Polarization Imaging via Polarization-Structured Illumination Microscope

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Polarized light imaging is an effective technique for visualizing invisible information of objects. For example, the diattenuation and birefringence of an object can be quantitatively evaluated [1]. Such polarization information is useful for understanding the function and structure of a material [2]. We are studying about a polarization imaging method using polarization-structured illumination that contains an array of small light spots with different polarization states [3]. In the previous system, the numerical aperture of the focusing lens used was low, so that the resolution was not enough to observe a microscopic object. Enhancing resolution broadens the scope of applications including bio-imaging, and therefore, we conducted fundamental experiments using a microscope to explore its potential.

Our method uses a polarization-structured spot array for illumination to obtain the information of diattenuation properties (absorption rate and axis angle) of a sample. In this array, horizontal and vertical linearly polarized light spots are arranged in a dense and regular pattern by computer generated holography, allowing simultaneous image construction of polarization images based on spatial division multiplexing. The light transmitted through a sample is captured by a polarization camera, providing intensities on different polarization components at a time. Next, the sample is assumed to have two diattenuation axes, with the maximum-absorption rate μ_1 and the minimum-absorption rate μ_2. To determin the orientation angle θ of the maximum absorption axis, intensity distributions from four pairs of polarization inputs (0° or 90°) and detection angles (45° or 135°) are analyzed. This intensity dataset allows for the calculation of the diattenuation parameters θ, μ_1, and μ_2.

Figure 1(a) shows the optical system we used. In a microscopy system, the light wave is focused by a 20x objective lens to generate a structured polarization spot array on a sample. The transmitted light from the sample is observed using a 40x objective lens. In the experiment, we used polarization filters with the axis of 45° and 135° as target samples. Figure 1 (b) shows the result. The line segments express the orientation angle of θ. Although, there are some errors, the direction of diattenuation axis is obtained. We confirm that the method enables us to get diattenuation information of objects using a microscope.

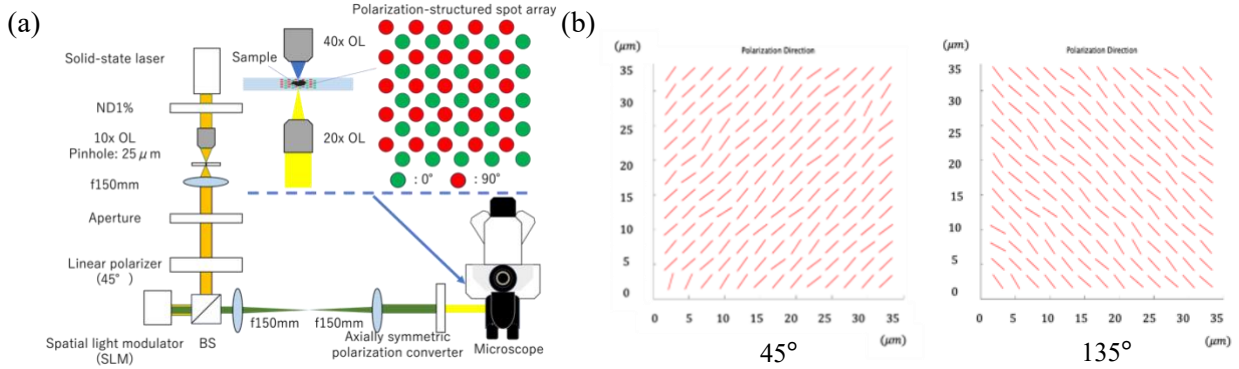

Fig. 1 (a) Experimental setup. (b) Direction of the diattenuation axis of polarization filters with the axis of 45°(upper) and 135°(lower).

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References

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