sible measurements on turbines of any velocity using a single fixed intermediate frequency amplifier. Smaller vibrations can easily be measured by stopping down the electronic bandwidth to improve the signal to noise ratio.

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Q. V. DAVIS
W. K. KULCZYK

Department of Electrical and Control Engineering,
University of Surrey,
Guildford, Surrey.

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Holographic Reconstruction of Animate Objects

IN conventional holography the object must usually be held stationary to within a fraction of a wavelength during the exposure. This means that in order to make bright reconstructions of animate objects one must either use a pulsed ruby laser¹ or resort to one of the multistage processes (ref. 2 and unpublished work of J. D. R.). Here we show that if one can tolerate dark reconstructions, much more movement of the object can be allowed.

Fig. 1. Two views of the reconstruction of a hand.

Consider, for example, white background screens assembled in the object space of any apparatus for making holograms. If the background is stationary to better than a wavelength it is, of course, capable of reconstructing brightly. But if an animate object such as a living hand is held between the background and the hologram plate during the exposure the reconstruction of the background will be partly obscured. In effect, a three-dimensional, hand-shaped hole is reconstructed. Although, of course, this reconstruction contains no information about the surface texture it can be used to make measurements in three dimensions just as if it were bright. Fig. 1 shows two photographs of a reconstruction from a hologram made in this way using a 10 mW helium-neon laser.

The technique may also be useful in the study of dynamic phenomena because any object which moves

considerably more than the normal holographic limit in effect digs a three-dimensional hole in the reconstruction space. An insect, for example, would leave behind a dark reconstruction of its flight path. The brightness of any given part of the reconstruction depends on the proportion of exposure time for which the background is obscured. This property might be usefully employed in the study of vibrating objects where it would complement the technique developed by Powell and Stetson³.

J. D. REDMAN
C. J. NORMAN
W. P. WOLTON

Atomic Weapons Research Establishment,
Aldermaston, Berkshire.

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BIOLOGICAL SCIENCES

Transfer of Ions against their Chemical Potential Gradient through Oil Membranes

LIQUID organic solvents have been used to simulate biological membranes by making the organic solvent act as a bridge between two aqueous pools. The transport of ions (both K⁺ and Na⁺) from one pool to another across such oil membranes has been studied¹⁻³. We report here a number of very interesting and perhaps useful features in the application of such membranes.

We suggest that the transfer of anions between aqueous phase 1 and aqueous phase 2 is impossible and that only exchange of cations is possible between phases. It is precisely this situation which can be achieved in the laboratory. Assuming that the negative ions are immobilized in their respective aqueous phases, then the number of positive ions leaving phase 1 must be balanced by a like number of ions leaving phase 2 and entering phase 1 to maintain electroneutrality. This coupling allows us to assert that the sum of the free energies for transferring a positive ion from phase 1 to phase 2 plus that for transferring a positive ion from phase 2 to phase 1 must be negative if the process is to be spontaneous at constant temperature and pressure, but we cannot insist that the individual free energies be negative. Thus

$$\Delta G_T = \Delta G_A + \Delta G_B \leq 0$$

is the criterion for a spontaneous process in which ΔG_A and ΔG_B are the free energies associated with the transfer of ions from phase 1 to phase 2 and from phase 2 to phase 1, respectively. If the electrical potential in phase j is denoted by φ_j , the electrochemical potentials are

$$\Delta G_A = RT \ln a_2 - RT \ln a_1 + ZF(\varphi_2 - \varphi_1)$$

$$\Delta G_B = RT \ln b_1 - RT \ln b_2 + ZF(\varphi_1 - \varphi_2)$$

where a_1 , a_2 , b_1 and b_2 are the activities of ions a and b in phases 1 and 2, respectively. The charge of both ions is assumed to be the same and equal to Z and Faraday's number is denoted by F . The net change in free energy is then given by

$$\Delta G^T = RT \ln (a_2 b_1 / a_1 b_2)$$