INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The laser scanning confocal microscope (LSCM) has become as a popular imaging tool for a wide range of investigations, particularly in biological and biomedical sciences, due to the ability of imaging thin slices of the specimen. Use of polarization profile of the illumination beam in an LSCM as one of the parameters can extract information such as on molecular organizations in the specimen, which is otherwise not possible. Many polarization measurements in LSCM require capturing images with more than one polarization. However, the change in polarization usually takes place at the end of one complete image frame, which leads to a delay between the illuminations with two different polarizations. Such an amount of delay may create issues for applications, for instance, imaging specimens which are not static. Besides, some applications require special illumination beams such as cylindrical vector beams. Therefore, the polarization based applications of LSCM require the setup to be equipped with a robust mechanism to generate illumination beams with arbitrary polarization profiles. Further, the system requires being capable of switching the illumination beam between different polarization profiles quickly. However, the conventional LSCMs do not have such mechanisms to generate and quickly switch between various user-defined polarization profiles of the illumination beam.

In this thesis, an experimental arrangement using a single liquid crystal spatial light modulator (LCSLM) is developed to generate arbitrary and user-defined vector beams with the highest average-power possible with an LCSLM based method. We carry out experiments to verify the working of the vector beam forming unit. We develop a galvanometer based laser scanning microscope employing the vector beam forming unit to design the illumination beam and introduce a few schemes to switch the polarization of the illumination beam at the end of each line scanned, in contrast to every full-frame image as in the conventional case. We implement polarization switching in both reflectance and fluorescence mode of the LSCM. We then introduce a holographic scanning confocal microscope working in both reflection and fluorescence modes that can provide better beam positioning accuracy than a galvanometer based setup. We also implement a polarization switching scheme in the holographic scanning confocal microscope.