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Brief 70-10271

NASA TECH BRIEF

Finite Fringe Hologram

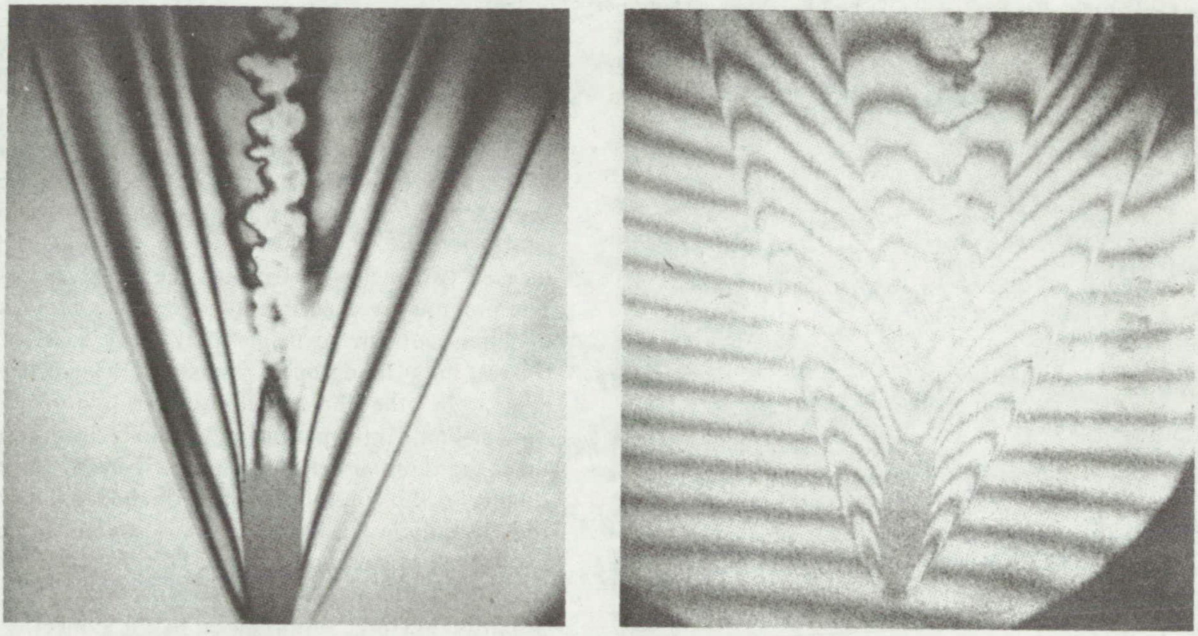
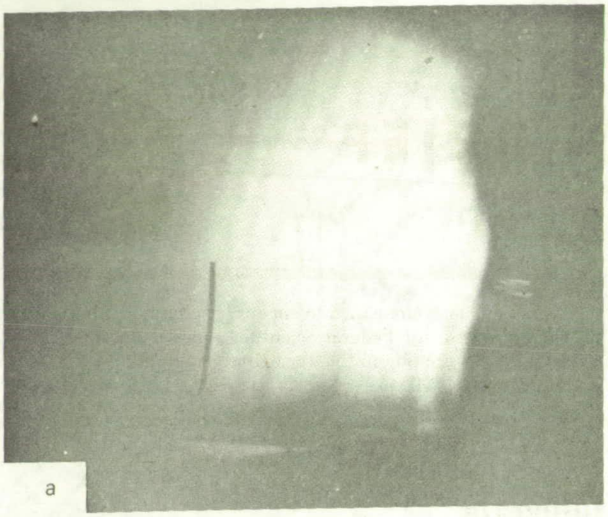


