HOLOGRAPHY

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For the past three years, I have read extensively and followed with extreme interest the numerous articles describing the techniques and new applications of a new photographic technique called "Holography".

Holography, although no lenses are used in its technique, does use sensitized film, and light; therefore it is considered a photographic process. It is therefore natural and expected that as head of photography at USL, I would be asked "What is Holography". In answer to the many such requests the following general description of Holography is provided.

Simply stated, Holography is a lenseless imaging technique by which one can produce a three-dimensional image of an object, which to all appearances faithfully duplicates the original. One accomplishes this by recording (on film) not an image of the object directly, but rather the Fresnel diffraction pattern of coherent light reflected off an object as it interferes with an off-axis reference beam of the same light.

Is Holography new?

Actually the theory of Holography was discovered by Dennis Gabor over 20 years ago while working on a way to improve the resolution of electron microscopes. The missing-cog. to an actuality of this technique at that time was the requirement for an intense monochromatic coherent light source. A coherent light source, (for those unfamiliar with this type source) is one which produces light waves of the same wave length all in phase with one another. Any coherent light sources available at that time were much too weak.

Around 1960, with the discovery of the Laser Beam (which just happens to be an intense, monochromatic coherent light source), this provided the necessary element to the actuality of this technique (Holography) and the new era is photography. The product of this technique is called a Hologram. Now that we have all the components necessary, how do we make a Hologram?

Using a laser as a light source, you arrange to split the laser beam so that part of it will strike the object and the remaining light ray of this same beam will strike a mirror, placed partially in the beam path. The reflected light waves from the object and the mirror are both directed towards a photographic glass sensitized plate, which records not a photograph as we know it, but the interference patterns of the reflected light wave from the image which looks like a meaningless gray mass of concentric circles.

To reconstruct or see this image as a photograph the laser beam is again utilized. You simply look through the Hologram into the Laser beam. A virtual image of the object in three dimensions will appear without the aid of polaroid glasses or stereo aids to be suspended on the other side of the hdogram plate. When you look at the image, you can move your head in any direction and the view changes, just as it would if you were looking at the real object. Another interesting aspect of a hologram is that you can break the plate up into 2 or 4 parts and still retain the entire image on each part.

Applications

In the past few years, there has been a large amount of laboratory work done. Every day, interesting new applications of Holography are announced. Here are a few of them.

Holography can be used to avoid spherical aberations which occur in lens type photography and in electron microscopes.

Holography can be combined with the x-ray level to produce sharp images at great magnification for medical analyses. This application is waiting an addition missing cog. in the form of an intense coherent x-ray source.

The U. S. Government is working on using hologram to help transmit data more quickly from satelites and to assist in weather control experiments.

If the object or components of the system moves, shifts or changes in any way between shots by as little as 3/millionth of an inch, it will degrade the reconstructed image. Knowing this, engineers can put an object under stress, employ a pulsed beam laser that emits a burst of light in periods as brief as 20 billionths of a second, and can measure the effect of the stress by measuring the amplitude of the degradation of the reconstructed image.

In the not too distant future, you may be able to watch 3-D movies and television produced by holograms. Such a movie has already been made by M. Lehmann and W. H. Huntley, Jr. of Stamford (presented at the 10th Technical Symposium of SPIE, August 16-20, 1965, which I attended). Granted, it was only $4\frac{1}{2}$ seconds long, but the first motion picture using photography wasn't much to look at either.

The possibilities in the field of data acquisition and retrieval are almost endless. Holograms can be made, for instance, of the light pattern of certain words or series of words contained on microfilm, and when developed, can be used as filters that will permit light to shine through only where these words appear. Such a hologram can then be used on high-speed readers or scanners for computers, scanning hugh amounts of printed material to select material that is wanted. The Post Office