Quantitative birefringence microscopy using a rotating polarizer

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ABSTRACT

It has been widely recognized that the phenomenon birefringence can act as an effective marker for various diseases including a variety of cancer types where loss of birefringence in normal tissues as in cervical cancer or the formation of birefringence structures surrounding accompanying inflammatory reaction as thyroid cancer has been established and well documented However, microscopes for complete and quantitative estimation of birefringence are not easily available as most of the proposed prototypes are complex in terms of their optical configuration and data acquisition. A simple hardware configuration whereby a standard light microscope may be converted to a birefringence microscope capable of quantitative analysis of birefringence is therefore the key to the use of birefringence for diagnostic purposes. The present work specifically addresses this problem. In a typical bio sample under test, both the magnitude of retardation and its direction are in general space varying parameters. It will be shown that if the bio specimen is illuminated by linearly polarized light it is possible to evaluate both of these parameters over the sample zone by combining a series of images captured as the polarizer rotates in steps from 0 to 180 degrees. The technique is refined further by using interpolation techniques whereby it is possible to decode the entire birefringence information accurately by using only five image frames at five different orientations of the output polarizer. Results in terms of the normalized Stokes parameter and degree of polarization images for several samples including nerve tissues, malignant breast tissues and botanical specimens will be presented.