HOLOGRAPHIC PORTRAITURE OF HUMANS, PLANTS AND GHOSTS IN BELGIUM

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ABSTRACT
The author describes his efforts to bring holography ad its artistic applications out of the realm of mystery or curiosity. Three areas of the author's involvement are treated: first, how holographic portraits were successfully made in situ during a technology convention (it is believed that this was a world's first); second, how holograms of simple vegetal objects, viewable under normal lighting conditions, are being used to bring holography to a larger audience; finally, how collaboration between technicians and artists can lead to results that are satisfying and enriching for both parties.

RESUMEN
El autor describe sus esfuerzos para sacar la holografía y sus aplicaciones artísticas del mundo de lo misterioso, o de lo curioso. Se tratan tres áreas de su labor. Primero, como se lograron exitosamente los retratos holográficos en una convención de Tecnología (probablemente por primera vez en el mundo). Segundo, como los hologramas de objetos vegetales simples, visibles bajo la luz normal, se pueden usar para llevar la holografía a una audiencia mayor. Finalmente, como la colaboración entre técnicos y artistas puede conducir a productos altamente satisfactorios para ambas partes.

SOME HISTORY

Although the most productive manufacturer of holographic silver halide materials was based in the beginning in Belgium, nothing very spectacular happened in this country in the field of holography since its inception over 50 years ago apart from stopping the production around 1975, due to commercial considerations. Coming from a scientific background, I began making holograms in 1966; using holography mainly for technical applications, such as non-destructive testing and displacement measurements. I began to feel increasingly disappointed after working in the medium for a decade, because so few people knew about holography and what it could do, and because many ignored holography completely. As a scientist I have learned to be logical, and it seemed logical to me to do something about this situation. So I organised exhibitions and gave lectures, thinking that bringing holography out of the laboratory would suffice to provide the needed impetus. A couple of years and a number of exhibitions later, I had to admit that, although some improvement could be noted, a large portion of the population was still unaware of the existence of holography and its applications. I decided that more spectacular things would have to be done before people really noticed, and I realized that the continuous presence of holograms in normal life would also be of much interest. When things cease to be a mystery, they become common; people are not only more critical about common things, but also notice them more.

At about that time, rainbow holograms became familiar to the general public by their appearance on credit cards and in magazines.

As proud as holographers were to see these images gain worldwide recognition, it needs to be said that their image quality falls somewhat short of our hopes. Because of their mirrorized nature, the stickers reflect a great deal of background light into the image, making it sometimes difficult to see; thus the subject matter must be easily identifiable. The practical necessity that the hologram be visible in any light severely restricts the depth that can be used. Thus the design of images for these holograms has its own special set of aesthetics and the creation of these holograms presents its own technical challenges. I therefore decided that it would be more logical to work with reflection holograms (as they are more simple to reconstruct properly) and not in the second-generation mode but in the direct one-step Denisyuk mode, for reasons that will be explained shortly.

Although I did not intentionally develop a particular strategy, my work seemed to follow a natural sequence of public appearances in the year 1987 in Belgium. My portrait holography was shown during a technology fair; I collaborated with two artists on specific topics; and my project called *Herbarium Holographicum* was begun (this should continue for some time).

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THE DENISYUK RECORDING SETUP

The in-line reflection recording scheme named after Denisyuk (1) is by far the simplest of the holographic schemes. It can be used for metrological and interferometrical purposes (in a piggyback setup (2-5) and for single-shot display applications. Apart from its simplicity, this setup where laser, sensitive material and object are almost in-line, is also very economical with light. The available energy is effectively used twice, and the viewing angle at reconstruction is very large, approaching 180/ when the object is close to the hologram plane. Moreover, the distortions introduced are minimal; they are due to slope variations in the recording material (which are small if the relative humidity is between 40 % and 60 %) and to color discrepancies between reconstruction and recording. Normally, records are made with a ruby laser (λ = 694,3 nm) or a helium-neon laser (λ = 632,8 nm), while reconstruction is optimised (by processing) between 580 nm and 550 nm, which is optimum in respect to human eye sensitivity.

