DIDACTICAL HOLOGRAPHIC EXHIBIT INCLUDING HoloTV (HOLOGRAPHIC TELEVISION)

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Abstract: Our Institute of Physics exposes since 1980 didactical exhibitions of holography in Brazil where nice holograms are shown altogether with basic experiments of geometric and wave optics. This experiments lead to the understanding of the phenomenon of images of an ample way. Thousands of people have been present at them, in their majority of the Universidade Estadual de Campinas, where since 2002 they have taken the format of a course without formal evaluation. This way the exhibition has been divided in four modules, in each one of them are shown different holograms, experiments of optics and applications of diffractive images with white light developed in the Institute of Physics. The sequence of the learning through the modules begins with the geometric optics, later we explain the wave optics and finally holography. The phenomenon of the diffraction in daily elements is shown experimentally from the beginning. As well as the application of the holographic screens in white light: the television images that appear in front of the screen and the spectator can try to experience the reality illusion. Put something so exclusive (that only exists in the laboratory) to the public is a way to approximate the persons to an investigation in course. The vision of images that seem to be of holograms, but in movement, and size of until a square meter completes this exhibition of an exclusive way in the world.

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DESCRIPTION

An exhibition of holograph performed with foreign material in São Paulo in 1980 motivated us to perform the first exhibitions of holography with brazilian material. These were helpful to better understand the relationship of the public with holograms, comparing it with our own way of interpreting them. While the person who did not know the theme was deeply intrigued and they wanted to discover the relationship between an object and its perfect image, we discovered that ourselves, even knowing the physical process also receive images through our unconscious, which assign a worth of reality greater than that we give to a photograph, for example. Children (and adults, too) looked behind the hologram trying to find the object or device that would allow the understand of the image (Fig.1).

Fig.1: Children observing a hologram in 1981. One of the children search behind the hologram for an object.

The Fig 2 shows a young person moving an object, that intentionally we placed next to its holographic image.

Fig.2: (year 1981) a visitor tests with curiosity the relation of an object with its hologram.

The four modules of our current course [1] are free and have the duration of two hours. The first module shows originally a single hologram, in colors and with movements, because we want to give the visitor an overview of the topic of the course, because most of people of today do not know what is a hologram bigger than a stamp of credit card. The audiovisual projection in the module defines image and refers to the oldest images made by the man, made using tools, such as the Olmec mirrors. The action of a lens illuminated by a cone of laser light [2] is shown, as well as the image with white light, emphasizing the fact that the image has its longitudinal position clear, or that it is three-dimensional. Adding that because the vision is more often monocular, or because the screens, photographic film or sensors are flat, the image has the idea of a flat image, an idea that was reinforced by the early explanations of Newton about lens. A series of stereoscopic projections, with its 3D glasses, is shown. This way the public observes what is the real three-dimensionality of an image. It explains why, in our view, holography is a technique that is declining rather than join the popular use: by the lack of market or consumers who buy their products. The holograms of Prof. Lunazzi are rarities which the mostly can not be purchased, and they are deteriorating because of the emergence of fungus, typical of tropical and humid climate.

Forward we show refraction experiments using a parallel face plate made of glass illuminated by a beam from a lamp that passes through multiple slits. After we employ a simple lens using the rays of the same lamp and then two separate lengthwise small lamps [2], a photographic camera. We also use a pinhole camera, a digital disc to work with diffraction and a didactic holographic diffraction grating.

We continue with experiments of reflection: we show hematite polished stones, and stones of pyrite to illustrate pre-Colombian mirrors. Using the light of a lamp after is passes through multiple slits we show the effect of a plane mirror and compare to the effect done by a large spherical mirror, a rare piece obtained casually by means of the broken parts of an experiment. The enlarged picture of the face of a person is impressive in this mirror. We also put a filament lamp with a mirrored half sphere that displays a realistic image, convergent, with 360º of horizontal field of view, the closest thing we find to a hologram household item. We show six different holograms of good size (30 cm x 40 cm and higher) including a portrait made with ruby laser.

Further we show the application of our work with elaborated diffractive images with white light developed at the Institute of Physics: HoloTelevision.

HoloTV

It is the projection on a holographic screen [3] by means of white light coded diffraction of a scene of conventional TV, made with a black background. The technique we invented [4], [5], [6], allows volumetric images generated from computer models made by dividing the volume of oblique image in planes, and each plane is projected in front of the screen. To reach the television system we limited to the use of a single plane [7]. A traversing oblique plane has a perfect representation in the holoprojection with continuous parallax; the plane could be about 50 cm in front of the screen. To record a scene we must put a subject in a way that is isolated with few objects ahead and behind, that correspond to the traversing oblique plane determined. The television images stand out of the screen and the viewer can try to touch the image, finding a fake and illusionary reality. In cases in which a video camera is placed in front of the observer, he observes himself on the screen as if there were a mirror before that, and magically, it makes the image to the outside (Fig.3).

