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NASA TECH BRIEF

Ames Research Center

Vibration Detection Using Lasers

The problem:

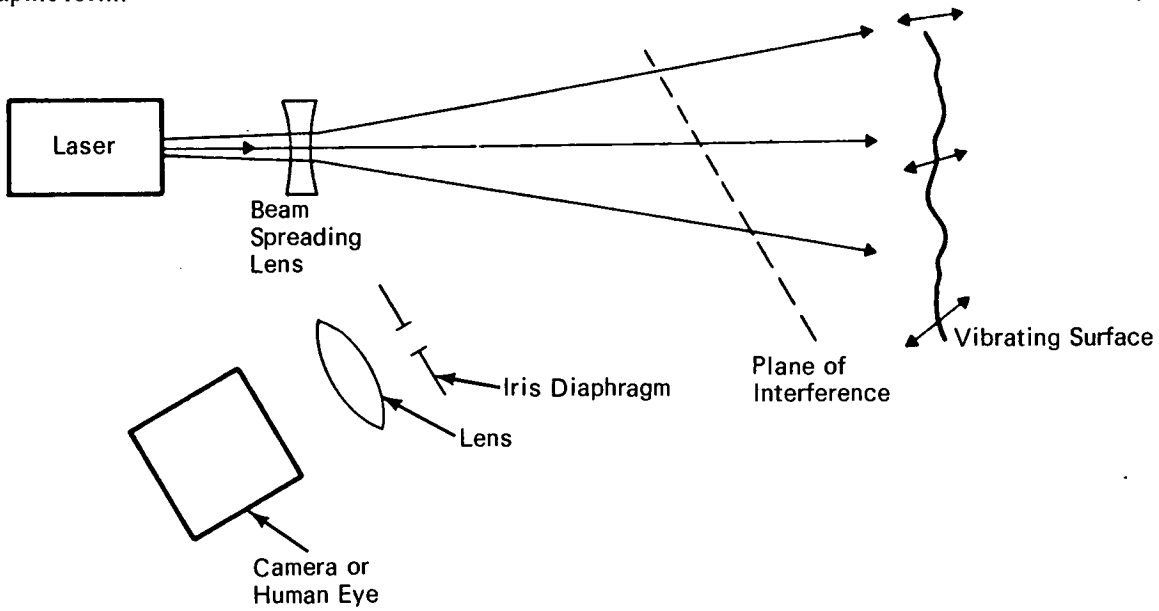
Qualitatively determine the vibrational modes of a large moving surface, and present this information in graphic form.

The solution:

Observe the interference displacement patterns produced when light from a laser illuminates a diffusely reflecting, vibrating surface. Photographs of the standing wave modes on the model surface can be interpreted in order to yield the amplitude and frequency of the vibrations.

How it's done:

A laser beam enlarged with a diverging lens illuminates a 25.4 cm (10 in.) diameter area on the surface of the diffusely reflecting object. The light reflected from the object consists of random phase waves which overlap in the region of space in front of the surface. The waves form random or "sparkle" interference patterns that can be correlated with the position of the many small scatterers that make up the diffuse reflector. A viewing lens focuses on the interference in a particular plane through an iris diaphragm, so that the pattern can be observed more easily. The iris diaphragm also limits the effective diameter of the observed region which is contributing light to the single point in the interference pattern.



Interference Displacement Mapping System

As the illuminated surface vibrates, the complex interference pattern is altered, and the tilt of the

(continued overleaf)

surface is detected as a lateral motion of the sparkle pattern. When the tilt occurs at a rate faster than the eye or camera can follow, the motion appears as a streaking of the pattern in the direction of the tilt, indicating the gradient of surface excursion in the direction of the viewer. The vibration level at which streaking begins to appear is the maximum displacement amplitude. For surface points separated by the effective diameter of the observed region, the displacement is equal to one-half the wavelength.

For example, if the motion to be resolved is over surface elements as small as 5 mm and the wavelength is roughly 10^{3} mm, the minimum detectable tilt angle is 10^{4} radian and the peak differential displacement is 10^{-3} mm.

Flat, white surfaces yield the best interference patterns, even over considerable surface curvature. Interference patterns may be produced from unpainted metal surfaces, aluminum-painted surfaces, and precision-machined metal surfaces.

Note:

Requests for further information may be directed to:

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Patent status:

No patent action is contemplated by NASA.

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