ÓPTICA

Anais do XV Encontro Nacional de Física da Matéria Condensada

Caxambu - MG - 5 a 9 de Maio, 1992

Resumos extendidos
Grupo de óptica

Editado por

Hugo L. Fragnito
UNICAMP - IFGW

THE CAPABILITY OF HOLOGRAPHIC SCREENS TO DISPLAY CONTINUOUS PARALLAX

Jose J. Lunazzi- UNICAMP - Institute of Physics

1. Introduction

Holographic screens has been used in the past as directional screens for many applications (1)(2), or even as bidirectional screens (3). Its possibilities of being used for the continuous case of displaying the horizontal parallax was first indicated by us (4) as a complementary process for the chromatic encoding that happens when objects are viewed through diffraction gratings. This process renders a one to one relationship between each encoded view from the object and a wavelength value. To the continuous sequence of wavelengths values corresponds then a continuous sequence of views directed to the projecting lens, from where they are superposed onto the screen. If the screen would be a simple diffraction grating, the result corresponds to the previously reported case of double diffraction (5), giving a real pseudoscopic image and an orthoscopic virtual image, at each lateral side of the screen. Fig.1 is a very simple description of ray paths for the first imaging case, based in point symmetry.

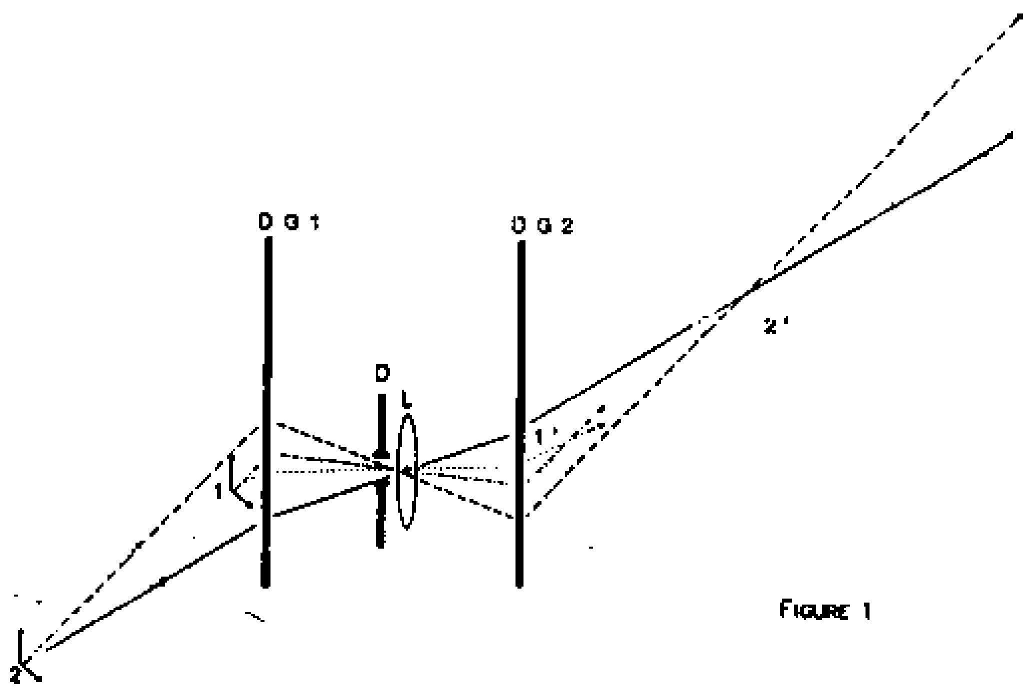


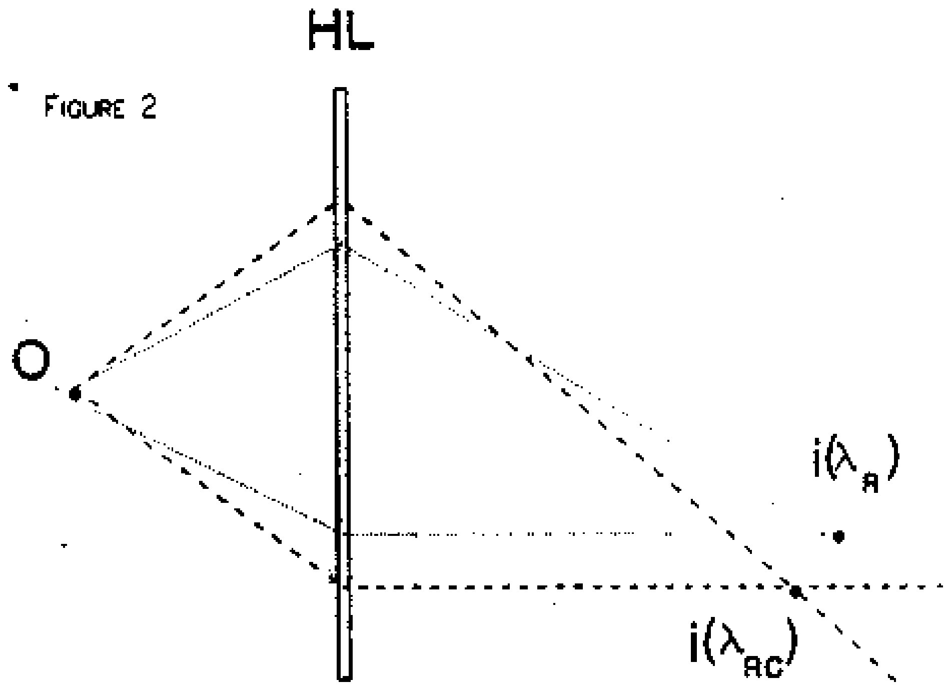
FIGURE 1

In this figure two diffraction gratings DG1 and DG2 are symmetrically located to the lens L. Light of different wavelengths creates then the image points 1' and 2' which are perfectly symmetric to the point objects 1 and 2 if the effect of diafragm D is not considered.
It is not so evident the situation for the second imaging case. Since the latter is which really matters for visual observation, we will explain it in terms of views and location of points of view, for the case of a holographic screen.

2. A holographic lens acting as a screen.

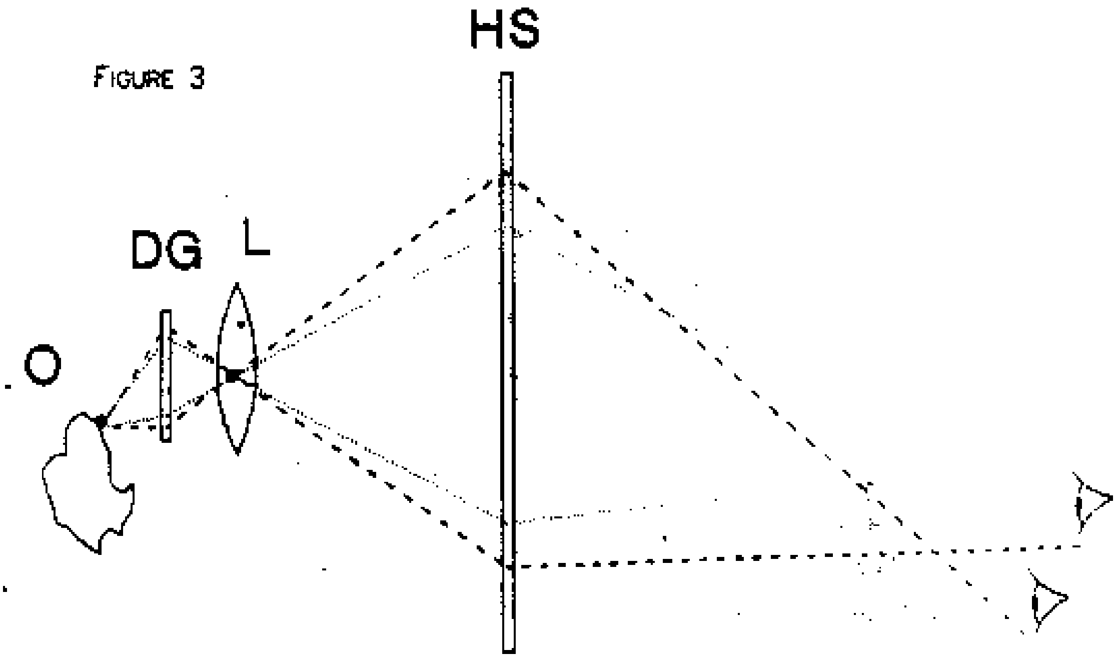
When a diverging beam originates at the point O where the reference beam was located for making the lens, a diffracted beam is obtained that converges to the point $i(\lambda_R)$, which is the position that the converging object wave had when making the lens (Fig.2).