The main drawbacks of this recording setup are the extreme requirements that must be met by the sensitive materials and by its processing, and the fact that the ratio of object to reference beam intensity can be altered only by treating the object surface (e.g. by painting it). A variation on this technique will be presented later.

The lack of constraints in the building stage of this type of setup allows one to exercise all one's creativity without having to think about lenses and mirrors; on the other hand, from the artistic viewpoint, each recording is an original one. No copies are made, and each record can be signed as "orig".

PROCESSING

Phenomena involved in the processing of silver halide holograms still are not fully understood. Most holographers use photographic developers, and almost everyone has a favorite developer, chosen as a result of experience, with consideration for the temperature and humidity of a specific darkroom. True holographic developers, based on a well-considered hypothesis of holographic image formation, are not available. Probably there are some scientists who have much knowledge of this subject, but little information is given free, probably because of commercial interests.

The quality of holograms is generally described in terms of the diffraction efficiency, the signal-to-noise ratio, and resolution (6). But subjective factors also play an important role in the judgment of the result: color acceptability by the viewer, acceptability of small defects, optimal amount of light, contrast renditon, etc. At the moment, there is no measuring standard; our experience is that viewers prefer wavelengths between 580 nm (a yellowish orange) and 530 nm (a not-so-yellowish green), the peak of the Gaussian distribution lying around 560 nm. Upon first viewing, the amount of light (the brightness of the image) is very important, but when people become accustomed to holograms, they pay more attention to contrast and resolution; a heavily reflecting background or flare (noise) is then perceived as a defect (7).

MAKING PORTRAITS AT A TECHNOLOGY FAIR

The first of my projects to bring holography to a large audience in Belgium was based upon an old idea, that of making holographic snapshots. These were feasible in principle, because the beam quality of ruby pulsed lasers reached a sufficiently high level. The Flanders Technology Fait was held from 10-16 May 1987 in new premises, and the first help came from the organisers, who gave me free use of an exhibition space, the stand itself, the photographic material and three engineers were put at my disposal by a Belgian manufacturer. In the small space available, I managed to build two darkrooms, one finishing room, one light-lock chamber and one general purpose area, where I explained the procedure to visitors and interested people. The subjects were illuminated by a strongly diverging beam (Figure 1); they were asked to focus on a green mercury vapor lamp placed about 0.5 m

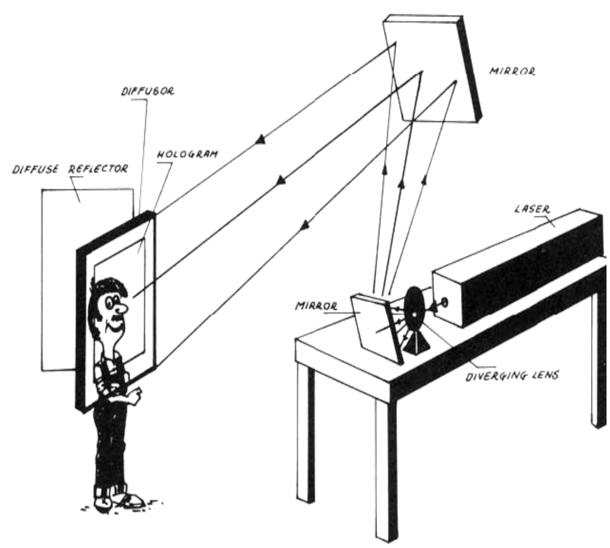

Figure 1. Setup used for marking portraits. A diffusor with a small scatter angle is introduced between the hologram and the subject.

away and about 30 cm out of the optical axis - this to avoid in the image the large pupil diameters that give a waxy look. An additional very weak diffusor was introduced between subject and hologram, for safety; it had a scatter angle smaller than the angle subtended by the reconstruction source but larger than the minimum angle that should be subtended by a laser source for accepting that source as broad (8). Some lateral diffuse reflectors completed the setup. The laser used was a ruby laser (9) giving an energy of 1 Joule per pulse in 25 ns at a wavelength of 694 nm. The coherence length was certified to be at least 1 m but generally was longer.

