The "Omnigram" for Teaching Holography

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ABSTRACT

An "omnigram" is defined as a hologram which is both a transmission and a reflection hologram recorded at the same time on a single recording medium. Using silver halide emulsion, high quality omnigrams can be created by students at minimum cost. The total time from exposure to the completion of chemical processing is less than two minutes. Because of its simplicity and high yield, making an omnigram in front of a live audience at the beginning of a lecture-demonstration is possible. It can also be a home project performed on a kitchen counter or on a sandy beach at night, using the moon as "safe light". A diode laser operating at 660 nm with an output under 5 miliwatts is used with a modified chemical regime previously developed for student usage.

Keywords: educational holograms, home holography, beach holography, making holograms, teaching holography

1. INTRODUCTION

In recent years, it has been commonly accepted that if you were to teach holography to students, the initial attempts should focus on the Dnisyuk type of reflection holograms. The major justification is that reflection holograms can be viewed with an incandescent light. In contrast, if one were to make transmission holograms, they need to be of a white light illuminated "rainbow" variety, far too complex for beginners.

Times have changed. Diodes lasers now cost less than halogen lamps without the excessive heat. Furthermore, the image of a transmission hologram can be much bigger than the hologram itself. Using a green laser pointer, the real image from a transmission hologram can be projected onto a screen visible to an entire class of students. The virtual image, of course, can have resolution that exceeds human visual perception. Furthermore, transmission holograms have far more applications such as HOE's, multi-channel recording, free-space interconnects, etc.

Thus, the omnigram, which is both reflection and transmission, takes advantage on the best of both. Furthermore, our new chemical regime allows high quality results using mild chemicals that fully process the hologram in less than two minutes.

Our chemical processing regime applies specifically to the Slavich silver halide PFG-03M emulsion for both transmission and reflection holograms with enhanced sensitivity and minimum shrinkage. Furthermore, plates two to three years old, normally considered useless, can still yield high efficiency holograms. This unique combination of simple set up and quick processing allows a teacher to make a hologram as part of a lecture-demonstration in front of a large class.

2. FROM SIMPLE HOLOGRAPHY[1] TO OMNIGRAMS

The omnigram technique is entirely based on our previous publication[1] for making Denisyuk holograms with one crucial but simple modification for the chemical processing. Figure 1 shows the set up for making a classical Denisyuk type of reflection holograms using a Student Holokit[2]. It can be performed on a lecture table in school or a kitchen counter at home. The diode laser is held by a clothes pin held in a cup of sand or salt. The collimating lens is removed

Figure 1

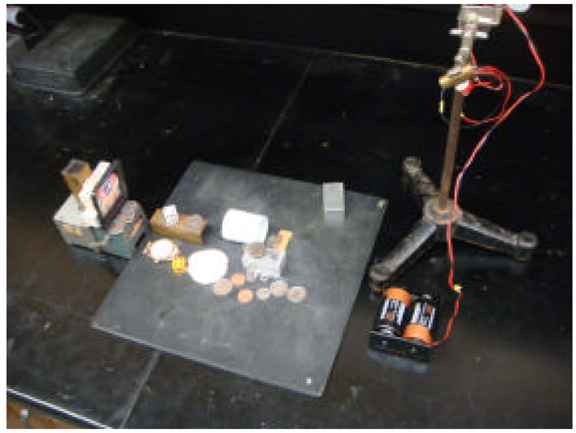

Figure 2

and the output spreads out without using any additional optics. The beam profile is that of an eccentric ellipse. When only a Densyuk hologram is to be recorded, the laser is rotated with the light spread out horizontally to avoid any reflection from the table top.

To record an omnigram, rotate the laser so that the beam spreads out vertically. As shown in Figure 2, an object is placed behind the location of the plate and flat objects are placed on the table top. The top of the spreading beam serves as the reference beam and illumination for the object behind the plate location, with the rest of the light illuminating the objects in front. Students can take time to design a scene ahead of lab time on a portable plate. A separately designed small object is place behind the plate.

An alternative to the above system is to make the omnigram on a sandbox or, as an adventure, on a calm beach at night using the moon as a "safe light." Figure 3 shows a "system" of ultimate simplicity.

