

## ON CHIAO TUNG UNIVERSITY'S LASER HOLOGRAPHIC SYSTEMS

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**Abstract**—The first laser holographic system in our country has been set up at the National Chiao Tung University. The main objective of this research notes is two folds: one is to show that we are able to make all kinds of holograms such as Leith-Upatniek hologram<sup>1,2</sup> and volumu hologram<sup>3</sup> only by means of a simple set-up. The other is to present some technique information which could not be easily found in the journals. It can be sure that this information would be very useful to the people who are interested in engaging in works of this field.

The invention<sup>4</sup> of the wavefront-reconstruction process by Dennis Gabor in 1947 has led to a growing number of applications of holography. The most significant applications<sup>5</sup> are in the aspects of microscopy, interferometry, data storage, coherent optical data processing, super-resolution for synthetic aperture radar, vibration analysis, contour generation etc. Hopefully, all these experiments could be carried out in our laboratory in the near future.

The purpose of the experiments we did in November and December, 1973, is to obtain some useful data for future reference. The first hologram we obtained is the Leith-Upatniek hologram. The experimental set-up is shown in Figure 1. The 15 mw cw He-Ne laser and all optical components are the products of Jodon Engineering Associates, Inc. The holographic films are Kodak 649F spectroscopic

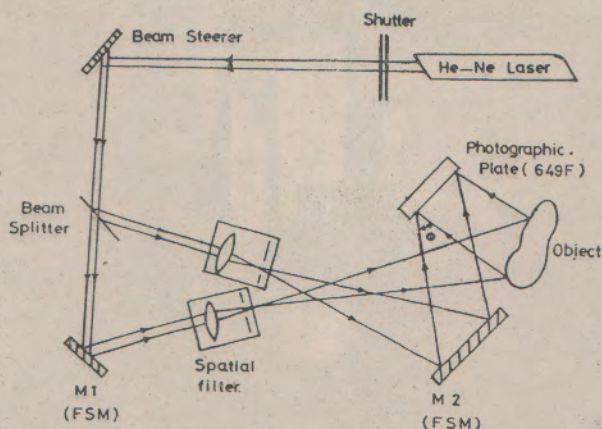


Fig. 1. Experimental Arrangement for Making A Hologram FSM stands for flas surface mirror.

plates. The whole set of apparatus is put on a vibration-free optical table. In order to make the system functioning more effective and efficient, attention has to be paid to the following steps of adjustment: (a) setting the laser stably located on the optical table (b) adjusting the beam steerer such that the laser beam is parallel to the surface of the table (c) locating a beam splitter in such a way that it can shorten the unnecessary path of light beam, and (d) adjusting the incident angle  $\theta$ , as shown in Figure 1, according to the criterion<sup>6</sup> for minimum incident angle. The formula is

$$\sin \theta, \geq 3B\lambda \quad (1)$$

where  $\lambda$  is the wavelength of the incident light and  $B$  is the spatial resolution in lines per mm. When the reference beam is much stronger than the object beam, this requirement can be relaxed somewhat and the minimum allowable angle becomes

$$\theta_{min} = \sin^{-1} B\lambda \quad (2)$$

The additional key point is to make both spatial and time coherence. One way of doing that is to arrange the light path of the reference beam  $d_1$  almost equal to that of the subject beam  $d_2$ . Two inches is the largest path-difference permitted and six to eight inches distance is required from the object to the plate holder. Based on the theory described in references and our operation experience, we would suggest taking the following data: (1) When the laser output power is 8, 10 or 12 *mW*, the corresponding exposure time for 649F plates should be 15, 12 or 8 seconds respectively. (2) The ratio of intensity of the reference beam to the subject beam 2:1, is suggested. (3) The optimum incident angle  $\theta$  could be  $45^\circ$  for our system. By means of these data we made several holograms (including Leith-Upatniek holograms and volume holograms as well) very successfully. Figure 2(a) is the

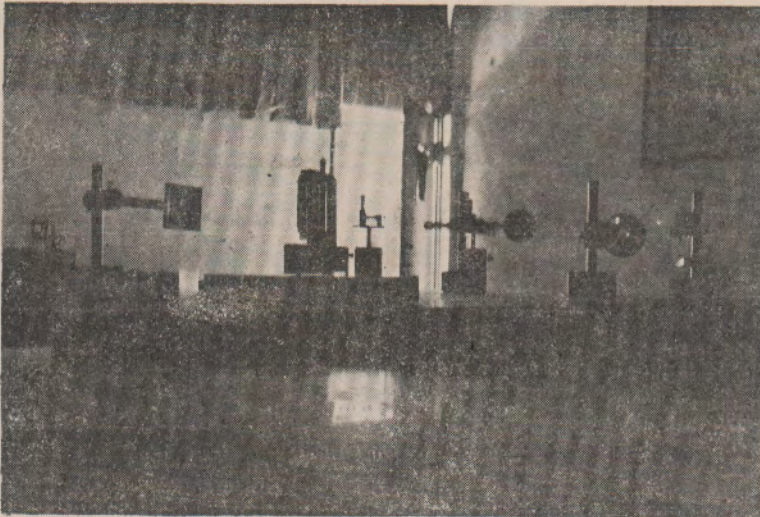


Fig. 2. (a) Photographs of a Laser Holographic System at the Laser Optics Laboratory of the National Chiao Tung University.

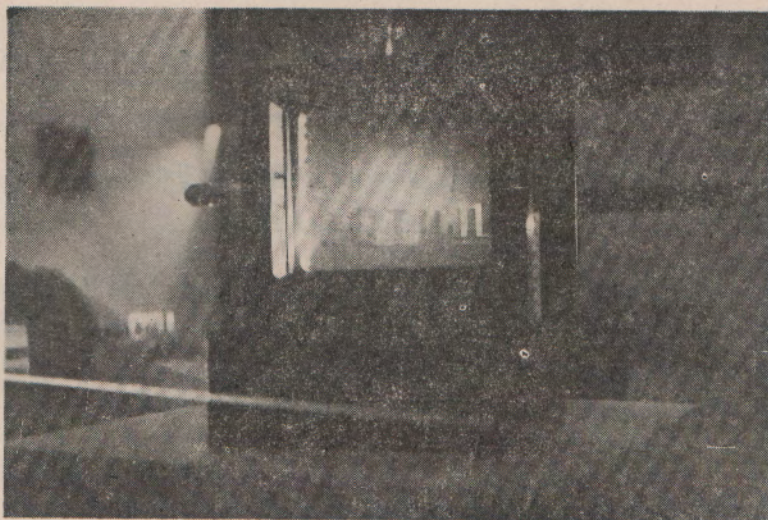


Fig. 2. (b) Photograph made from a single holographic reconstruction of an object "CTU", showing the three-dimensional character of the virtual image.

photograph of our laser holographic system and Figure 2(b) is the photograph made from a single holographic reconstruction of an object "CTU", showing the three-dimensional character of the virtual image.

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