. Flicker stereo was found to overcome these effects very successfully and convey correct stereo aspects for both local detail and overall surfaces.

The same software may also be used to assemble "film clips" as one rotates around an object or penetrates in depth. The program appears useful for additional purposes. Studies of various applications for X-ray and other SEM signals and applications are being investigated.

Instructions for Viewing Flicker Stereo of Figures

The stereo pair pictures in this article are printed on two successive pages. Turn the magazine sideways and rapidly lift/lower the top image. With a bit of practice a flicker stereo view will result. Better yet, go to the Microscopy Today webpage (www.microscopy-today.com)***. The same stereo images are available in digital flicker stereo form. You can adjust the slider on the right to get the most comfortable rate for your purposes. The images were taken digitally with uncoated samples at low voltage (near the zero point of charge) on a Zeiss (LEO) Gemini 982. The stereo effect is much easier to see on a PC. ■

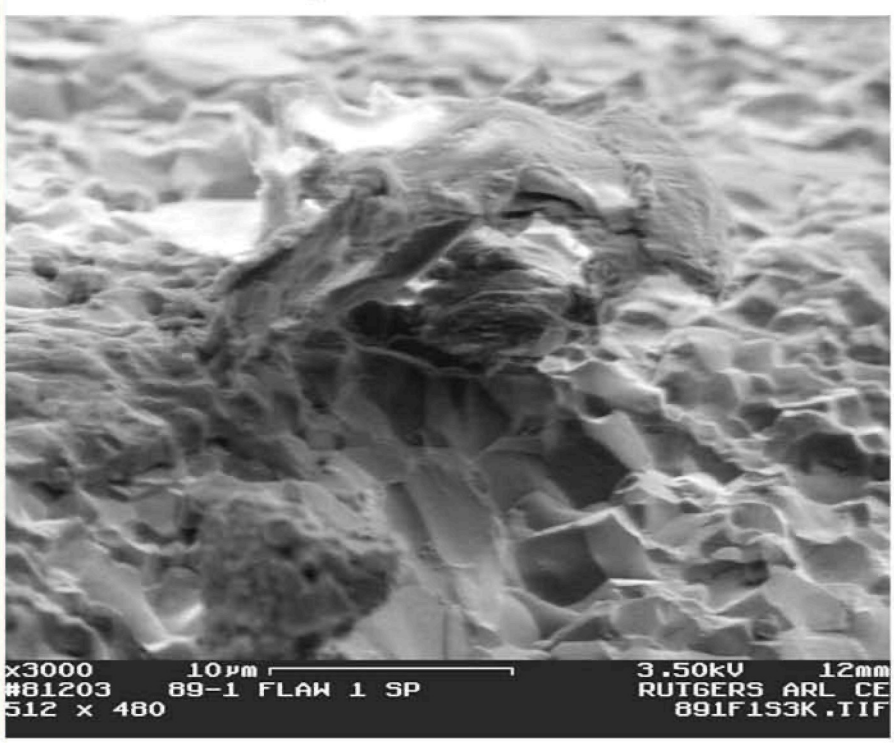


Figure 2 a & b Stereo images of a ballistic fragment showing an inclusion which has "popped" out of the surface. Note that a hole in the ejected material becomes apparent when flicker stereo is used.

Dedication

In memory of Norman Norbert Greenhut (b. 11 Feb. 1913 - d. 17 April 2004), our beloved grandfather and father. A wounded World War II veteran, he made us particularly aware of the utility of flicker stereo.

Endnotes

* The flicker stereo program will be provided as freeware exclusively for not-for-profit, personal use upon request to: flickerstereo@comcast.net

** Princeton GammaTech provided a flicker stereo tool with their systems about two decades ago, but this tool was not implemented on their more recent systems.

*** Links to the flicker stereo program have not been set up at press time. – *Ed.*