

Point, Shoot, and View — in 3-D

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Abstract

This report describes some early investigations in techniques for stereoscopic photography and related research projects. Present achievements in the technology of image capture should be helpful in the design of a consumer type of "twin lens" stereoscopic camera. Such a camera would offer pre-registered images with correct framing and parallax for direct viewing or for projection.

Introduction

Some fifty years ago, at the Research Department of Polaroid Corporation, we investigated stereoscopic photography as applied to Polaroid's Vectograph process[1] and also as applied to the projection of stereoscopic slides and motion pictures with polarized light. At that time we reviewed the existing concepts for stereoscopic photography and produced a practical calculator for the interaxial distance. We constructed an experimental, variable-interaxial stereo camera to study and evaluate our findings. The present paper is a flashback on the highlights of this project, many of which are still applicable.

Stereoscopy at Polaroid in the Early 1940s

The late 1930s and early 1940s found the Polaroid Research Laboratories very active in the field of stereoscopic photography. Stereoscopic movies were demonstrated at various meetings, and a brand new mode of presenting stereoscopic images was being developed at Polaroid under the name of Vectographs. Stereoscopic movies were promising big business with Hollywood, and Vectographs were being used to train aerial reconnaissance interpreters in the defense effort.

The New York World's Fair of 1939 featured a very effective stereoscopic motion picture short at the Chrysler Corporation pavilion. The film, which was made by the Loucks and Norling Studios, presented, by means of animation, a ballet of spare parts dancing and assembling themselves into a completed engine. John A. Norling was already known for his anaglyphic stereo movies, but this time the show was using the polarized light technique of projection. My recollection is that the screen width was about ten feet and that much of the action was in front of the screen.

Polaroid recognized immediately that for optimum results some basic rules must be established and engaged as a consultant John T.(Jack) Rule, a Professor of Mathematics at MIT. Jack Rule made a very thorough study of the geometry of stereo projection, later published in the *Journal of the Optical Society of America*.[2]

At the same World's Fair, the Eastman Kodak Company was demonstrating giant-size projections of Kodachrome slides. A joint experiment was conceived to utilize Kodak's setup, the Photorama, for testing some of Jack Rule's new formulas. The studios of Vogue magazine cooperated, and a full set of slides for the giant carrousel was produced. According to the late Richard Kriebel, one of the observers of the final demonstration, it was a superb show, but it lacked completely any stereoscopic effect!

The explanation of the lack of stereo depth was found on examining the stereo pairs of images and finding that for practical purposes they were identical. The formula used for computation of the interaxial distance assumed all far points to be at infinity, and the subjects themselves were rather far from the taking camera. Good proof that if one wishes a stereoscopic depth effect there must be parallax present.

In the meantime Polaroid established a training school for aerial reconnaissance technicians to teach them the making of Vectographs. Aerial reconnaissance vertical overflight negatives that were utilized normally included a 60% overlap. The overlapped sections portion presented sufficient parallax for an effective Vectograph.

William H. Ryan, who was in charge of Vectograph Research, requested my help in solving the problem of guidelines for optimum stereophotography, especially for Vectograph prints and stereo slide projection.

A Vectograph reflection print would normally display a depth effect of about 2 inches. This indicates a separation between the homologous far points of 1/4 to 3/8 of an inch. This became the prime requirement for the final format. Translated to the original photography, it indicated a displacement of about 1/24 the image width. The reason for approximation here is the fact that we must accommodate our vision to the viewing distance, but the mind interprets the point at the distance of convergence.

In normal, natural vision the convergence function and the accommodation are connected. If they are to be separated, nature imposes certain limitations or even refuses to allow this function. The 1/24 image width seems to be a good choice for practical image sizes viewed at "normal" distances. When the displacement exceeds 2.5 inches on a

60-inch screen or a larger one, the point of convergence lies behind the observer, and most observers experience visual discomfort.

Another important consideration in stereoscopic photography is the framing of the two views. Not only must the sizes of the images be exactly the same and without vertical disparity, but certain rules of convergence or location of the stereo window must be satisfied. My assignment from Bill Ryan was to provide a simple means of obtaining these specifications and to demonstrate the results with some hardware.

We worked with Jack Rule's formulas and introduced the concept of the Parallax Index, or the reciprocal of the ratio between the horizontal displacement and the width. We also introduced the limitation for large-size projection screens and came out with the Polaroid Interocular Calculator, a rotary multiscale calculator that took into consideration the far and near distances, lens-to-film distance, image width on the film, and screen width. The preliminary results of our work were presented at a Research Department seminar on May 15, 1945.[3] A more formal paper was presented at the PSA Conference in New York on August 15, 1952.[4]

While we were working on the horizontal displacement problems, others in the Engineering Department were working on an optical linkage between focusing and a prismatic variable convergence device. One such arrangement is illustrated in a patent of Land, Bachelder, and Wolff.[5]

For basic hardware we constructed a 5 x 7-inch variable interaxial studio camera. The reason for the 5 x 7 size was the contact mode of proofing our images on wash-off relief film for production of Vectographs. By reduction optical printing we could also make slides and study projection requirements. No suitable stereo cameras were available at that time. Existing 6 x 13-cm and 35-mm cameras were of fixed interaxial distance, and we definitely wanted to experiment with variable interaxial distances.

The layout for the camera was the scheme used by Floyd A. Ramsdell of the Worcester Film Company. A beamspiltter comprising a 45-degree semi-transparent mirror provided simultaneous images in a pair of Burke-James view cameras. Calibrated focusing scales provided focusing means, and the convergence was obtained by sliding the camera backs, We had only one set of lenses, 10-inch Wollensak Velostigmats, which were sufficient for a variety of subjects.

With the help of set designer Patricia Havens, we created a number of studio scenes and produced samples in black-and white and in color. We assembled a collection of stereo photographs, produced sample Vectograph prints and also giving demonstrations for a number of prospective clients, using a 3 1/4 x 4 1/2 Brost projector.

Some of our work was in color, and this fact brought us indirectly into a parallel nonstereoscopic activity. Bill Ryan, Vivian Walworth, and I were working to develop a chromogenic color printing process applicable to Vectograph motion pictures. As a result of this work we obtained a contract from Paramount Studios to print their Famous Studio cartoons. We provided the release prints for about thirty of their cartoons over the next two years.

Another fallout of these activities was that in the early 1950s Bill Ryan became a frequent visitor to Warner Brothers Studios, and an Acme stereo motion picture camera patterned after our studio model was assembled by Harold Scheib at Producers' Service in Burbank, CA.

During the 1950s public enthusiasm for stereoscopic motion pictures waned. At Polaroid the whole subject of stereophotography was overshadowed by the developments in the field of Dr. Land's one-step photography. The rest is history!

Conclusions

The title of this communication is perhaps misleading. It does not describe a novel stereoscopic or holographic miracle. Is it just a nostalgic recap of events that happened some fifty years ago? The public interest in things stereoscopic comes and goes in cycles. Then the novelty was the use of polarized light; now we are entering the brand new phase of image acquisition by electronic means. Perhaps some new developments to solve the old problems are to emerge. Just read the title of the next paper; help may be around the corner!

Acknowledgments

This paper is dedicated to the memory of William H. Ryan, whose encyclopedic mind and inquisitive nature was a constant inspiration to our work. I wish to thank Vivian Walworth for suggesting this presentation and for her priceless editorial assistance.

References

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