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Research Article

Improved Diagnostics Using Polarization Imaging and Artificial Neural Networks

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Abstract

In recent years, there has been an increasing interest in studying the propagation of polarized light in biological cells and tissues. This paper presents a novel approach to cell or tissue imaging using a full Stokes imaging system with advanced polarization image analysis algorithms for improved diagnostics. The key component of the Stokes imaging system is the electrically tunable retarder, enabling high-speed operation of the system to acquire four intensity images sequentially. From the acquired intensity images, four Stokes vector images can be computed to obtain complete polarization information. Polarization image analysis algorithms are then developed to analyze Stokes polarization images for cell or tissue classification. Specifically, wavelet transforms are first applied to the Stokes components for initial feature analysis and extraction. Artificial neural networks (ANNs) are then used to extract diagnostic features for improved classification and prediction. In this study, phantom experiments have been conducted using a prototyped Stokes polarization imaging device. In particular, several types of phantoms, consisting of polystyrene latex spheres in various diameters, were prepared to simulate different conditions of epidermal layer of skin. The experimental results from phantom studies and a plant cell study show that the classification performance using Stokes images is significantly improved over that using the intensity image only.