DERIVATIVE OPTICAL IMAGING TECHNIQUE USING SINGLE-ELEMENT PHOTODETECTOR

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Optical microscopic systems are crucial tools for studying a wide range of materials and biological specimens. As a result, continuous efforts are being made to enhance existing microscopy techniques and develop novel contrast mechanisms for imaging, which can offer improved or complementary information. Among laser-based optical microscopy techniques, Spatial Frequency-modulated Imaging (SPIFI), developed by Futia et al. [1], has garnered attention due to its relatively simple setup that enables fast acquisition and compatibility with scattering media. SPIFI uses a cylindrical lens and a spinning disk (Lovell's reticle) for intensity modulation. It projects a modulated line onto the sample, encoding spatial information with specific frequencies, and spatial details of the sample are recovered using Fourier Transform from the collected signal in a single-element photodetector. Based on the SPIFI microscope, we developed a new approach to optical imaging also using a single-element photodetector, which we refer to as the Derivative Optical Imaging Technique (DOIT). DOIT also uses a cylindrical lens, which enables a swift acquisition of two-dimensional images with the necessity of scanning along only one axis. However, in DOIT, spatial modulation is achieved through a traditional optical chopper rather than the SPIFI mask. Despite sharing a similar setup, this innovative system is based on a distinct modulation and signal processing approach. We compute the derivative of the collected signal, and by performing the normalization of this result by the one without a sample, we reveal the image of the object. DOIT images may be obtained using linear and nonlinear optical processes and, although this technique is in its initial stages, it has already demonstrated to be a promising microscopy system, with the potential to be employed with radiation frequencies where an array camera is yet unavailable such as at terahertz and extreme ultra-violet range.

[1] Futia, G. *et al*. Spatially-chirped modulation imaging of absorbtion and fluorescent objects on single-element optical detector. **Optics Express**, v. 19, n. 2, p. 1626-1640, 2011.