At figure 3, an observer watches his own image in front of the screen.

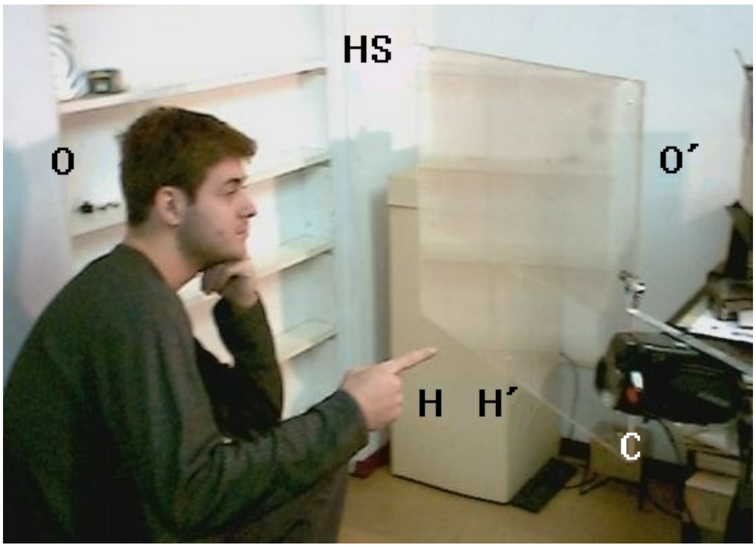

Fig.3 The observer **O** watches his own image (**H'** is the finger's image and **O'** is the image of the head). **H'** is in front of the screen (**HS**) and **O'** is behind of the screen. **C** is the camera that takes the observer's image.

Figures that appear in motion, even with artificial monochrome color, show that there is in the university a way to put the third dimension on television.

The second module explains the behavior of the waves and shows experiments of diffraction and interference. Starting the speech a demonstration on waves is performed by projecting a water tank as a transparency. It is a well known experiment to demonstrate reflection and diffraction were the surface of the water is made to vibrate by means of a small motor. In another experiment, we show the colors by interference using soap filmes, in the usual way of bubbles and also extended over a dark background to show fringes. Interference and diffraction in nature is shown by mean of butterfly flies and beetles. A video is shown describing how a hologram is made. It is a version of the production “Introduction to Holography” made by Tung Jeong in the sixties for the British Encyclopedia whose speech was adapted and translated to Spanish and Portuguese. The making of white light holograms was removed from the film to be presented at the third module.

Experimentally, we show :

- The diffraction of light from a filament lamp seen through a slit made of a razor blade.
- The diffraction of light from a fluorescent lamp seen through a compact disc which generates thin spectral lines.
- Interference from and extended fluorescent tube at grazing incidence in the air film between two sandwiched glass plates.

– A didactical Mishelson interferometer, with diode laser and common glass.

To show the photographic process primarily, the shape of an object is photographed as a simple shadow, supporting it on photographic paper with just the illumination of a filament bulb. The revelation was made at the same table, in front of an audience using red light security.

We show a new set of six different holograms, including the tomography of a head converted into a hologram, and holograms by double exposure with two distinct scenes and exclusivity of our invention: Holoprojector by a horizontal lens [8], [9]. It is an apparatus using the properties of a diffractive ("holographic") screen to reproduce complete three-dimensional images ("holoimages"). Two ways of codifying a continuous sequence of views of a scene to be projected on the screen where developed and in these page we are showing the one that employs the spatial distribution of view points which is naturally projected in any projector lens. The holoprojector is like a slide projector but, due to the developed technique it functions as a perfect three-dimensional projector projecting not photographs but objects itself. The Figure 4 shows the apparatus:

Fig.4: Holoprojector and screen, with size reference to a pen.

The third module describes the focusing properties of a hologram and discusses the case of diffractive lenses, including those that may be performed with holography. The hologram is presented in its simple way of reproducing a light ray, such as by placing as object a small beam which meets a reference beam generating periodic structures that when we develop the film, the interference generated diffraction gratings can be seen. We describe the didactical equipment to be used to make a hologram and we comment the holograms to be seen with white light by Denisyuk's and Benton's techniques. We describe our own techniques by detailing the operation scheme of the spectral coding that allows holograms to be enlarged and the HoloTV principle. We show enlarged holograms and the holoprojection of objects in a screen a meter square large. Figure 5 shows the stereoscopic picture of the expansion of a hologram in the format of 35 mm and seen in a screen of a square meter. From left to right we have the left view, then right, then left view again. This allows that the first two pictures can mount a stereoscopic pair with naked eye, fusing the images by parallel vision, and using the last two pictures by crusade vision.

