AD-A156 538 SHEAROGRAPHIC IMAGING SYSTEM(U) UNIVERSITY COLL OF NORTH WALES BANGOR SCHOOL OF ELECTRONIC ENGINEERING SCIENCE D K DAS-GUPTA 1984 R/D-4679-E-01 1/1

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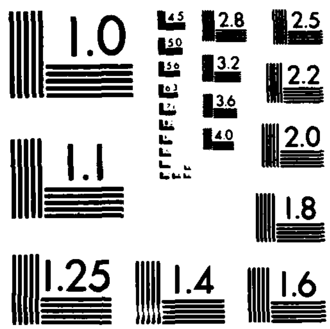
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First Interim Report on Shearographic Imaging System

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1. Introduction

The purpose of the present work is to develop an on-line optical image shearing method together with an electronic camera and storage system to study surface deformation, voids, cracks and other flaws in material media in a nondestructive manner. It is intended that the initial work is to be divided into two parts. The first part of this investigation is to set up an all optical system in which an object under observation is illuminated normally by a coherent source of light (He-Ne laser) and is imaged with an image shearing technique (figure 1) in which a small angle prism (approx. 1 degree) covering only one half of a lens system. This prism is located in the iris plane of an optical camera and it deviates the incident path of a ray, thus providing a pair of the laterally sheared images at the image plane of the optical camera. The photographic plate in the image plane is double exposed with the object being stressed between the exposures. If the object is deformed under stress, an optical path change occurs due to surface displacement of the object which provides a phase change between the two sets of sheared wave fronts. The resulting intensity distribution on the photographic plate after the double exposure provides high frequency fringes which are generally function of displacement derivates in the x, y, z coordinates. The speckle shearing interferometry (SSI) described above, is particularly suited to studies of flexural strains and flaw detection in composite materials.

The second part of the initial work is to replace the optical camera with an electronic imaging system with relevant hard and software to provide an on-line study of strain gradients in materials under stress.

Unfortunately, the 5 mW He-Ne laser, available in our department, was found to be unsuitable to obtain satisfactory images due to low power of the laser beam. A 50 mW laser was subsequently ordered by the ERO Office of the U.S.Army in London with a promise of delivery by Spectra Physics in March 1985. Thus very little experimental work could be carried out until an adequate laser source could be available. However, in the AMMRC laboratories at Watertwon, Ma., a 15 mW He-Ne laser was available. Using this laser and other optical equipment in the AMMRC laboratories preliminary experiments have been carrie dout by Messrs R. F. Anastasi, S. M. Serabian, Dr. R. J. Shuford and the present author and this work is described below.

Experimental Set-up and Results

Figure 2 shows the shearographic system in which a coherent laser (15 mW) beam of He-Ne is incident on a specimen s, under observation, via a set of reflecting mirrors MM and M and a spatial filter assembly SF. A Toyo-View 45E camera C was used for imaging the reflected rays from the specimen surface. An optical wedge M of prism angle 1 degree was located appropriately covering half the field of view of the optical camera C (Toyo-View 45E). The remaining optical path in figure 2 is for reconstructing the image taken on the photographic plate to view the fringes with clarity.

Figure 3 is the speckelgram obtained with a 0.020 inch thick aluminium specimen which was bonded to a 0.75 inch thick aluminium plate with double sided tape except for a central area of approximately two inches in diameter. A suitable grid of one inch square on a white background was located on the front surface of the aluminium specimen. The specimen was positioned infront of the recording camera such that the image size was 0.85 x the actual object dimension. The shearing wedge (1 degree optical prism) was placed at the iris plane of the recording Toyo-View camera lens. This resulted in a shearing in the image plane of 0.16 inch in the X-direction. A load cell, located on a suitable translation stage was used to deflect the centre of the specimen out of plane and a displacement transducer was used to measure the displacement of the translation stage.

