this article is taken from
"Proceedings of the international symposium on display holography", volume II
ISBN 0-910535-04-3

SEVEN SINGLE BEAM PROJECTS

ED WESLY

Fermi National Accelerator Laboratory, P.O. Box 500. Batavia, IL 60510

Colunbia College, 600 S. Michigan Avenue, Chicago, IL 60605

Lake Forest College Holography Workshops, Lake Forest. IL 60045

Abstract

A curriculum for low budget holography classes is presented consisting of seven different types of holograms, requiring no more equipment than a laser, beamspreader, and a mirror. Of these seven holograms, three are white light viewable, and two of these are image plane types. In addition to the software, hardware in the form of a novel isolation device dubbed 'The Big Beam" is described.

Introduction

As the demand for holograms increases, so does the demand for welltrained holographers. Just as poets must learn their ABC's to be in control of their craft, so should holographers know the medium inside out so well that the technical aspect is second nature to them. There are certain programs for the elementary teaching of reading and writing, and there should be some guidelines for the teaching of holography.

This paper outlines such a curriculum, entitled "Seven Single Beam Projects", which illustrates almost all the concepts of wavefront reconstruction through hands-on experience. These projects show the student what is possible with the medium by finding out its shortcomings, limitations and impossibilities. On the other hand, the students will also see what is so wonderfully possible that is unique to this medium that no one could ever imagine it without having been initiated into the field at the grass roots level. 'Ihe students should begin to think holographically, from recording to reconstruction.

Single Beam Philosophy

No one should pooh-pooh these projects as not being "true holography" for not splitting the beam. They are not just Mickey Mouse science fair projects but do have real life applications. Many of the world's more impressive holograms have been made using these techniques. See the references with each project.

This curriculum has been designed to be catholic in its approach, by training students to make good holograms regardless of whether they are technically or aesthetically oriented. Learning is by doing, and working within the framework of restrictions. Knowledge gained in this program, on this type of equipment, gives students an understanding of what to do once they get out in the real world and want to set up their own systems.

It is best to start out small, so mistakes are less costly and time consuming. For the learning process includes discovering not only what to do but also what not to do. There is no need to back student time up waiting to use more expensive equipment to learn the rudiments. All that can be learned earlier in preparation. By making the projects single beam simple, troubleshooting becomes easier as less variables are involved.

These seven single beam projects, three of which are white light viewable and two are image-plane types, require nothing more in the way of equipment than a laser, beamspreader, hologram holder, objects, glue gun and for one project, a large front surface mirror. This software can be applied to any type of table:

steel, concrete, or sand. But a solution to the problem of cheap, portable, yet effective isolation has been found in a novel piece of hardware which I have dubbed "'The Big Beam".

The Big Beam

The beam itself should be 2 to 3 meters long the major considerations being the desired reference source to holographic plate distance and/or whether the unit will fit in the holographer's car. There is one practitioner who has a home beam and one for the road for demonstrations. The tee crosspiece should be long enough to straddle two inner tubes.

Wood is the preferred material of construction, as it is strong and rigid in sizes 4" by 4" and larger in cross-section, and it can be glued and screwed into. Good polyurethane varnish and nice flat black enamel paint are necessary to seal the beam from the effects of humidity. Carriage bolts and wingnuts fasten all the pieces together for easy assembly and disassembly. All the tools the holographer need have access to are a saw and a drill with an alignment device to drill holes into the wood nice and straight.

These units with their three point suspensions and only one axis of symmetry are very hard to couple into a resonant mode. 'They have been successful in environments as hostile as third floor lofts and fifth floor classrooms. The trick is to have the whole unit move together by bolting and clamping everything so that there is no relative movement between the object, reference source, and holo-plate. Of course, single beam set ups have an advantage here, using only the minimal amount of components.

Exact sizes are not given in the blueprint of the Big Beam, as this should be an exercise in ingenuity and improvisation with materials on hand, especially for the fabrication of mirror mounts, beamspreaders, object stages and laser holders. There is room for growth, as split beam type set ups like rainbow transfers can be done on the beam in a double decker fashion.

