Abstract

The recent technological advancement has changed the face of the tools, instruments, and gadgets especially in the case of manufacturing & design industries and biomedical sciences. Many technological marvels have been invented and are functioning to provide enhanced results in their respective fields. Optical techniques are more favored especially in many cases as it provides many benefits especially in applications involving the investigation of transparent and translucent materials. Although noteworthy advancements have been achieved in the imaging as well as optical metrology applications, still, there is a significant demand for compact, simple, effective, rugged, and low-cost optical techniques.

In this thesis, an effort has been made to investigate optical techniques involving laser speckles for industrial and biomedical applications. The objectives of the thesis were achieved in three steps; (1) Laser speckle de-correlation technique where mere use of correlation function has yielded satisfactory results while measuring optical and physical properties. (2) Laser speckles phenomenon with the concepts of lens-less Fourier transform digital holography was employed to obtain complex amplitude which yielded the map of change in the refractive index of macroscopic technical samples subjected to thermal stressing. This technique thus helped in defect detection in transparent dielectric materials. The same technique is applied to obtain complex amplitude which yielded the phase contrast images of microscopic biological samples. (3) phase contrast imaging without using digital holography by employing iterative phase retrieval techniques and by using two wavelengths. Contours for steep objects were obtained thereby helping in shape measurement of objects such as lens; thus, the use of phase unwrapping was avoided keeping the experimental setup simple.

Emphasis has been laid upon reducing the form factor as well as the cost of the system, keeping the functionality intact. To summarize, in this research work a sincere effort has been put forward in the direction of developing compact, simple and cost-effective techniques and instrumentation for measuring and mapping

various physical and optical properties, based on laser speckles, which can be applied to various areas in the field of manufacturing industries and biomedical imaging.