研 究 速 報

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HOLOGRAPHIC OPTICAL SECTIONING FOR INFORMATION REDUCTION OF THREE-DIMENSIONAL IMAGE

三次元像の情報削減を目的とした断層ホロググラフィ

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A new information-reduction scheme of the three-dimensional image by using a holographic optical sectioning technique is proposed and demonstrated by utilizing the optical picosecond pulse by a mode-locked SHG YAG laser.

R.H. Johnson *et al.*[2] reported the holographic optical sectioning by using the mode-locked ruby laser, and M.E. Fourney *et al.*[3] reported the similar results by using the Nd-glass laser. Since they used the single-pulse laser, these methods cannot be applied directly to the transmission of the three-dimensional television. Recently, W. Schmidt *et al.*[4] reported the holographic contour mapping using a dye laser.

In this report, the mode-locked pulse from the continuous YAG laser is used, and the hologram is taken by the SHG laser pulse. This hologram is generated only where the signal and reference pulse coincides on the plate. So the scanning of the image in depth is realized by changing the optical path difference of the reference and illuminating light. This YAG laser is mode-locked and the second harmonic is internally generated at 5300 Å by the same $LiNbO_3$ crystal. The obtained pulse width measured by the interferometric method is about 30 ps, the resolution in depth is about 1 cm. The holographic plate is Scientia 10E56 of AGFA, which has a sensitivity peak at 5600 Å. The object is illuminated by the mode-locked pulse light, the optical path length of which is scanned by the pairs of corner mirror (Fig. 1). The hologram of the sectioned part of the object (Fig. 2) is recorded. So the object is succeedingly decomposed into optically sectioned holograms which are eleven in this experiment. The reconstructed images of which are shown in Fig. 3. In the proposed three-dimensional television system, these sectioned holograms are reconstructed on a scanning screen, the images are transmitted sequentially by the conventional picture tube, and they dis-

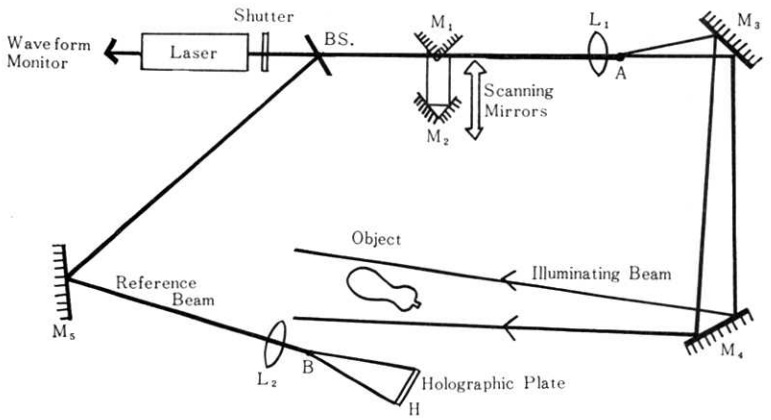

Fig. 1 Experimental set-up for the optically sectioned holography

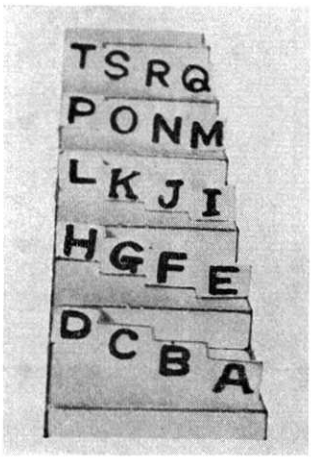

Fig. 2 The original object

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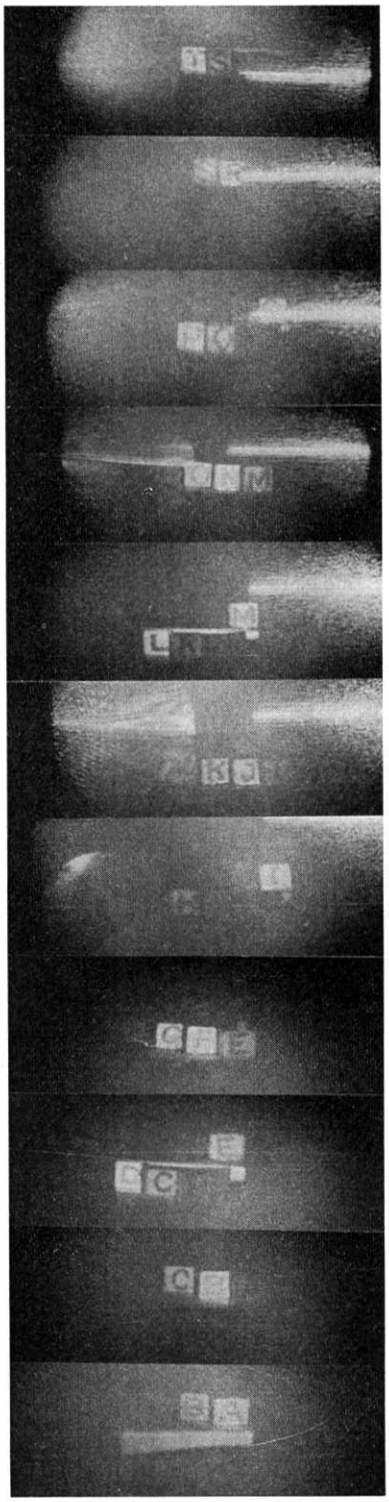

Fig. 3 Reconstruction of the original object which is optically sectioned in depth into eleven parts

played by the varifocal mirror. An example of the recomposed image from the four sectioned holograms is shown in Fig. 4.

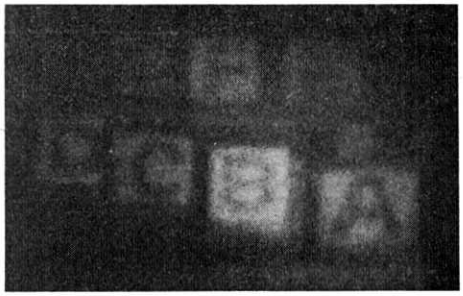

Fig. 4 The restored object from the four optically sectioned objects recorded in the transparencies which are reconstructed from the hologram

In the reconstructed image, the discontinuity between the two sectioned images occurs. The discontinuity Δt is determined by the viewing zone Ψ and the resolution in depth Δl:

$$\Delta t = \Psi \Delta l / 2 \qquad (2)$$

If the discontinuity is admissible within a constant $m \times$ transversal resolution $\Delta d/2$, Ψ is given:

$$\Psi = md / \Delta l N d \qquad (2)$$

where d is the width of the object, $Nd = d/\Delta d$. The total information in the image is given:

$$P = l \Psi N d^3 / md \qquad (3)$$

Burckhardt[1] obtained for the sampled hologram

$$P_B = 8 l^2 / d^2 \Psi 2 N d^4 \qquad (4)$$

For numerical example, if the object in this experiment is transmitted in the three-dimensional television at 30 frames per second, the necessary bandwidth is 12 GHz for the conventional holography, 1 GHz for the sampled holography, and 48 MHz for the optically sectioned holography.

In conclusion, the optically sectioned hologram is one of the promising techniques to realize the 3-D TV.

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