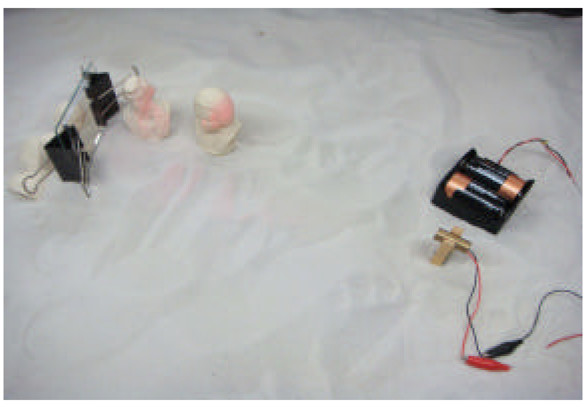

Figure 3

Figure 4

The most effective way of holding the plate is to sandwich it to a larger piece of glass using two steel paper clamps. The supporting plate should be on the laser side and the emulsion side of the recording plate should face down stream. The excess length of the support plate is stuck into the sand for a firm and stable support. The laser is held by a clothes pin stuck into the sand, and the elliptical profile of the spreading beam is turn so that the light fans out horizontally, illuminating object on both sides of the plate. The object located on the back side should be placed as closely to the emulsion side as possible, but not touching it. Assuming the laser is approximately 40 cm from the plate, the exposure time is 15 seconds.

Figure 4 shows a viewing stand we designed with a laser and holder for the finished hologram mounted to simulate the configuration during recording.

Figure 5

Figure 6

Figures 5 and 6 are photographs of the reflection and transmission images, respectively, recorded on the same plate as shown on the viewing stand.

3. PROCESSING

No safe light is necessary. Reduce the lighting in the room by any means available until only the headlines in a typical newspaper can be read. For beach holography, moonlight provides ideal lighting without exposing the red sensitive emulsion. The processing chemicals are from the JD-4 kit which is part of the Holokit, comes with all instructions. Table 1 shows the detail compositions.

Table 1 Processing Chemicals

<u>Developer</u>:

Part A (1000 ml)

Metol or Elon (p-Methylaminophenol sulfate)	4 grams
Ascorbic Acid (powder)	25 grams

Part B (1000 ml)

Sodium Carbonate, Anhydrous	70 grams
Sodium Hydroxide	15 grams

<u>Bleach: (1000 ml)</u>

Copper Sulfate, Pentahydrate	35 grams
Potassium Bromide	100 grams
Sodium Bisulfate, Monohydrate	5 grams

The most important innovation in the otherwise standard regime is the first step in the development – **a soaking of the plate in distilled water for 5 – 10 seconds!!!** All water and mixed chemicals must be at a temperature below 22^0C, colder is better, hotter is a disaster!

After an exposure of 15 seconds, hold the plate by it edges with its emulsion facing upwards throughout the processing. Never touch the emulsion at any time.

Processing procedure:

Submerge in cool distilled water	5 – 10 sec
Submerge plate in developer, with sideward agitation	10-15 sec
Agitate in running cool tap water or in a tray of clean water	15-20 sec
Submerge in bleach until cleared, no agitation needed	25-40 sec
Agitate in running cool tap water or in a tray of clean water	15-20 sec
Soak in Photoflo solution	15 sec

Keep the plate vertical on top of tissue paper to dry naturally, generally takes 30 minutes or longer

The dried hologram generally show little shrinkage, thus both the reflection and transmission images can be viewed by replacing the plate back to the location it was exposed.

4. CONCLUSION

Herein we describe a simple method along with a short procedure that allows us to make both a reflection and a transmission hologram at minimum cost. To use this procedure as part of a class, the hologram should be made near the beginning of the lecture. By the end of a typical class, the hologram will be dried and ready to be shown to the students. The most dramatic demonstration is to project the real image onto a screen using a green laser pointer, allowing the entire audience to see the real image. Point out the following fact: Assuming the real image projected has a minimum of a 100 x 100-bit resolution, or 10,000 bits of information, and the hologram is held at 30 cm from the screen, you are "downloading" from the hologram to the screen at the data transfer rate of over one terabyte per second! For dramatic effect, smash the hologram (first fold it inside a paper towel) with a hammer. Then pick up a piece and project a complete view of the recorded image onto the screen.

5. ACKNOWLEDEMENT

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6. REFERENCES

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2. All details can be found at www.holokits.com.