New Technique of Holographic Multiplexing

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Received 2 *February* 1978

A new technique of holographic multiplexing in which a single exposure is given and the object transparencies are placed in one line before the imaging lens is reported. Hologram is recorded after stopping lower order spatial frequencies in the focal plane of the imaging lens, by mixing the combined object wavefront with a coherent reference wavefront. The reconstructed images are free from cross-talk.

Several techniques have been suggested for holographic image multiplexing. These are based on the idea of modulating the signal with spatial carriers. Leith and Upatnieks[1] devised the process of using different

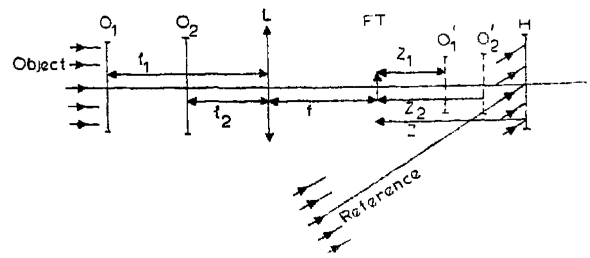

Fig. 1—Schematic diagram of the method [O_1O_2 are object transparencies, L is the imaging lens, FT focal plane; S circular stop and H the hologram recording plane]

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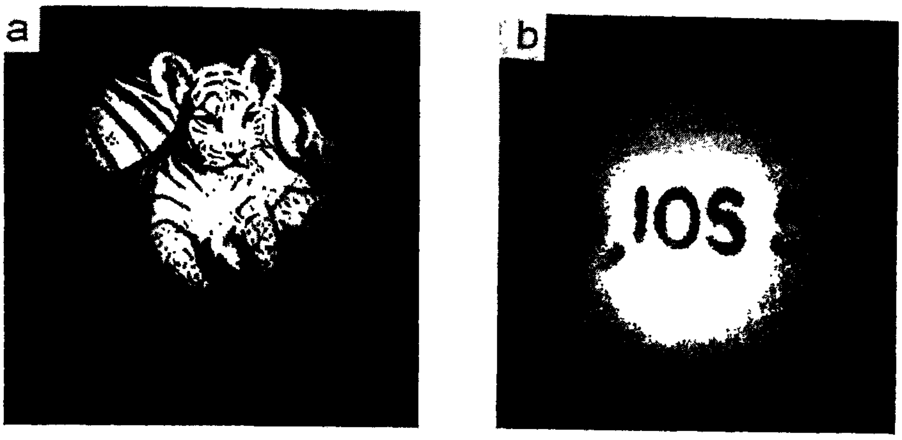

Fig. 2—Reconstructed images

carriers for different spatial signals. The other techniques proposed by Collier and Pennington;[2] and Caulfield;[3] and Som and Lessard,[4] make use of a proposed by single carrier frequency. However, in the methods Leith and Upatnieks,[1] and Som and Lessard,[4] multiple exposures are given, thus the diffraction efficiency is reduced, and in other methods the resolution is decreased and speckling is enhanced due to the reduction in aperture size for each hologram.

Grover[5] has suggested a new method of image multiplexing using a random diffuser, based on the idea similar to carrier multiplexing. However, these techniques also require multiple exposure thus decreasing the diffraction efficiency. Mehta and Singh[6] have proposed an entirely new technique using a random diffuser and single exposure for holographic multiplexing. They have succeeded in getting good reconstructed images without overlapping.

The present article describes another single exposure method for holographic multiplexing by spatial filtering The reconstructed images obtained by this process have finer details and are with reduced speckling without cross talk.

The schematic diagram of the method is shown in Fig. 1. O_1 and O_2 are the object transparancies placed at a distance l_1, l_2 from the imaging lens L of focal length f. These are illuminated by a collimated coherent beam. FT is the focal plane, S is a circular stop placed in this plane to cut off the lower order frequencies. The hologram is recorded in the plane H, at a distance Z from the FT plane such that $Z > Z_1, Z_2$ where Z_1 and Z_2 are the respective distances of the real images of O_1 and O_2 formed by the lens L from the FT plane. In reconstruction (by the same reference beam), the images are focussed at separate distances without cross talk. The reconstructed images are shown in Fig. 2. In actual experiment, the author has used λ 6328Å He-Ne laser source of 2 MW power, Agfa 10E-70, Scientia photographic plate, Kodak D-19 developer, stop size 15 mm in diameter, convex lenses of focal lengths 10 cm and 50 mm diameter. The separation between the two transparencies was 5 cms.

The reconstructed images, as shown in Fig. 2, have finer details, i.e. even scratches on the transparency, are present and are with reduced speckling without cross talk. The minimum distance which can be set between the two transparencies depends upon the size of the stop, lens parameters, and diffuseness of the transparencies.

Filtering of the lower order frequencies in the FT plane, reduces the depth of field thus facilitating the separation of the reconstructed images, and since the high spatial frequencies correspond to fine details, this process improves discrimination considerably. Again the spatial filtering of lower order frequencies removes the defects of film grain noise[7,8] and speckling.[9]

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