Abstract

The light beam carries different types of optical information like polarization, frequency, complex amplitude, and spatial structure and these can be used for optical communication. When coherent light passes through a rough surface that is on the scale of a wavelength or any diffusive medium light gets scattered and those scattered light interfere to generate speckle, a random pattern of granular intensity patches. This makes it difficult for the conventional optical method to tell the desired optical information through a scattering medium. Exploiting the randomness is the best choice to use speckle for different applications. It has progressed rapidly and now the focus is on spatial statistical optics rather than temporal statistical optics. The developed techniques have applications in synthesizing the optical field with desired coherence and polarization shaping, and correlation imaging. These techniques utilize the concept of spatial stationarity of the scattered optical field for replacing the ensemble average with a spatial average under the condition of spatial stationarity and spatial ergodicity of the scattered field. The choice of spatial average permits the analysis of the statistical properties of the instantaneous speckle field or the time-frozen speckle field. The main work is done in two directions modulation of optical information and sensing of optical information through a scattering medium. First, we have concentrated on the coherence polarization shaping of the speckle pattern. A suitable choice of the source structure gives the possibility to modify the statistical characteristics of the optical field in the desired way since the intensity of the source structure term influences the intensity autocorrelation function. The work started by characterizing overhead projector (OHP) transparenciesand then using it to produce different source structures for the random medium to shape the coherence polarization (CP) property of speckles which can have bio-medical applications. Intensity correlation is used as a characterizing technique for speckles CP property. We have developed techniques to sense polarization and optical vortex (OV), beams through scattering medium using intensity and Stokes correlation. Intensity correlation was an already proposed technique for the characterization of the CP property of speckle patterns but was unable to state complete information of any arbitrary polarization through a scattering medium. Using intensity correlation and speckle superposition concept we have developed a technique to sense arbitrary polarization through a scattering medium. OV beams are used in communication and there is a possibility that we have to send it through a scattering medium. There is a need to sense it through a scattering medium. During encoding and decoding or in its way it can face aberrations. We have addressed the challenges of many techniques for recovering optical vortex through scattering layer with limitation and proposed Stokes correlation to speckle and demonstrated theoretically and experimentally the insensitiveness of the technique towards aberration. As aberration of an optical element can distort the wavefront of OV beams, leading to effects on its intensity, power spectrum, and propagation. A technique for faithful recovery of the OV beam was needed at this time.

Keywords: *Speckle pattern, Spatial coherence-polarization, Intensity Correlation, Speckle superposition, Optical Vortex, Stokes Correlation, Aberration, Polarization correlation.*