PREFACE

The birth of a new area in modern optics took place when, in 1948, Dennis Gabor, the Hungarian physicist conceived the idea of wave front reconstruction. But it was the advent of Lasers in 1960 which impelled the growth of this new technique named Holography. Holography emerged as a faithful form of photography to render the life-like 3-D images. As it stands now it is more a scientific search tool whose applications are as diverse as imaging, information storage and processing, non-destructive testing, vibration analysis, microscopy, road flatness testing and identification of target objects.

This thesis documents the details of fabrication of an indigenous holographic setup and the results of some experimental research done by using it. All the components of the setup except the laser and lenses were fabricated in the department. The methods used for the fabrication of spatial filters, beam splitters, beam directors and other system components are also presented.

The initial part of the work is the study on the isolation capability of a newly designed low cost holographic table. The design details of the table and the essential vibration characteristics are discussed. It is seen, by comparison with commercial data, that the overall performance of this table is comparable to that of the ordinary honeycomb structures without internal damping.
The studies conducted are mainly on Holographic Interferometry (HI) and Holographic Optical Elements (HOEs). The HI part consists of real-time and time-averaged studies. A new non-destructive method for the study of thermal stress in thin films has been introduced and tested. Both diffusely and specularly reflecting films were used.

Time-averaged holographic interferometry has been generally applied for the vibration analysis of musical stringed instruments. But the use of this technique is limited in the case of musical wind instruments, due to problems of stability during excitation. We have made an attempt to record the vibration pattern of an air-reed wind instrument excited in an almost realistic way. It has been shown that well defined time-averaged interferograms can be obtained in the case of a wind instrument.

Different holographic optical elements were recorded using the setup and an optical pattern recognition system using HOEs has been fabricated and optimized.

The contents of the thesis are presented in six chapters.

An overview of the growth of holography and the necessary theory are given in the first chapter.

The second chapter discusses the experimental setup, fabrication details of the various system components and the preliminary experiments done. Vibration analysis of the low cost holographic table is also presented in this chapter.

The in-situ processing of the holograms and the real-time monitoring of the thermal stress in thin films, its measurements and the studies conducted in this area are given in the third chapter.

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The fourth chapter is concerned with the experimental setup for the excitation of an air-reed musical wind instrument in an almost realistic playing condition and without introducing any stability problem. The time-averaged holographic interferograms obtained for the Indian flutes that we have used, are also presented.

Holographic optical elements and the development of a holographic pattern recognition system form the theme of the fifth chapter. Finally, the summary of the investigations done and the contributions of the work are listed.

Most of the conclusions drawn through this research work have been published/ accepted /communicated for publication/presented in seminars, in the form of the following papers.

1. "A New Design for a Holographic Table ",
P.T.Ajith Kumar, E.M.S.Nair and C.Purushothaman,

2. "A New Method for the Study of Vibrations of Air-Reed Wind Instruments by using Holography ",
P.T.Ajith Kumar, Jessy P. Thomas and C. Purushothaman,
Presented in the " National Symposium on Current Trends in pure and Applied Physics",

P.T.Ajith Kumar and C.Purushothaman,
"Proc.of the International Workshop on Holography and Speckle Phenomena and their Industrial Applications.",
P.T.Ajith Kumar and C.Purushothaman,
Optics and Laser Technology, 22, 2841, (1990), ENGLAND.

5. "Some Studies on Fabrication of Optical Elements, Stress in Thin Films and Vibrations of Air-Reed Wind Instruments, by using holography",
P.T.Ajith Kumar and C.Purushothaman,
First Kerala Science Congress, CUSAT, COCHIN-22, Feb:(1989).

6. "Vibrations of Flutes Studied by Holographic Interferometry"
P.T.Ajith Kumar and C.Purushothaman,
"National Symposium on Acoustics",
Sangeeth Research Academy, Dec: 14-16, (1989), CALCUTTA,

7. "Study of Flute Vibrations by Holographic Interferometry",
P.T.Ajith Kumar, Jessy P. Thomas and C.Purushothaman,
Appl. Opt.29, 2841, (1990),USA.

8. "Study of Thermal Stress in Thin Films by Real-Time Holographic Interferometry" (Accepted),
Sixth International PRECISION ENGINEERING Seminar,May:27-31,(1991), Stadthalle,GERMANY,

J. Acoust. Soc. Am.,USA, (Communicated).

10."Thermal Stress Variation in Reflecting Thin Films studied by Holographic Interferometry"