CHAPTER FOUR
SUMMARY AND CONCLUSION

4.1 INTRODUCTION

The growth of the optics from the early stages is very interesting. The recent trends in the optics are Fourier optics, Lasers, Holography, Non-linear optics, Fibre optics and communication. The tremendous progress has been made during the past couple of centuries not only in understanding the nature of light but also in exploitation of this knowledge for engineering and technological applications. For this we should be greatful to Newton, Rayleigh, Fresnell, Huygen, Abbe, Einstein, Gabor and many others.

When we come to know that the items kept in the jewellery shop are not really in existance, but it is the creation of light beam, then we surprise to accept the fact. The above said thing is not magic, nor it is merely an imagination. Now, it is possible by holography to produce three dimension images with full depth, parallax and perspectives, so realistic that it becomes difficult for the viewer to believe that the object donot really exist there.

Chapter I, deals with the introductory concepts in the holography. The survey is given right from Bragg's explanation of diffracted beam from crystal. It is also dealing with important part of recording and reconstructing the hologram with its varieties. The elementry analysis of simple hologram is given. The brief account of holographic interferometry is given with its basic techniques. In order to reconstruct the object, the direct holographic recording of projected original image is recommended, because in this process the lens system can be excluded and elementry holograms can be produced.

4.2 CRITICAL REVIEW ON HOLOGRAPHIC INTERFEROMETRY

In Chapter II,we have presented a survey of literature on the holographic interferometry. This chapter deals with following things.

(i) Theory of fringe formation and localization.

(ii) Holographic interferometric information.

(iii) Strategy of evaluation of holographic interferometric information.

(iv) Basic techniques of holographic interferometry.

The classical interferometry is applied to explain the holographic interferometric information. The strategy of evaluation gives the brief account of strain, rotation, bending and tortion with the help of displacement vector for image of the object and same is transformed for extracting information about the object using mathematical manipulation. Also, basic techniques of holographic interferometry with their merits and demerits are discussed. Because of its high energy, short emission time, narrow band width, the laser holds a unique position in the application of holography. We have applied the theory of two-beam interferometry to the analysis of the reconstructed image from a hologram produced by using a spatially incoherent light source and have drawn attention to several important physical requirements for this type of holography. The hologram should be placed in a plane where the reference beam and object beam form the most distinct fringes. In hologram production, there are two causes of reduction of fringe visibiity that depend on the finite time coherence of light source. The first originates from the path difference between the interfering beams, the reference beam and undiffracted beam from the object. If this is compensated over the hologram plate, a light source of quite short coherence length can be used for the production of the hologram. Leith and Upatnieks' achromatic fringe system is typical example. Gabor in-line holography also belongs to this class, because undiffracted beam surves as a reference beam. This may be accomplished also by use of the rectangular interferometer, in which path lengths of two beam falling upon the plate from opposite directions can be made to coincide. The second cause of reduction of fringe visibility is diffraction from the object. The diffracted wave from the object falls upon the plate at an angle θ to the undiffracted wave, where $\theta = \lambda l$, 'l' is the spatial frequency of the object. Then, an additional path difference Δ is introduced inspite of the exact equality of the path lengths of the reference and undiffracted object waves, where

$$\Delta = \frac{D\,\lambda^2 \iota^2}{2}$$

where D = distance between hologram & object.

If this path difference is equal to the coherence length L of the source, the highest spatial frequency that can be reconstructed is given by :

$$\iota = (\lambda)^{-1} (2\ L/D)^{\frac{1}{2}}$$

4.3 APPLICATIONS OF HOLOGRAPHIC INTERFEROMETRY

Chapter III, accounts for complete experimental aspects of holography. An account of vibration isolation table, recording materials, processing of hologram is elaborated.

In addition to this most viable technique of holographic non-destructive testing through double-exposure interferometry is given. The stressing concept which plays an important role in detecting abnormalities in the surface of the object by observing fringe pattern is discussed. We have carried out the stressing with thermal treatment and mechanical loading. The qualitative interpretation is given.

