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The Anisotropy of Light Propagation in Biological Tissues

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In this paper we present a modified transmission digital holographic microscope that can be used to image the state of polarization of biological tissue. The resulting device, called polarization-sensitive phase-shifting digital holographic microscope (PS-DHM), records in on-axis geometry the interference between the reference and object beams with the same polarization, but were acquired at two orthogonally polarizations. The object wave transmitted by the biological tissue and magnified by a microscope objective. CCD camera records the two resulting holograms at vertical and horizontal polarizations. The PS-DHM system was upgraded with the liquid crystal variable retarder to perform phase shifts in the reference beam. The polarization-dependent phase-shifted holograms are recorded by rotating the half-wave plates. Using a single hologram, we reconstruct separately the phase map at each polarization, which are used then to represent the phase difference at two orthogonal states of polarization. This phase difference reflects *the polarization-dependent refractive index* associated to the anisotropy of biological tissue under study. The reconstruction and least-square unwrapping algorithms are used to extract phase information of biological tissues at different polarization states. The birefringence of tissue is obtained from the above-phase distributions. The proposed method is illustrated with applications to three samples: the cancer cells hematoblast, the pollen cells and the heart tissue. The results show that polarization sensitivity exists in the cancer cells hematoblast tissue, the pollen cells itself are not the anisotropic, but their walls are birefringent, and any significant anisotropy in the heart tissue was not watched. These results will provide reference for clinic diagnoses and pathological research.