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An application of white light multi-exposure speckle photography

R. N. SINGH, A. K. SINGHAL

Department of Physics, Indian Institute of Technology, New Delhi, India.

Introduction

Speckle formation by laser light is now a well known optical phenomenon which has found extensive applications in many diverse applied disciplines [1, 2]. In particular, much work has been reported on the measurement of small displacements by laser speckles [3, 4]. Recently, BOONE and DE BACKER [5] have demonstrated the possibility of applying white light speckle photographs and reconstruction technique to various types of measurements. In this letter we presented results of some of our experiments on reconstructions of bleached white light multi-exposure speckle photographs by incoherent white light as well as by the laser light. With these techniques very sharp fringes of high contrast were produced. Such experiments may lead to simple methods for precise measurement of small displacements.

Experimental arrangement

A 500 watt projection bulb was used as a white light source. A divergent beam of light from the source was used to illuminate a diffuser consisting of a thin glass grounded on one side by emery. The diffuser was mounted in a manner which permitted its lateral translation by small amounts with the help of a precision micrometer screw. A Kodak 649F hologram plate was placed immediately behind the diffuser. By using a short exposure the fine speckle pattern, generated by scattering of light at the diffuser was photographed. Together with this pattern a shadow of the diffuser will also be cast on the plate. A number of exposures were made on the hologram plate as the diffuser was given a constant small displacement every time before the exposure. The multi-exposed plate was then processed and bleached.

A number of wet bleaches [6] such as potassium ferricynide (10 gm/L), mercuric chloride (10 gm/L), and cuperic bromine (50 gm/L) were tried in our experiment to find the most suitable bleach for our case. Potassium ferricynide was found to produce lot of scattering, due to heavy fog, hence the reconstructed fringes had a lot of noise. Mercuric chloride led to poor difffraction efficiency. The most suitable bleach for large fluctuations of photographic density turned out to be cuperic bromide, because it led to lower noise and better diffraction efficiency.

The Fourier transforms of such bleached white light multi-exposure photographs will consist of fringes characteristic of the small displacement. The photographs presented in this paper are of fringes obtained from the bleached double, four and ten exposure speckle photographs.

Results and concluding remarks

To reconstruct sharp and high contrast displacement fringes, use of white light multi-exposure speckle photography has been demonstrated. The fringes reconstructed from bleached photographs by using incoherent white lighte as well as the laser light are shown in figs. 1 and 2, respectively. The three photographs in each figure are obtained from double, four and ten exposures, respectively.

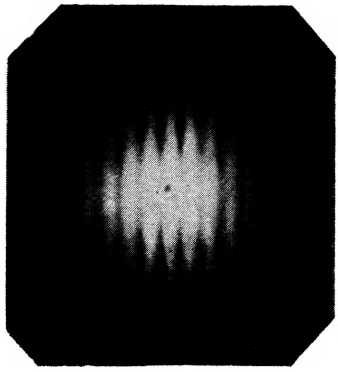

Fig. 1a

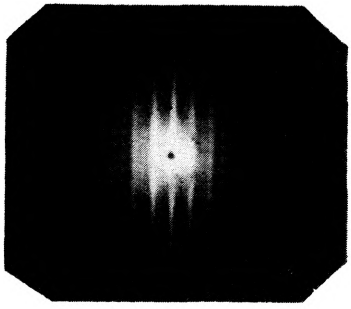

Fig. 1b

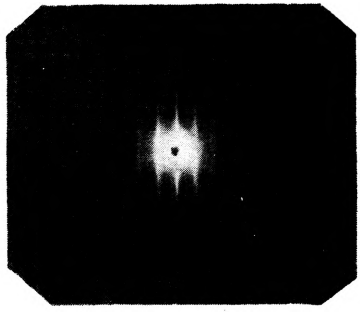

Fig. 1c

Fig. 1. Double (a), four (b), and ten (c) exposure fringes reconstructed by using white light

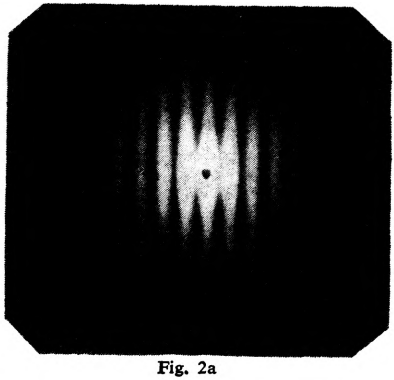

Fig. 2a

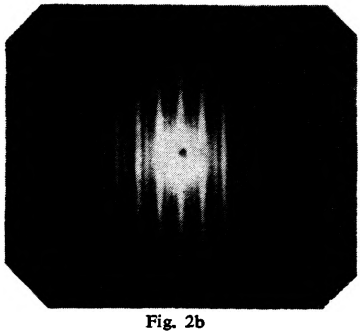

Fig. 2b

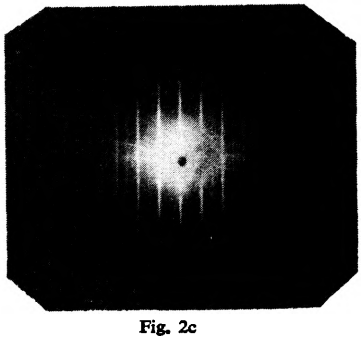

Fig. 2c

Fig. 2. Double (a), four (b), and ten (c) exposure fringes reconstructed by using laser light

The sharpening of fringes due to multiple exposure is seen both in figs. 1 and 2. The sharpening due to multiple exposures and the possibility of using white light, as demonstrated in this letter, may lead to the development of simple, precise and inexpensive techniques for measurement of small displacements by speckle photography.

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