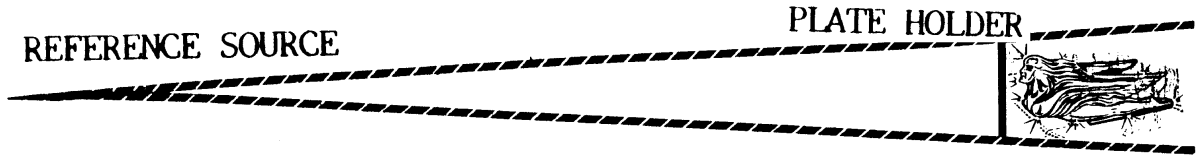
??The Curriculum

?The descriptions of.the projects are presented in a formto either be Xeroxed and passed out to students in a basic holography class or to be used by the instructor as a crib sheet. It is hoped that these modest outlines can be helpful in organising a class and that the instructors can flesh out these rough sketches with their own personal examples and explanations. It is recommended that instructors work the bugs out of the systems by preparing their own classroom set of all the projects using an object comon to all the holograms.

These exercises work on any scale, certainly lasers with power > 5mW are preferred, but we have been successful at reflection holography with 800 microwatts of power exposing 60 by 60 mm plates for 20 to 40 seconds at Columbia College in Chicago's Loop on these units. But at the other extreme, when we had a chance to have fun with a 25 Joule Ruby laser at Fermilab, the first thing that we did was to spray paint our hand silver and make large Denisyuks of them. 'Ihese Seven Single Beam Projects provide a firm foundation which will pay off in the studants' future adventures in holography, whatever. type of laser or recording material may be available to them at that time.

Photographs of Successful Big Beams would be a welcome addition to my collection, please send them to my in care of the Lake Forest Holography Workshops, as well as any questions or comments.

PROJECT 6: Denisyuk Holograms



SET UP STEPS:?

1 Spread beam so that the primary Gaussian center is larger than the holographic plate.

2 Position object and Plate holder.

3 Settle system and then shoot Hologram.

4 Process hologram then reconstruct under white light.

OBSERVATIONS/ DEMONSTRATIONS:?

Real and virtual images; color changes as a result of processing and exposure; the need for good isolation.

PROJECTS for EXPLORATION:

Pseudoscopic imagery; color control with triethanolamine; exact laser color reconstruction; testing processing variables.

OBJECT POSSIBILITIES:

Must be highly reflective without being too specular. Krylon #1401 Bright Silver Spray Paint works swell. Must be about the same size as the plate without being too deep.

TIPS:?

Don't bother with film at first, go with plates. Make sure polarization is in proper plane to minimize woodgrain. Mounting object upside down or on its side will make it easier to attain top reference angle in some configurations.

MASTERING CONSIDERATIONS?

For PROJECT 7: Use a process which reconstructs brightly under laser light. Make master hologram larger than object.

REFERENCES and EXAMPLES:?

Yu. N. Denisyuk, "On the Reproduction of the Optical Properties of an Object by the Wave Field of Its Scattered Radiation", Optics and Spectroscopy 15. p.279, (1963) Unterseher, et al., p.279.

PROCESSING:?

W. Spierings, "Pyrochrome Processing Yields Color-Controlled Results with Silver Halide Materials", holosphere 10, July/Aug. 1981, p.1.

G. Saxby, "Jottings From the UK", holosphere, Fall 1983, p.9.

D. J. Cooke, A. A. Ward, "Reflection Hologram Processing for Hlgh-Efficiency in Silver Halide Emulsions,"App, Opt. 23p p.934y (1984).'

COLOR?

L. Moore, "Pseudo-Color Reflection Holography", Proc. of the Int'l Symp. on Display

CONTROL:?

Holography, Vol. 1 p.163, (1982). J. Kaufman, "Previsualization and Pseudo-Color Image Plane Reflection Holograms", ibid., p.195.

PSEUDOSCOPY:?

J. Blyth, "Pseudoscopic Moldmaking Handy Trick for Denisyuk Holographers", holosphere, Nov. 1979, P*5*