AUTOMATED QUANTITATIVE DIFFERENTIAL INTERFERENCE CONTRAST MICROSCOPY IMPLEMENTED VIA LIQUID CRYSTAL DEVICES

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A phase shifting differential interference contrast (DIC) microscope which provides quantitative phase information capable of imaging at video rates has been constructed. Using a combination of phase shifting and bi-directional shear, the microscope captures a series of 8 images which are then digitally integrated. The resultant image intensity profile linearly maps to the phase differential across the object. The necessary phase shifts are performed by a set of 4 liquid crystal devices (LCDs) that shear the beam in orthogonal directions and can operate at high speeds. These replace the traditional Nomarski DIC microscope prisms. A liquid crystal bias cell delays the phase between the e- and o-beams providing phase-shifted images. The devices are then synchronized with a CCD camera in order to provide real time movies of live cell dynamics. This new electronically-controlled system, with no moving parts, overcomes the prior image registration and focus drift errors that plagued earlier implementations.

Fig. 1: Comparison of a traditional DIC versus QDIC image of an unstained human epithelial cell. The intensity of the QDIC image has a direct relationship to phase delay and can be used to measure the optical path length (OPL) through the various cell features (OPL=refractive index x thickness) and may be provide useful information to a biologist. Objective = 20x, 0.5NA.