FIGURE 2



We assume for the moment to have the same wavelength λ_R for reconstructing and registering the holographic lens. If we project an image on the screen from an objective whose optical center is located at point O, and by assuming the approximation that the aperture of the lens is very small, it can soon be concluded that the image at the screen has the unique point of view i(λR). If the projected image has a wavelength λRc , the point of view will be laterally and longitudinally displaced, but it will be close to i(λR) as far as both wavelengths have close figures. If, as a first aproximation, we do neglect the influence of the longitudinal displacement, we may say that if a continuous sequence of views is projected codified by diffraction, a continuous sequence of points of view will be allowed within a certain arc around the screen (Fig. 3).

FIGURE 3



If the period of the codifyng grating coincides with the period at the center of the holographic screen we may look around the screen as if we were looking around the object, just noting a change in color at each different horizontal position. This result merits further analysis but clearly allows for obtaining holographic-like images (holoimages) using white-light illumination of objects or holograms, including the enlarging factor of the lens as an aditional useful advantage. In a second approach, we may add that fact that the distribution of images at the first diffraction step, when imaged by the projecting lens, gives a focusing change that tends to equalize the distance from the observation points to the screen.

3. The observed image is not focused at the screen.

In the projection of stereo pairs we focus our eyes at the screen, while we see the 3D image far from the screen plane. It may be argued that it should be the same for our continuous case, differentiating our images from the holographic ones. A more detailed analysis reveals that we really focus the image were it is seen, so that if, f.ex., we see an image in front of the screen, this is a real image and may be focused on a white piece of paper at its position.

Visual observation of the pseudoscopic image shows that it keeps its proportions after enlargement, and that it can be seen on the other side of the screen as a complementary diffraction order.

4. Experimental details.

A holographic screen of 30cm x 40cm was made on AGFA 8E75 holographic film, with the main angle between object and reference beams being 45 degrees. A white object, 4cm high, 2cm wide and 1,5cm deep was first imaged through a holographic diffraction grating of period 1,5 micrometers. The objective had f = 50mm , f# = 1,8 values. Intense light from an halogeneous lamp was concentrated on the object obtaining at a distance of a few millimeters after the grating an inverted image 3cm high. The first diffraction order was projected by means of a second objective of f = 135mm , f# = 2,5 values onto the holographic screen at a 2m distance, giving a phantasmagorical real image 25cm high appearing at 20cm in front of the screen, resembling a holographic image. The lateral degree of continuous parallax was 15cm at a 1,5 distance from the observer to the screen.

5. References

1) US Patent 4,500,163 ,Feb.19, 1985.
2) US Patent 4,372,639 ,Feb.8, 1983.
3) Courjon D., Bainier, C., App.Opt. V21 N21, p.3804/5, Nov.1982.
4) Lunazzi, J.J., Opt.Eng. V29 N1 p.15-18, 1990.
5) Lunazzi,J., Anais do XIV ENFMC, Caxambu-MG-Br., p.1-6 5a OTI, 1991.

6. Acknowledgements:

Finantial contributions from the following institutions are acknowledged: CNPq , FAPESP, FAEP-UNICAMP.