

MAS 450/854: Holographic Imaging: Final Project Examples

Studies of Hologram Developers and Bleaches

Several simple developers and bleaches work well, but there are significant advantages and disadvantages to each, depending on the situation. A few tests of some alternates should help you generate some recommendations.

Pseudoscopic Image Effects

It seems to be very difficult to grasp the structure of a pseudoscopic "outside in" image. A gallery of effective images of this kind for student study would be very helpful. A series of four to six holograms playing off of various depth cues is envisioned.

Holographic Collimators

This project would attempt to fabricate a holographic collimator without the use of a glass collimator. Simple optical design as well as careful exposure and processing will be required.

Polarization Effects in Holography

Only the component of the reference beam that is polarized the same as the object beam will be recorded. Deliberate manipulation of the object beam polarization therefore offers an interesting level of control that can be explored in several ways, such as the suppression of highlights, of reflections, of woodgrain noise, and so forth.

Reflection False-Color Studies

The swelling of a holographic emulsion prior to exposure can decrease the eventual reconstruction significantly. Control of this swelling by painting the swellant on the plate, for example, can offer a new type of creative control of the medium, but must be based on careful prior calibration studies.

Animated Holograms

Several different images can be stored in a single hologram by several different methods. These can be played back by simply rotating the hologram, in some cases. A simple animation sequence can thereby be presented.

Projection of Dimensional Images

What about projecting a 3-D image right into thin air? Or a cloud of smoke? It doesn't work very well, but it might be interesting to figure out exactly why. This would involve making a few test holograms, and seeing what can be done with them in various situations.

Holograms on Flexible Film

Holographic emulsions are commercially coated on flexible film as well as glass, but films are considered much more difficult to handle, expose, and process. Lets see if that is really true! (film is significantly cheaper)

Aberrations in Holography

A few well-thought-out demos of astigmatism, coma, and spherical aberration in holography would help people grasp these concepts more easily. Any ideas for making these things come clear?

Signal and Noise in Holograms

The brightness and contrast of holographic images are not always easy to quantify, but a few simple experiments ought to reveal the basic dependencies on exposure and beam ratio that we have talked about in class.

Three-Color Theory

The reproduction of all colors by additions of three primary colors is central to the future of color holography. A few demos should clarify some of the problems of holographic color rendition. This will require using several different lasers, so be sure to check that they are available!

Cylindrical Holograms

The 360° view provided by a cylindrical "lampshade" hologram offers a variation on the formats we have been used to in this course. Includes all of the problems of dealing with holographic film, plus developing a novel exposure geometry.

Computer-Graphic Stereogram

Generate sequential perspective views of a simple computer graphic scene, with careful attention to geometrical scaling to make sure the image comes out in correct proportion. Uses a very simple optical process.

Reflection Holographic Stereogram

Extending the class labs by doing a transfer into an off-axis reflection hologram. Residual blur needs to be analyzed in terms of high-order aberrations.

Minimal Stereograms

Conventional two-step holographic stereograms involve a process that is so elaborate and time-consuming as to discourage the kind of interactive "try something else this time" approach that is so important to successful innovation. A much simpler one-step approach may be possible if the number of perspective views is held to a bare minimum, perhaps even two, as a way of "previsualizing" the outcome of the more elaborate procedure.

Holography with Diode Lasers

Improvements of diode lasers, with higher power further into the visible spectrum, may make He-Ne lasers obsolete! The coherence of these lasers is somewhat limited at the moment, but it is possible to make some impressive holograms with them nonetheless.

Hologram Interferometry

There are three classes of interferometry with holograms: 1) "live fringe" holograms, such as the coffee-cup demo, 2) double-exposure holograms, with some stress in between, and 3) continuous exposure holograms for repetitively moving objects. We need some interesting-looking demos of all of these!

Reflection/Transmission Holograms

It is possible to combine transmission and reflection holograms in a single plate so as to provide a 360° view of a scene (well, nearly).

Design of Holographic Optical Elements

Holograms can be used to replace many simple conventional optical elements and devices. This project would identify a few examples and make an initial try at one or two.

Reciprocity Failure in Holography

In principle, if the exposure of a hologram is divided into N equal incoherent parts, each sub-hologram's diffraction efficiency goes down as $1/n^2$. In practice, there is a strong effect of the ordering of the exposures, termed "reciprocity failure." These observations need to be verified for the materials and processes used here.

Serial Stacking

One way to build up a 3-D image from a series of cross sections is to array them in space via a series of multiple exposures. This project would explore the strengths and weaknesses of such a simple optical slice stacking method.

Pattern Recognition

A variation of a simple hologram can be used to "sift" a document for a key word, and produce bright spots corresponding to each location, a process called "matched filtering." This project would demonstrate this filtering over pages of text, and photographs containing enemy tanks.

Dichromated Gelatin Holograms

Take a break from the silver halide routine, and dabble in really arcane chemistry. Expose would-be desserts with deep blue lasers, rinse in hot rubbing alcohol, and behold peculiarly bright and clear 3-D images. Some chemistry experience needed.

Embossed Rainbow Holograms

Fool your friends and make phony credit cards at home by converting volume silver halide holograms to surface relief images that can be pressed into common plastics. Possibilities include: exposure of photoresist coated plates, and severe tanning development of silver halide emulsions. Images are reproduced by solvent casting of vinyl sheet.

Shadow-Grams

Interesting rainbow holograms can be created in a single optical step if the subjects are shadows of three dimensional objects. Shooting is quick enough to encourage experimentation. Refracting elements can be added to produce fascinating color modulations. The mathematics aren't as complex either.

One-Step Image-Plane Holograms

Large lenses and mirrors can be used to create "image plane" holograms in a one-step "holocamera," which makes image experimentation much easier. Control of distortions is important, so some optical exploring will also be needed.

Reduced Image Holography

Demagnifying the image of a subject brings a certain charm to the resulting hologram. Although this is most interesting for pulsed-laser portraits, the optics can also be explored with continuous-wave table-top holography. The main problem seems to be spherical aberration, which causes a strong "swinging" of the image.

Achromatic Imaging with Rainbow Holograms

It is interesting to try to make multi-color rainbow holograms, and possibly extending this approach to make "black and white" or achromatic images too.

The Demons of Holography

A collection of holograms vividly demonstrating the effects of everything that can go wrong about making a hologram: fringes on the object, fringes on the plate, scatter in the reference beam, uneven drying, higher order images, lots of halo noise, etc. The ultimate collection of **bad** holograms!

Adhesives & Object Holding Technologies

Record holograms (reflection and transmission) made of precarious objects mounted with a variety of adhesives. Is hot-glue adequate? Is Duco epoxy the superior brand?
