DEVELOPING UNCONVENTIONAL HOLOGRAPHY AND IMAGING METHODS USING INTENSITY AND POLARIZATION CORRELATION: SPATIAL STATISTICAL OPTICS APPROACH

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by

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ABSTRACT

The random scattering of coherent and polarized light generates a complicated and spatially varying polarization states apart from the intensity and such random field is referred as polarization speckle. The speckle is a ubiquitous feature due to a complicated interference of the randomly scattered coherent light. Because the light is considered to be monochromatic and scattering medium is static, the scattered light is free from any temporal fluctuations and carries only spatial varying information. Investigations on such random light fields are important to understand physical properties of the speckles, and use physical parameters for applications such as lensless imaging and diagnosis etc.

This thesis covers investigations on the generation and analysis of the speckles using the spatial statistical optics. This is realized using the Hanbury Brown and Twiss (HBT) approach and polarization correlation. The HBT approach makes use of the two-point correlation of the random light fields. On the other hand, polarization is associated with the correlation between two orthogonal polarized components at a single point and described by the Stokes parameters. To characterize in-homogeneously polarized light, extension of the Stokes parameter to the two points known as generalized Stokes parameters and the HBT for polarized light are required.

New and significant features of this thesis are: The effects of different parameters of random source structures on two-point intensity correlation, in a two-dimensional and a three-dimensional propagation, are studied. A computational model is developed to analysis the 2D and 3D intensity correlations for comparison of the results with experiments. The effects of degree of spatial polarization on intensity correlation of the speckle are studied. An experimental technique is efficiently demonstrated to recover the polarimetric parameters of light field from a non-imaged laser speckle. To recover polarized objects hidden behind a scatter, a new approach, Lensless Stokes holography with Hanbury Brown Twiss interferometer is presented. The advantage of compressive sensing in correlation imaging is also presented.