Holography, a simple technique in testing the optical component is discussed, by using the simple arrangement of off-axis holography. The holographic interferometry has many advantages over the conventional one and can be applied in many fields of engineering. The features of holographic interferometry, the appearance of fringes on a rough surface, the multiplex recording of a state of objects, self compensation of initial conditions, and so on are utilized in the thermal and mechanical experiments. The new character of the technique produces a new method. Experiments in three dimensions may be promising in engineering by using the reproducibility of three dimensional information, which is also one of the distinctive features of holography.

In recent years the evaluation of optical system has come into wide use and various practical instruments for testing have been used at institutes and industries. These instruments are generally complicated and delicate with optical, mechanical and electrical parts. Compared with those instruments, the holographic devices for testing optical components are simple in construction and operation. The autocorrection methods by holographic interferometry need no complicated interferometer, but only a hologram scanner and photometer. This is very convinient for testing a lot of lenses for industry.

Applications of holographic non-destructive testing in industry includes metals, non-metals, very small to very large objects and stationary as well as moving objects. In medicine, holographic non-destructive testing includes mammography, NMR Scan, general x-radiography and microangiography. Noncontact measurements using sensors are important in a whole range of subjects from geology, forensic studies, aerial temperatures and authentication. The examinations are concern with flaws, defects, discontinuities, imperfections, inhomogeneties, temperature and pressure variations, topography and surface contamination.

For elaborating above things, NDT by itself is not really sufficient, it is essential to add nature of the specification of product or material. The operator of test is another important factor, and operator fatigue, as well as training, represents both an essential ingredient and a several problem affecting, it is the most useful to have library of as many examples as possible, all concerned with practical situations. For this reason a very extensive method of NDT that is holographic interferometry is given.

Holographic optical component testing is simple. The distortion is obtained by the deliberately irregular spraying of transparent flat piece of plate glass. It is difficult to estimate in this case, the exact amount of the thickness variations thus obtained, but the order of magnitude computed appears in reasonably good accord with the thickness variations on the plate. Even though the actual results in this case appear only qualitative, to some degree, but greatly improved image reconstructed from the hologram.

It is difficult to obtain a magnified image without abberation, because an abberation free image with a hologram can be reconstructed only when its magnification is unity. A combined optical system with lens and hologram should be taken into account in order to make it possible to expand the function of a conventional lens system as well as holography itself. In this system lens forms a magnified image of an object and the hologram corrects the abberations of lens. This optical system has a disadvantage that it does not enable us the real-time observation of image. However, it gives us some benifits such as a working distance which is longer than that of a conventional lens system because the defocusing abberation of the lens can be corrected with a hologram. Further the lens is quite simple in its construction, because almost all abberation can be corrected with the hologram. Now-a-days, for getting the best resolution in the instrument like telescope, optical engineers want to make measurements of fine structure.

4.4 CONCLUDING REMARKS

The following points emerge from our studies on holography.

(i) We have successfully recorded different types of holograms.

(ii) Our critical assessment on holographic interferometry indicated that Double-Exposure Technique is simplest for practical purpose of flaw visualization.

(iii) Our studies on the test samples used in double-exposure holographic interferometry showed that fringe spacing is more in copper as compared to aluminium which is due to difference in thermal conductivities of these two metals.

(iv) In double-exposure hologram of steel plate it is noticed that there is a discontinuity in the fringe pattern indicating fracture in the plate.

(v) In double-exposure hologram of jet valve, it is found that the fringe pattern consists of fringes with different widths indicating a flaw in the object.

(vi) Double-exposure hologram of steel cylinder shows circular fringes, and have been shifted upward or downward depending upon the position of applied load.

(vii) From double-exposure holographic interferometry using thermal and mechanical stressing it is possible to find out flaws, defects, discontinuities and inhomogeneties of the rough metal surfaces and any industrial products. Since it is non-destructive and non-contacting test technique, has advantages over conventional test technique.

(viii) Holographic interferometry can be successfully used for optical component testing. It gives best resolution required in optical engineering and has many advantages over conventional interferometry.

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