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Brief 71-10534

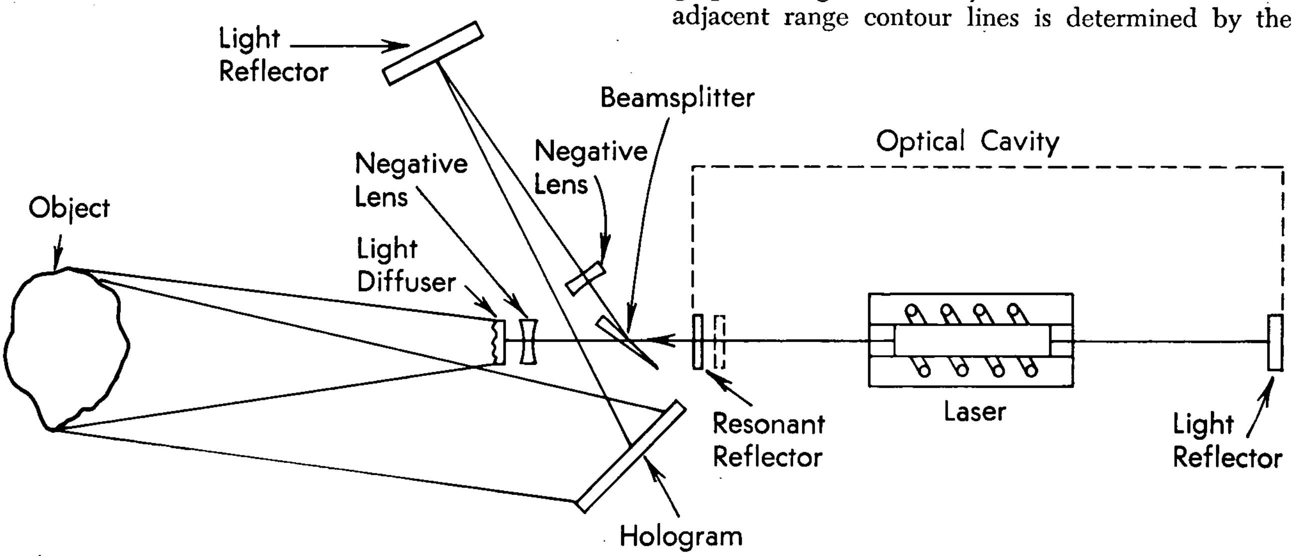
NASA TECH BRIEF

Ames Research Center

Multifrequency Laser Beams for Holographic Contouring

The problem:

To generate contour maps with contour intervals of the order of a few millimeters for practical applications such as gaging the size and shape of mechanical parts or of structures such as parabolic antennas.



The solution:

By using a pulsed ruby laser which emits two optical frequencies simultaneously, holographic recordings of the test object give images covered with the desired range contours.

How it's done:

The holographic apparatus comprises a pulsed laser with a given lasing linewidth and optical means for pumping the laser. The optical cavity of the laser includes a reflector for the monochromatic light developed by the laser. The reflector defines one end or boundary of the cavity; the other end is defined by optical means for selecting at least two frequencies, each within the lasing linewidth. Illumination of the object by light of two adjacent, distinct frequencies generates the desired range contours on the holographic image of the object. The distance between adjacent range contour lines is determined by the frequency difference between the two light waves. The hologram is obtained by splitting the laser light into a reference beam and a scene beam; the reference beam is directed onto the hologram, and the scene beam is first directed onto the object and then onto the hologram.

The laser depicted in the diagram is a ruby rod pumped by a helical flash lamp. Alternatively, the laser may be of any other type which permits pulsed operation with high power, and has an equivalent lasing linewidth (of the order of 0.025 nm), for example, a neodymium laser.

(continued overleaf)

The boundary of the optical cavity is formed by the light reflector which may be a mirror, with a dielectric coating at its plane front surface, that reflects substantially all of the light, say 99%. The other end of the optical cavity may be formed by a Fabry-Perot etalon or resonant reflector; the resonant reflector may be either a single slab of sapphire or two slabs of quartz. The resonant reflector selects two closely adjacent frequencies within the lasing linewidth of the laser. It is shown as forming one end of the optical cavity; however, a suitable, partially reflected mirror may also be used to define the cavity, whereupon the resonant reflector may be disposed anywhere within the cavity.

The laser in the diagram operates in a conventional manner and develops an output beam which impinges on the beamsplitter, and is split into a reference beam and a scene beam. The reference beam is reflected by the front surface of the beamsplitter and then enlarged by the negative lens to a size which fills the entire area of the hologram after reflection from the light reflector a front-surface mirror of aluminum). The scene beam may also be enlarged by a negative lens prior to falling on the object. The light scattered by the object is then also recorded on the hologram Interference between the waves scattered from the object and the reference beam is recorded as amplitude and phase of the scattered scene beam and permits reconstruction of the object by the light of a suitable reference beam.

The light diffuser is optional; it is constructed so as to ensure that the apparent light source does not appear too large, and preferentially scatters in the forward direction. It may be fabricated from ground glass with a thin coating of lacquer that has the same index of refraction as the ground glass. The hologram is a suitable photographic film or plate.

Notes:

1. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference:
   NASA CR-114274 (N71-17271),
   Holographic Instrumentation Studies.

2. No additional information is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: B71-10534

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457(f)] to the TRW Systems Group, TRW, Inc., One Space Park, Redondo Beach, California.

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