One of the main problems I encountered was dust. The stand was made out of plaster plates nailed to a wooden framework; it had been painted, but unprofessionally. Lenses and mirrors had to be cleaned before each recording. Processing was done by hand, as the temperature rose from about 17/C in the early morning to about 28/C at the end of the day. The diffraction efficiency seemed to be related to the density of the film after development, although these are basically quite different physical phenomena; the optimum lay around D = 2.3. In this case, the reconstruction wavelength was about 550 nm; it was generally shifted to pink during the final drying operation, which was carried out by a mechanical drier, the tank being filled with a solution of 5 g sorbitol per liter of distilled water. Backing was done by sticking a black plastic foil to the emulsion side with a professional laminator.

During the 6 days of the fair, approximately 120 portraits were taken; the mean duration of a full cycle (from recording to development to finishing and framing) was about 20 minutes with a crew of four; the shortest time was 12 minutes. It is not yet a Polaroidtype of instant holography, but I hope I have made a good step in the right direction; at least I showed that holography can be done in relatively harsh circumstances and at acceptable speed.

HERBARIUM HOLOGRAPHICUM

Almost nobody -not even the most enthusiastic hologram fanatic- has a hologram hung in the living room. Hologram exhibitions attract thousands of visitors, holography is a good conversation item and one finds rainbow stickers on magazines every month; but almost inevitably even a good reflection hologram ends its life in a drawer because few people like to see the black square hole on the wall when the hologram is not illuminated by a suitable halogen source. I therefore looked for a solution to this problem, trying to use relatively simple objects that would allow for reconstruction by ambient light; the objects needed to be recognizable by everybody and also pleasant to the eye, occasionally even beautiful.

I found that leaves of some trees and plants were very hologenic; so I started to make small numbered series of vegetal images. Those limited editions are marked HH for Herbarium Holographicum (10), followed by a series number and the total number of holograms shot from that subject. The Latin name of the plant and my signature complete the caption. At least one more authenticity clue is encoded in the holograms; details of that will only be given free after my death. The series are small (containing typically between 10 and 40 holograms), because the recording has to be made soon after harvesting the vegetal materials. As shown in Figure 2, such a hologram can be reconstructed with normal light; of course, the fine details and the deeper parts of the scene need a point-source type of reconstruction light.

Figure 2. *llll ll 6/20 Ficus carica,* hologram, triacetate-based emulsion, 30 × 40 cm, 1988. Hologram of a leaf of a fig tree, reconstructed with neon-tube lighting.

As the objects involved in this project are rather small and stable, a much simpler setup using small continuous wave lasers can be used, provided one can eliminate movement between subject and hologram; in most cases, this also means avoiding the transfer of vibrations to the setup. As as example, Figure 3 shows the recording of such a hologram in the fifteenth-century vaulted brick cellar of my former country house. Typical exposure times on 8E75 film are 5 to 10 seconds with a small HeNe laser; as shown, the whole setup can be built on the floor.

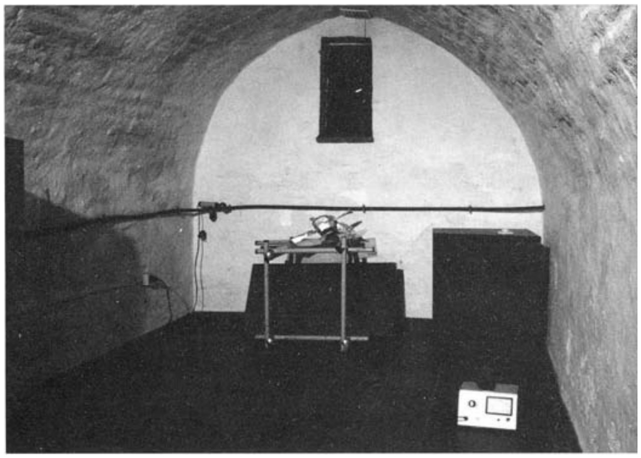

Figure 3. Practical setup for recording holograms of stable objects. The objects rest on the emulsion, which is supported by a Frame. The mirror reflects the light of the laser (not visible in the figure, as it is behind the camera used to photograp the scene) upwards: laser and frame are on the floor, as it is only the position of the hologram relative to the object that has to remain constant.