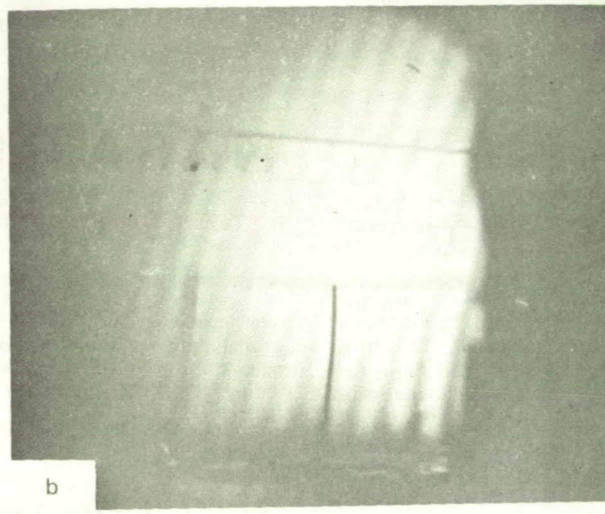
Figure 1. Infinite fringe and finite fringe interferograms of slightly skew bullets in flight. Both are copies from double exposure interferograms. No motion of the apparatus took place between the exposures for the left exposure. For the right picture, a small motion of the hologram plate was made between the exposures, introducing a background of fringes. Because of the lack of precise control of this motion, the fringes form in a different plane than the bullet plane. This makes copying difficult. This copy was made at f/16. Copies made at f/2 show no fringes. Visual viewing gives a better impression than does the above copy due to the eye's ability to accommodate and tolerate coarser granularity.

The type of interferogram which is normally produced by holographic interferometry is the "infinite fringe" interferogram. Such interferograms result when there are no changes between the two exposures other than those associated with the subject. If a small movement of the apparatus takes place between the two exposures, then the background of the reconstructed scene will be covered with interference fringes approximately parallel to each other. Figure 1 shows a photograph of a finite fringe holographic interferogram made by introducing a small motion between exposures. The fringes have an appearance very similar to the finite fringe interferograms of conventional interferometry. However, there is an important aspect of the holographic case which requires further consideration; the three-dimensional

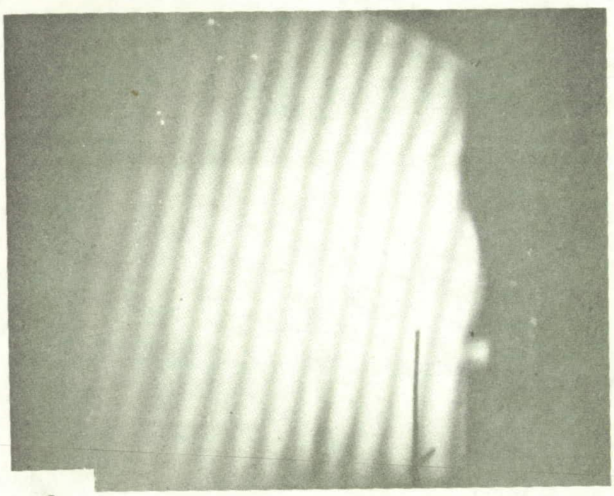
(continued overleaf)



a



b



c

Figure 2. Copies from gas laser holograms showing the focusing ability and placement of finite fringes. The three different wires in focus in *a, b,* and *c* are separated by about one inch in depth. The fringes focus in the plane of the wire in *c*.

quality of the holographic image gives the interference fringes an appearance of having a specific location in space. For certain practical applications, such as wind tunnel measurements of aerodynamic flow, it is desirable to be able to place these fringes in the plane of the subject. In order for such an interferogram to be useful for the quantitative evaluation of minute details, it is necessary that the background fringes focus in essentially the same plane as the subject.

To solve the problem of deliberately placing the finite fringes in a desired plane, a mathematical model has been derived which gives the location of the fringes in terms of the movement imparted to a ground glass and the directions of viewing and illumination. Based upon this model, experimental tests were conducted to demonstrate the effectiveness of the model in locating the fringes in actual three-dimensional arrangements. Figure 2 shows the focusing ability and placement of finite fringes. In this example there are three wires separated in distance along the viewing direction by approximately one inch. The copy camera was focused on these three different wires in A, B, and C. The finite fringes are approximately in the plane of the wire, which is in focus in C. One can see from view A that the fringes are considerably reduced in contrast when the wide-aperture copy camera was focused two inches in front of the fringe focal plane. The preliminary experimental tests have demonstrated that it is possible to deliberately place a set of finite fringes in a holographic image at a selected focal plane. In the holographic interferogram, three-dimensional information is available insofar as the holographic image permits a wide viewing angle. The quality of the fringes produced by the rigid motion of the ground glass is completely insensitive to the quality of the optical components. This insensitivity to the optical quality makes possible a more accurate determination of fringe shifts caused by the subject.

Note:

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

Technology Utilization Officer
Headquarters
National Aeronautics
and Space Administration
Washington, D.C. 20546
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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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Category 03