Fiber Based Polarization Insensitive Optical Coherence Tomography System

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Optical coherence tomography (OCT) is a widely known imaging modality for high-resolution three-dimensional imaging in various medical & industrial applications[1,2]. While imaging, any polarization variation in the system can cause imaging artefacts. These artefacts compromise the ability of imaging system to accurately map the sub-surface features of the sample, hence degrading the overall image quality.

Many techniques like polarization controllers[1], polarization diversity detection schemes[2] and polarization maintaining fiber-based systems[3] are used to eliminate imaging artefacts from the OCT images. However, the complexity and instability of these systems makes it harder to implement them in clinical and industrial settings[4]. In this work, we have developed a polarization independent system which uses the excess depth scan range of the system, to detect the two orthogonal polarization images simultaneously. In this approach, a polarization delay unit separates the two orthogonal polarization signals by half of the scan range. This signal is then detected by using a single detector, reducing the complexity of the system.

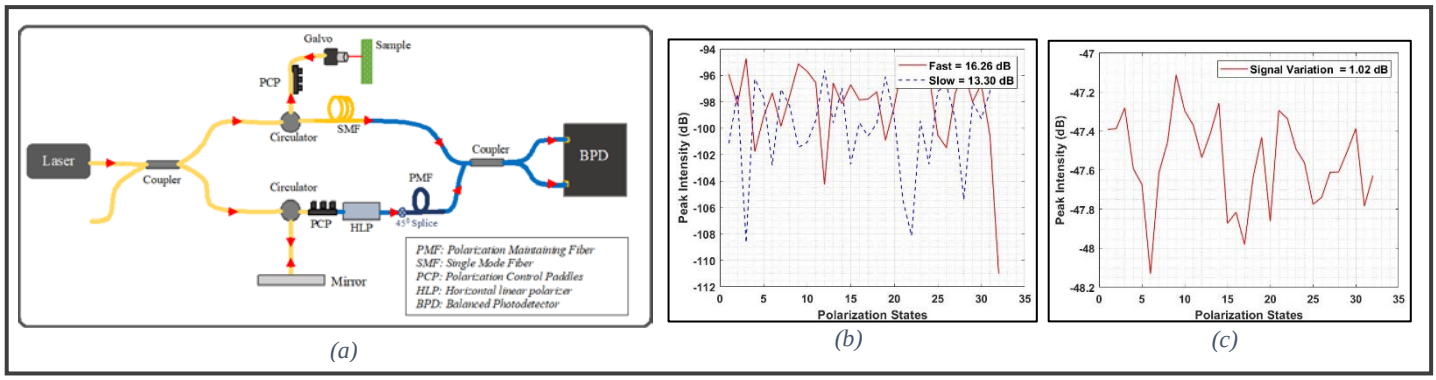

Figure 1: (a) Polarization Independent OCT System (b) Slow & Fast axis Polarization Variations with Sample Arm Rotation (c) OCT Total Signal Intensity Variation with Sample Arm Rotation

In this work, the OCT signal fluctuation with sample arm polarization variations for this design along with a few images of some birefringent samples will be presented. A comparison of this design with various other polarization independent schemes will also be discussed.

[1] Nanshuo Wang, Xinyu Liu, Qiaozhou Xiong, Jun Xie, Shi Chen, and Linbo Liu, Polarization management to mitigate misalignment-induced fringe fading in fiber-based OCT, Optics Letters (2017).

[2] Anthony M. D. Lee, Hamid Pahlevaninezhad, Victor X. D. Yang, Stephen Lam, Calum MacAulay, and Pierre Lane, Fiber-optic polarization diversity detection for rotary probe OCT, Vol. 39, Issue 12 (2014).

[3] Erich Götzinger, Bernhard Baumann, Michael Pircher, and Christoph K. Hitzenberger, *Polarization maintaining fiber based ultra-high resolution spectral domain PS-OCT*, Optics Express Vol. 17 (2009).

[4] Asha Parmar, Gargi Sharma, and Kanwarpal Singh, *Polarization Independent Optical Coherence Tomography*, IEEE Photonics Journal, Vol. 14, No. 2, (April 2022).