The recording camera was used at f/5.6 for the f/stop value. An exposure of 3 minutes was given for each of the two expostures (i.e. before and after displacement). Agfa photographic plate type 10E 75 was used to record the specklegram. An out-of-plane displacement of 0.0010 inch was produced with a load change of 0.09 lb for the specklegram (figure 3). Kodak D-19 developer was used at 70 degrees F. for approximately five minutes to develop the photographic plate.

In view of the long delivery date of the 50 mW laser a request has been made to Spectraphysics for a loan of a 20 mW laser so that a shearographic system, as shown in figure 2 may be established in our laboratories for further work.

Acknowledgement

The author is deeply indebted to Messrs r. F.Anastasi, S. M. Serabian and Dr. R. J. Shuford for carrying out the work, described above, in their laboratories at AMMRC, Watertown, Ma.

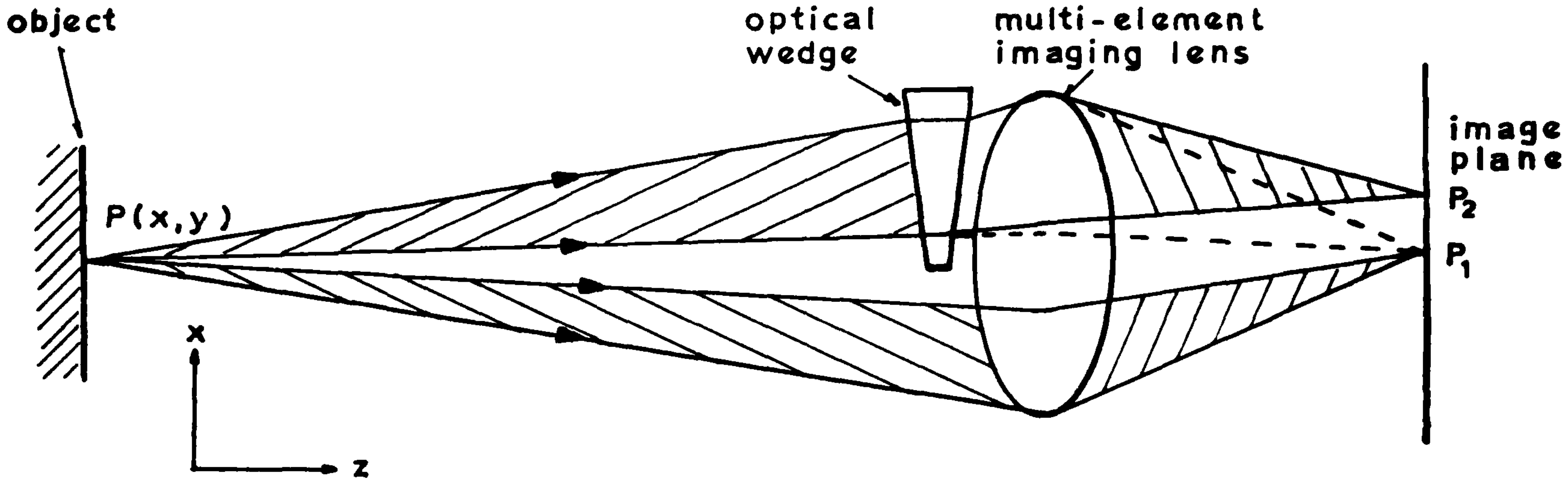
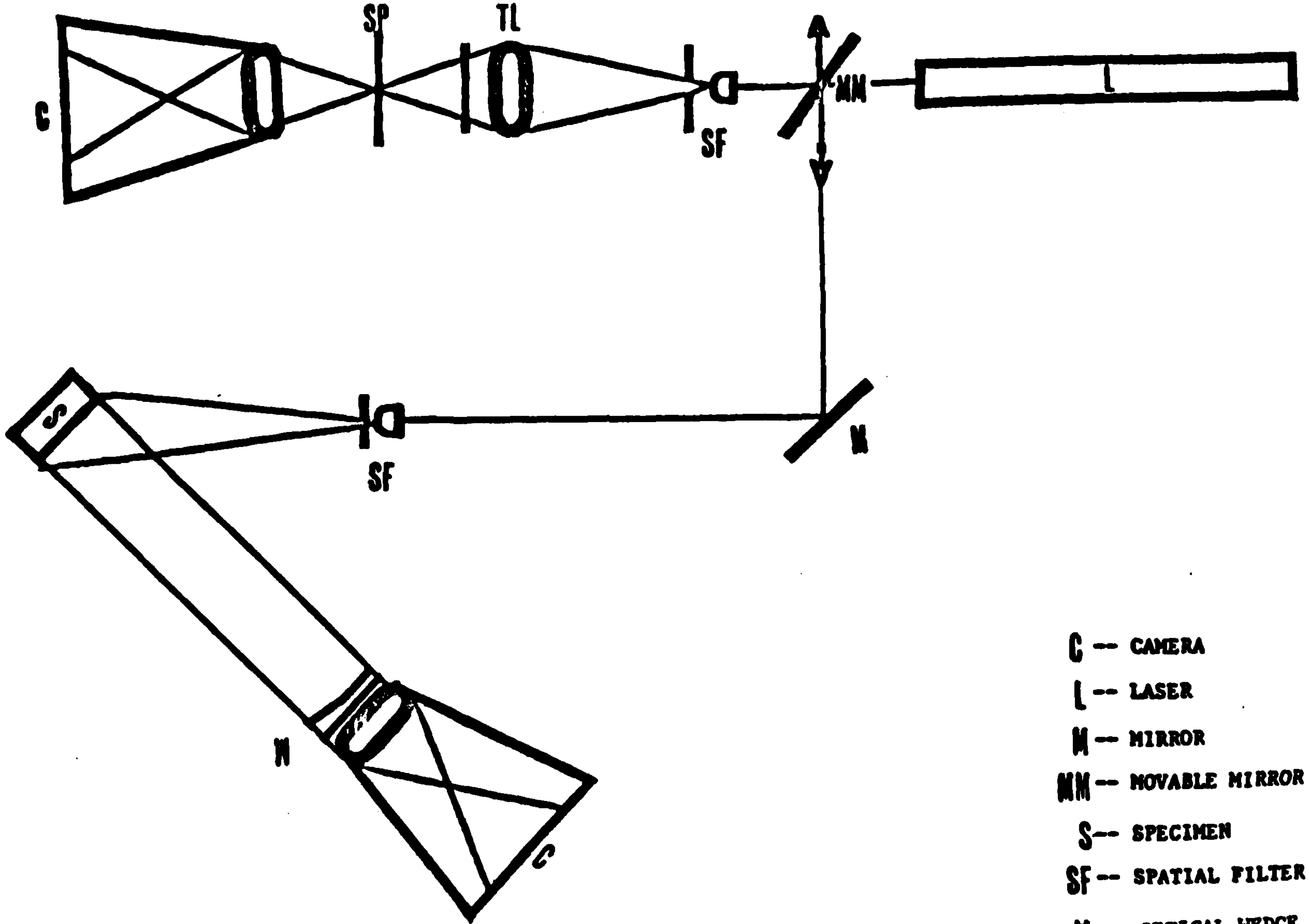


Fig. 1. Schematic diagram of shearography.



