SINGLE-SHOT INTERFEROMETRIC POLARIZATION MICROSCOPY

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We developed a novel interferometric microscopy technique, named Single-shot interferometric polarization microscopy (SIPM), to measure the birefringence distribution of an anisotropic sample. We use right-handed circular polarized He-Ne laser to illuminate the sample. Meanwhile, we built a near common-path interferometer with a Wollaston prism and a linear polarizer. A new digital holography algorithm is developed to simultaneously retrieve the retardance and orientation distributions with a single shot. Samples of quarter wave plate and liquid crystal are used to validate the efficiency of our method. We can recover the retardance of anisotropic sample with 4% error by an imaging speed of 150fps. We believe that our method has a great potential to be applied in biomedical observation and material inspection.

The experiment setup for Single-shot Interferometric Polarization Microscopy (SIPM) is shown in Fig.1(a). The wavelength of the laser is 633nm. The NA of the objective is 0.16 and the magnification is 4X. One of the axes of Wollaston Prism is set to be horizontal (zero degree), while the LP is 45 degree to the Wollaston prism. The design of near common-path interferometry provides with us the possibility of recovering the complex field, so that a single-shot image will elucidate the results of multiple measurements. Combining digital holography and Jones calculus, we designed an algorithm which can recover both the retardance and orientation angle distribution with a single interferometric image. Therefore, SIPM is much faster than the other intensity measurement based polarization microscopy techniques.

We used a 633nm quarter wave plate as a sample to validate our theory. We manually rotate the wave plate, and took the average value of the recovered retardance and the orientation angle of each pixel. The results are shown in Fig. 1(b) and (c), the average value of recovered retardance at different rotation angles is 0.491π, and the standard variance is 4% of the average retardance. While the standard variance of the difference of the measured orientation angles and the actual ones is 6%.

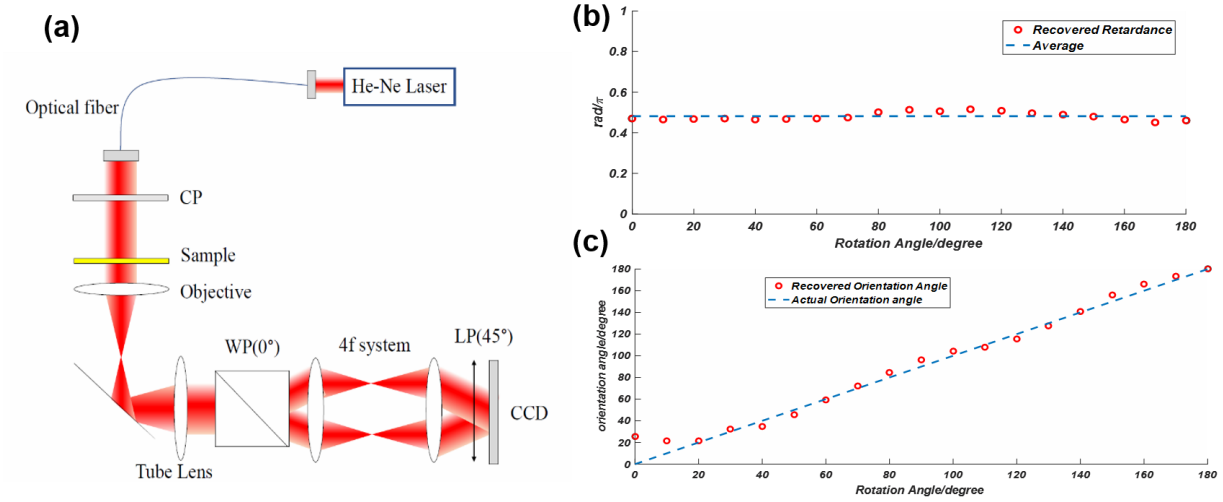

Figure 1 (a) The system scheme of Single-shot Interferometric Polarization(SIPM). CP, circular polarizer; WP, Wollaston Prism; LP, Linear Polarizer; CCD, charge coupled device. (b) the recovered retardance of a quarter wave plate sample on the dependency of rotation angle. The dashed line shows the position of 0.5 π. (c) The recovered orientation angles of a sample of quarter wave plate. The dashed line shows the position of the actual orientation angles.