Fig. 5: Stereoscopic photo of an observer in front of a amplified hologram. Height of the screen: 1.1 m.

We record a small hologram to be seen with the same 5 mW diode laser we use to record together with the public. Green security light illuminates the dark ambience in that case. It works on a common table because the environment has no vibrations. Once ready, the hologram is shown in its normal reconstruction way and also generating a projected image using a narrow beam with opposite illumination.

The fourth module shows audiovisual pictures of artistic holograms, especially the works of professor Lunazzi and his students. Figures 6 and 7 show examples.

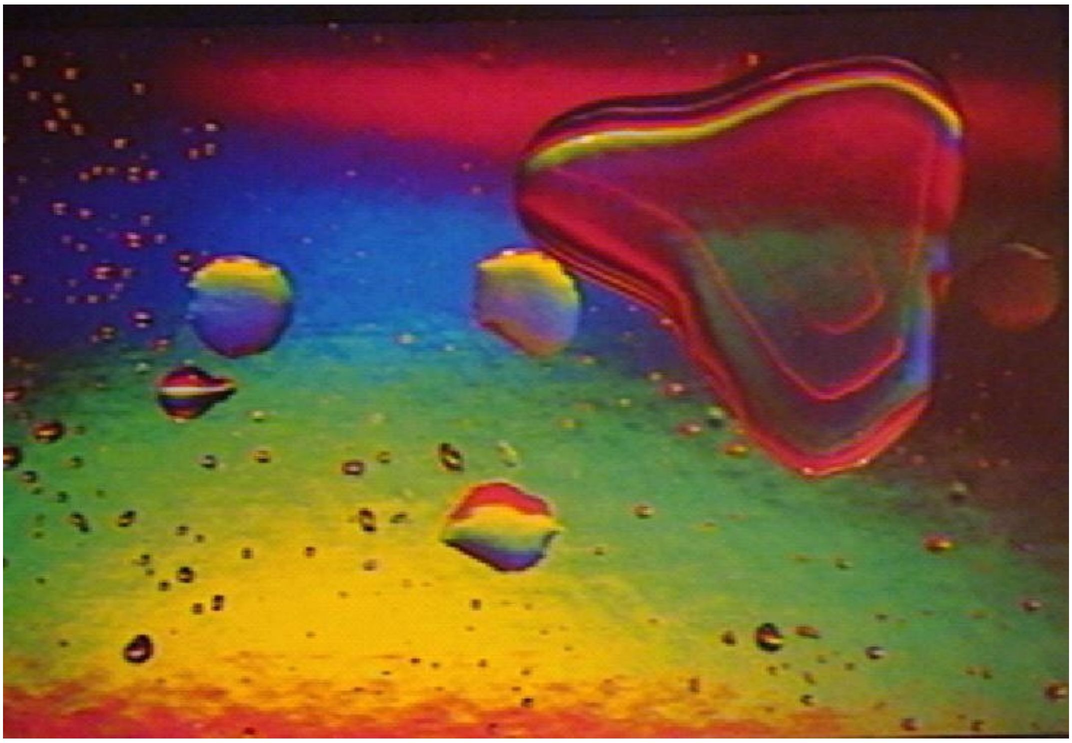

Fig. 6: Work of Photographic Spectral Art, J.J. Lunazzi, year 1.985.

Fig. 7: Work of engraving converted photographically to be holoprojected. The projection appears more than 50 cm in front of the screen. Paola Azevedo, year 2.007

The fourth module also shows the double diffraction situation and describes the experiments that will be displayed and which are the result of our latest research. At the end, the issue remains opened to questions that the public wants to do, ranging from commercial holograph to the mechanics of metrology. The questions that were not already answered by students or assistants in the previous modules can be done personally to the Professor Lunazzi.

The experiments we show consist in works of holographic art based in various techniques and of images where two imported common holographic diffraction gratings cost approximately one dollar each one. The sequence leads to a set of two digital audio discs (commonly called "CD") generating a similar type of image but it is reversed[11]. We show as well as with common elements can be used in research.

Conclusions

Put together elements of everyday life, simple experiments and other novel and surprising elements is unique because, although holograms are known in many parts of the world, holoprojected images are not. It can be considered a very sophisticated demonstration, but it is how we conceive work at the University of La Plata at the beginning of my career when working with Dr. Mario Garavaglia and follows the spirit of the events that UNICAMP develops to open its doors once a year to public schools. The exhibition includes the idea of democracy and the ideals of the reform movement called “University Reform” towards making a less elitist university. Trying to explain what is hard to understand, answering questions without preconceived ideas and using the simplest terms always leads us to increase our understanding of the conceptual idea. The vision of images that are the closest of which the popular imagination conceived as holograms, usually those in the "Star War" movie, brings the public to the real world.

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