Chapter 6

Summary and future scopes

On the course of this work, digital holography has been looked upon as a tool for 3D imaging of wavefronts. By three dimensional imaging, it means that both the amplitude and phase of the object wavefront are imaged. Phase contains information about the object such as its shape, density, temperature distribution etc. By reconstructing the phase of the object wavefront, various object parameters can be determined.

Lenses are one of the most important optical elements used. The characterization of wavefronts produced by lenses can be determined by various methods. But digital holography opens up a new way for imaging these wavefronts, directly yielding their characteristics. Digital holography was used for imaging wavefronts from test lenses and the reconstructed phase information was used to determine various parameters of the test lens. Since the phase information was directly available, it is possible to compare it to a computer generated ideal wavefront rather than comparing it with an optical one as is the case in many lens testing methods. The lens parameters measured were the curvature of the wavefront, focal length of the test lens, radius of curvature of the test lens as well as the refractive index of the lens material. Accurate focal length measurement of test lenses is very easy with this method. It is achieved by just comparing the wavefronts for two de-collimation positions of the test lens. In the future, the method will be extended to measure the tilt as will as shift of the wavefront produced by the lens. Digital holography will be used for testing various other lens aberrations such as spherical aberration and coma.

Study of temperature distributions in glass materials is very important form their application point of view. Here digital holographic interferometry was applied to image heat diffusion into glass plates as well as for imaging temperature distributions in flames. The change in refractive index in side the object was imaged using digital holography. The computed phase distributions from digital holograms before and after the existence of the spatially varying refractive index distribution were used to determine the refractive index change. This refractive index change in turn depends upon various parameters inside the object such as the temperature distribution, density distribution and even on the impurity concentration. So by measuring the refractive index change all these parameters can be studied. In the case of the glass slab, the thermal diffusion coefficient can be determined by finding the temperature and temperature change at two spatial points inside the medium. This temperature values is obtained from the computed phase distribution from digital holograms. In eh course of this work only axi-symmetrical refractive index distributions were investigated. For these types of distributions, a simple Abel inversion was used to determine the local refractive index changes. This was applied to flames as well as heat distributions in air. In the future non-symmetric refractive index distributions will be investigated using digital holographic interferometry. In that case several projections of the refractive index distribution for the object under investigation is necessary for determination of local values. This will be achieved by using detector placed at several angular positions.

Investigations of micro-organisms are very important especially from the view point of people involved in the study of biological objects. Especially the imaging of living cells and study of their dynamics under various conditions is a very important as well as challenging problem. Microscopy is the tool for viewing and studying such objects. Most of the biological micro-specimens are transparent to electromagnetic radiations in the visible regime. So it becomes very difficult to image those using conventional microscopic techniques. One has to use phase contrast techniques, which distinguishes between the optical path length changes occur to the probe beam inside the object. Digital holography is an appropriate tool for phase contrast imaging since it can directly provide the phase information of the object wavefront. Here digital holography was used for the phase contrast imaging of micro-objects. Its ability to image dynamic object was tested by imaging the thermal diffusion process in a

microscopic section of acrylic sheet. In the future the digital holographic microscope will be extended to study living cells for their characterization as well as identification.

The thesis dealt with the applications of digital holography in the filed of imaging of transparent object such as glass plates, lenses and biological specimen. But its application is not limited to transparent objects alone. It can be used to image diffuse objects. This aspect of digital holography will find application in many areas including its use in industrial environment for measurement and testing.