Chapter 6

Conclusion and future plan

6.1 Conclusion

In this thesis, different randomness-assisted imaging schemes are presented. In the first chapter, a background of coherent and incoherent features of light is discussed. Different types of digital holography designs and polarization schemes are discussed in detail. Few techniques such as phase conjugation, transmission matrix, and adaptive optics techniques are discussed to tackle with randmomness. Later in this section the main content of this thesis i.e, correlation based schemes are discussed in detailed. These schemes faithfully extract information from randomness by utilizing the randomness. New experimental methods and designs are developed for different imaging schemes. Moreover the work is extended to vectorial domain for developing polarization modes recovery schemes.

Before moving to the randomness-assisted scheme, in the second chapter of this thesis, we developed a compact, sable, and lensless experimental geometry for the polarimetric analysis of the SLM. This method is capable of providing amplitude, phase, and polarization of orthogonal polarization modes with the help of a cyclic interferometer. This concept of digital polarization holography is used to retrieve quantitative information for both the orthogonal polarization components. This is done by designing a stable cyclic interferometer which records the interference fringes by lateral shearing of two beams. The technique is tested in the external disturbances produced by the vibrations of a mobile phone and results are compared and found to be in good agreement.

In the third chapter, a new technique for simultaneous recovery of orthogonal polarization modes is presented. A tuneable beam displacer with triangular Sagnac geometry is designed to recover the orthogonal polarization modes in a single shot. The experiment is verified by performing experiment for different states of polarization and results confirm suitability of our technique in the parallel recovery of polarization modes from the randomly scattered coherent light.

In fourth chapter, we have demonstrated a new method to record holograms in the second-order intensity correlation, and the advantage of this recording appears in the quality of the reconstructed object from the hologram. This chapter in detail; discusses the role of intensity correlation for a number of incoherent random patterns that leads to the enhanced quality of image reconstruction. A twin image issue of the inline hologram is resolved with a deep learning method that uses an auto-encoder model. The quantitative features are retrieved, and quality is compared in a conventional and the proposed scheme. Moreover, the robustness of the scheme is tested and quantitatively examined by adding simulated white Gaussian noise. The scheme is expected to be useful in imaging beyond the diffraction limit and developing new holographic schemes.

In chapter 5, we developed a new technique of phase recovery in ghost diffraction. We implemented the replacement of ensemble averaging with spatial averaging instead of temporal averaging in GD. Moreover an iterative phase algorithm provides the complete recovery of two dimensional object from the spectrum. Use of Stokes parameter and their correlation is analysed for ghost polarimetry,where full polarization information is obtained for an object and simulation results combined with the iteration algorithm are presented.

In conclusion, the randomness assisted methods presented in the thesis successfully retrieve the desired information from randomness. These methods are stable and have potential applications in polarimetry, imaging through scattering media, biomedical imaging, defense, metrology and sensing, etc.

6.2 Future plan

Imaging through randomness is a very practical problem and researchers are still in the process of developing new ideas and designs to deal with randomness. As disscused in chapter 4, second order correlations have been used to improve image quality in holography. In future, we plan to test and implement higher order correlations, such as third and fourth order correlation for surpassing resolution in conventional imaging. Implementing higher order correlations in imaging techniques may require more advanced algorithms and computational resources compared to second order correlations. Therefore we wish to design some fast algorithms for this purpose. We also intend to explore the high quality imaging in vectorial domain. We could further test our experimental ideas for natural objects such as biological objects.

There is always room for enhancing the resolution quality in ghost diffraction schemes. We would like to explore other techniques and algorithms that would be applicable and valid for enhancing the image quality. We plan to investigate the possibility of using other algorithms, such as complexity guided algorithm for retrieval of more complicated objects or pure phase objects in ghost diffraction. These algorithms may be able to enhance the quality of the reconstructed image by include the extra information such as inherent complexity or structural information present in the object. They can aid in overcoming difficulties like noise or errors. Another interesting idea is to extend our study for phase-space interpretation. We would use the Wigner function for this study. In addition to this, we plan to design experimental schemes to examine effect of geometric phase on fundamental features of light specifically coherence.

On the other hand, the role of incoherent random patterns is important in studying basic light properties. We wish to explore algorithm such as non-matrix factorisation (NMF) for this purpose.