RF-Photonics for spectroscopy and fiber-based sensing

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Developments in the field of RF photonics have led to new techniques for fiber-based sensing and spectrum analysis. One such technology exploits chromatic dispersion to distinguish between the spectral components. The underlying concept of the technique, first described by Tong et al [1], relies on the time-response to dispersion, enabling the linear transformation of wavelength distribution to temporal distribution. One way of accomplishing this is by measuring the time response of a pulse passing through a dispersive element. This method, which is used in several applications including dispersion measurements, fiber sensors, and spectroscopy, requires the modulation of short pulses and the use of fast oscilloscopes to achieve high spectral resolution.

In addition, the temporal response can be resolved by carrying out measurements in the frequency domain, and then applying an inverse Fourier transform on the results. In this method, the light is modulated by an RF frequency-swept sinusoidal signal and the RF response is recorded after passing through the dispersive element. This method was recently investigated for the purpose of FBG interrogation and spectral analysis. Besides the advantage of redundancy for high sample-rate oscilloscopes, frequency domain measurements have the advantage of incorporating a narrow-band filter around the measured frequency which is desirable for noise rejection.

We describe a new technique for incoherent optical frequency domain spectroscopy (I-OFDS) that does not require measurements of the RF phase spectrum in order to reconstruct the optical spectrum [2]. It is based on the addition of either an optical or electronic reference line to the I-OFDS system. Compared to the spectrum acquired by a regular I-OFDS system, high accuracy (error < 1%) is predicted and achieved.