Linear signal distortion correction using an Optical Fourier Transform

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The use of an optical Fourier transform (OFT) has recently been proposed as a suitable technique for correcting for the effects of linear impairments such as dispersive pulse spreading that arise during the transmission of short-pulse signals [1].

The approach relies on the fact that although the direct temporal representation of an optical signal is degraded by linear impairments the spectral shape remains unaffected. Thus it follows that if one can reliably Fourier transform the spectrum of a data pulse into the time domain, and make decisions based on this temporal signal rather than the direct temporal signal then the effects of the linear impairments should be avoidable. In the case that the transmitted data pulses are Gaussian then their spectral shape resembles their temporal shape and the approach is intuitively understandable. However, it is to be appreciated that subject to certain caveats, the concept can be also be applied to other pulse forms even if their spectrum does not have exactly the same shape as the pulse in the time domain.

OFT can be achieved by applying phase modulation to the signal, (in order to impose the required linear chirp), followed by the application of linear group velocity dispersion. By carefully balancing the amounts of the applied phase modulation and dispersion, the temporal intensity profile of the pulses can be transformed to the spectral domain and vice versa. OFT is typically demonstrated using an electro-optic phase modulator driven by a sinusoidal signal at the repetition rate of the transmitted signal followed by a length of standard single mode fibre. However, the phase modulation imposed by a sinusoidal signal generates a linear chirp over a limited time window centred about the peak of the sinusoid. In our demonstration, we impart the required phase modulation onto the signal via cross-phase modulation (XPM) using intense pump pulses with a parabolic intensity profile generated using a superstructured fibre Bragg grating pulse shaping technique [2]. Our technique is based on the observation that XPM with such pulses generates a linear chirp (since the derivative of a parabola is a first-order polynomial). Thus the region of linear chirp can be extended over the full duration of the parabolic pulse which can be shaped to extend over the majority of the bit slot.

References

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