Letters to the Editor

Coffee-Table Holography

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INDEX HEADINGS: Holography; Photographic films.

THERE is in general consensus of professional opinion has indicated, in the past, that the successful production of holograms requires a set-up having a high degree of mechanical stability. This opinion is unquestionably true but it had led me to believe, until about two weeks ago, that holography is exceedingly difficult and should not be attempted by the casual experimenter. I am now convinced that it is really quite easy and that good holograms can be made by anyone having access to a small gas laser, provided that reasonable care is exercised to minimize vibration.

Since we have a Spectra-Physics Model 130 laser in our department at U.C.S.B. I became interested, some weeks ago, in using it to make some holograms of three-dimensional objects. Several 35-mm rolls of Kodak Special High Definition Aerial Film (Gray Base), Type SO-243 were obtained. This film has resolution capabilities in excess of 500 lines per millimeter and is the fastest of the emulsions currently available which are suitable for holography. Since no heavy mountings were available, I decided to use a fairly solid, living-room type coffee-table. A Heiland Pentax single-lens reflex camera with the lens removed was used to hold the film and a surplus 90° glass prism was used to provide the reference beam. The entire set-up is shown in Fig. 1. The reference-beam angle was about 15°.

For an object, a Rolls-Royce radiator cap was chosen since it is quite heavy and not prone to vibration. In addition, it has high specular reflectance and thus partially compensates for the relatively low-power output of the Model 130 laser (about 0.30 mW).

Several exposures were made with a Bausch & Lomb 43X microscope objective used to diverge the laser beam for illuminating the object. Rather than use the shutter of the camera, which would produce excessive vibration, a small piece of cardboard was used to hold the film and a surplus 90° glass prism was used to produce the reference beam. The entire set-up is shown in Fig. 1. The reference-beam angle was about 15°.

When the film was developed, it was found that exposure times of five to ten seconds had produced reasonably good holograms. Though the small size of the film limits the observable parallax effect, the three-dimensional quality of the images is very noticeable. A direct photograph was made of the virtual image, by holding a camera up to the illuminated hologram and exposing just as though the object were actually there. One of these photographs is reproduced in Fig. 2. Though the quality is certainly not excellent, we feel that it is reasonably good, considering that all of the interesting characteristics of holographic images are readily observable when the virtual and conjugate images are viewed directly.

From the experiment, I conclude that three-dimensional holograms can be easily made on commonly available set-ups provided that a moderately fast film, such as SO-243, is used. I hope that this letter will stimulate the interest of other engineering students who, like myself, have thought that holography is just a bit too difficult to attempt without sophisticated equipment.

Acknowledgement: I would like to thank the many professors and associates who assisted me with this project.


New Method of Detecting Weak Light Signals

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Even when the light flux incident on a photocathode is constant, the output of the phototube is not constant but fluctuates irregularly with time. The reason for this fluctuation lies in the discrete and random nature of photoelectric emission; these fluctuations are commonly referred to as "shot noise." The complete average power spectrum of the output consists of (1) a delta function at zero frequency, representing the dc component that is usually referred to as the "signal" and (2) a continuous ac portion of constant height ranging from zero to some cutoff frequency prescribed by the RC characteristics of the photo-detector circuit. We point out that for sufficiently low flux levels, there is more power in the ac portion of the power spectrum than in the dc component, and furthermore the total shot-noise power varies linearly with the light flux.

Because of these two features, it is advantageous under such circumstances to detect the signal in a seemingly indirect way, that is, to ignore the smaller "signal" and to recover the desired information about the incident light by detecting the larger "shot noise" power instead. This note describes the new method of photodetection and reports on an experimental demonstration of its effectiveness.