COLLABORATION WITH THE ARTISTIC COMMUNITY

A number of artists are interested in finding technical help for realizing some of their basic ideas with holography. I have collaborated with Julien De Groeve. This artist has a classical academic background and has been producing and exhibiting paintings and lithographs regularly since 1965. At one point, however, he felt increasingly disappointed about not being able to bring the third dimension to the public in these works, and he stopped production around 1980. We were brought into contact by a common acquaintance, talked a lot about the potential of holography; and began our collaboration early in 1984. It was only after 2 years of experiments that we produced our first really satisfying results, but the cooperation and especially the crossfertilisation taught us a lot.

Generally, De Groeve first produces a mixed-media sculpture, to ethereal and to fragile to last or even to be shown for long; this is called a morphogram. This piece is never shown to the public. A series of Denisyuk holograms is taken of the morphogram, which is then destroyed. In this way, the circle of illusion is complete. De Groeve claims that he sees his creatures (he calls them ghosts) even when he is sober. I make the holograms in a one-way Denisyuk fashion, so that the only tangible clue of the existence of these creatures is given by the resulting recording. Even the color is synthetic; most of the objects are silvered before recording. An example of this collaboration is shown in Figure 4.

Figure 4. Hologram of *Creature of Rigel*, triacetate based photographic emulsion, 30 × 40 cm, 1987. The mixed-media object (morphogram) was made by Julien De Groeve specifically for recording holograms of it.

DISCUSSION AND CONCLUSIONS

Denisyuk reflection holograms produced in the setup described reconstruct in bright colors, have large viewing angles, and few if any cosmetic defects. I have tried (a) to interest people in holography by making holograms of a subject they are interested in; (b) to demystify and debanalise holograhy by presenting an everyday object in an almost natural fashion, showing that such things can be pleasant to the eye and even beautiful;(c) to collaborate with interested artists in such a way that both parties are enriched by the experiment and satisfied with the result.

Although doing all this is a lot of fun, not least because of the people one learns to know, I will probably return to my old love, the purely mechanical applications of holography, once a generation is persuaded that holography not only exists but also can be of practical importance. But before this goal is achieved, a lot of work remains to be done. Even if the goal is achieved, I hope than the fruitful discussions and the cross-fertilisation of different approaches by various holography users will continue; it certainly was, probaly is and I hope will be one of the lasting bridges between science and art, I believe that this will be true even when holography will have turned-like electricity, the telephone, radio and television-from a technical curiosity to an irreplaceable part of daily life.

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7. At present I use Metol ascorbid acid superadditive developer. Ascorbic acid as a developing agent was first studied by Kendall (1935); it was brought to my attention by J. Gutjahr of the Photographische Faschhochschule Köln, Germany. See also the MAA3 developer of Benton. I use baths of very simple formulation (see L. Joly and R. Van Hoorebeeck, “Development Effects in White Light Reflection Holography”, Photographic Science and Engineering 24, 1980, pp. 108-113, and a Kodak R9 type ofbleach (see Kodak Plates and Films for Scientific Photography (Eastman Kodak, 1973, pp. 17-23). This has the advantage that acceptable quality is produced consistently; other developments schemes involving very rapid developers and/or rehalogenating bleaches can give better results in terms of diffraction efficiency but normally are accompanied by a higher flare and are also more prone to variations in result because of intrabatch differences in the emulsions and/or the age of the material.

8. SLIMEY, D. and M. WOLBARSHT (1980): “Safety with Lasers and Other Optical Sources”, New York : Plenum Press, 261 ff. see figs 8-10 in this book.

9. An HLS2-Ruby Laser made by Lumonics (formerly JK Lasers).

10. The name Herbarium Holographicum and the initials HH are registered.