C -- CAMERA
L -- LASER
M -- MIRROR
MM -- MOVABLE MIRROR
S-- SPECIMEN
SF -- SPATIAL FILTER
W -- OPTICAL WEDGE
TL -- TRANSFORM LENSE
SP -- SPECTRUM PLANE

FIGURE 2 AMMRC SHEAROGRAPHY SYSTEM

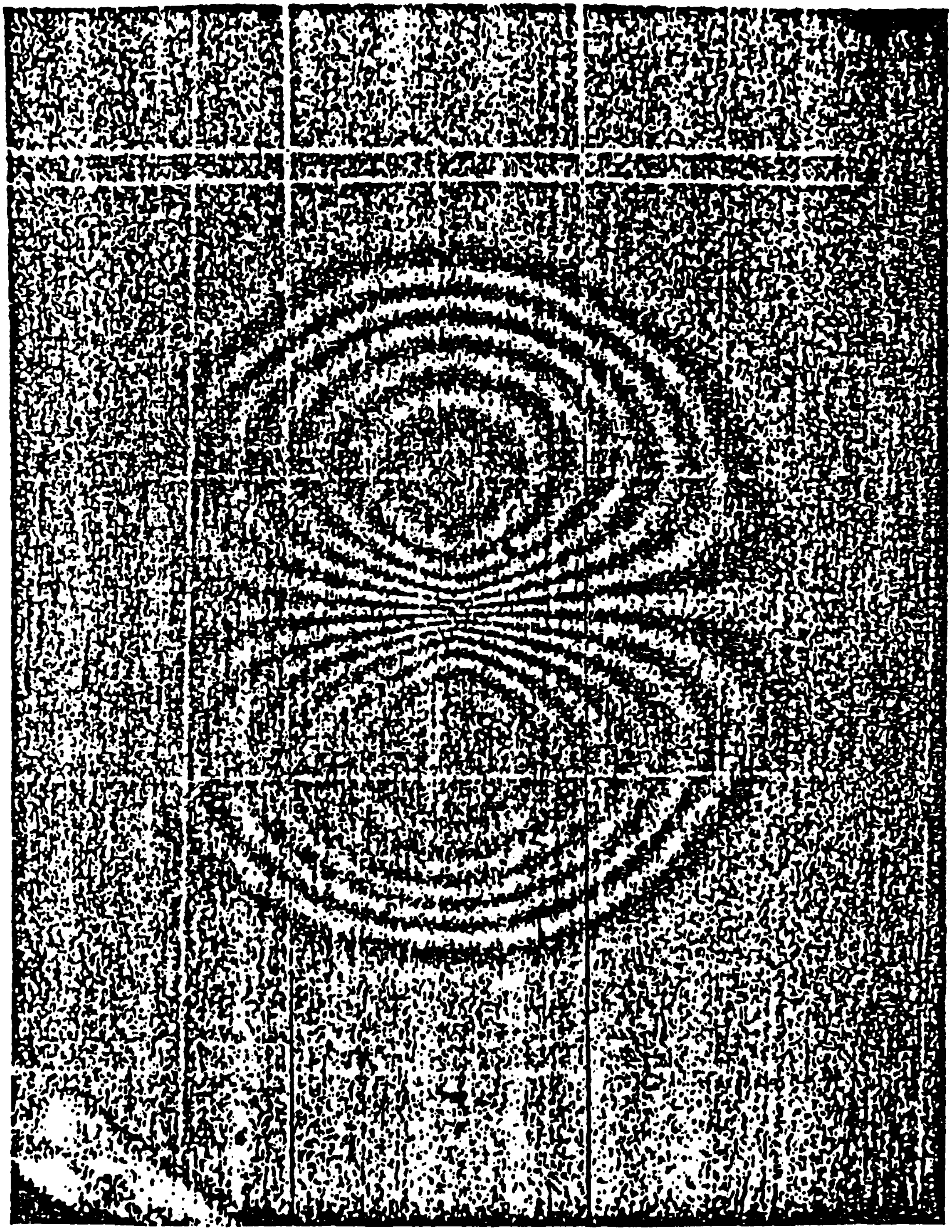


FIGURE 3 RECONSTRUCTED SPECKLEGRAM WITH AN ALUMINIUM PLATE OF 0.20 INCH THICK FOR AN OUT-OF-PLANE DISPLACEMENT OF 0.001 INCH CAUSED BY A LOAD CHANGE OF 0.98 LB.

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