Convolution theorems for the linear canonical sine and cosine transform and its application

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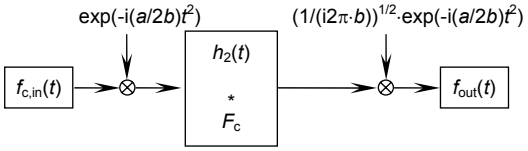

The method to achieve the bandpass multiplicative filters in the CCT domain by convolution in the time domain

Overview: In the modern optical signal processing domain, the collected signals must be denoised before the signal is analyzed and processed. The multiplicative filtering is one of the effective denoising methods in signal processing field based on the convolution theorem. The classical convolution theorem shows that the convolution of the two signals in time domain is leads to simple multiplication of their Fourier transforms in the Fourier transform domain. But Fourier transform is a holistic transformation based on the time domain or frequency domain, which is not suitable for modern optical signal processing.

As generalization of the Fourier transform and the fractional Fourier transform, Linear canonical transform has become a one of the powerful tools for modern optical signal analysis and processing, and has achieved fruitful research results in recent years. In order to further reduce computation and improve computing efficiency, convolution theory and application based on linear canonical transform has become one of the hot topic research in modern optical signal processing. Therefore, this paper will mainly focus on the research of convolution theory and application based on canonical sine transform and canonical cosine transform which have very close relations with the linear canonical transform, and have important role in signal processing, optics and other fields. Because canonical sine transform has no even eigenfunction and canonical cosine transform have no odd eigenfunction, therefore, it is much more efficient to use the canonical sine transform to deal with the odd signal and use the canonical cosine transform to deal with the even signal. Moreover, the complexity of the canonical sine transform and canonical cosine transform is one half of the complexities of the linear canonical transform, then, it is more suitable for engineering applications.

Hence, for the denoising problem of odd and even signals, a multiplicative filter design method based on the convolution theorem of the canonical sine and cosine transform is proposed. Two kinds of the convolution theorems associated with the canonical sine and cosine transform based on the existing linear canonical transform domain convolution theory are derived. Using this two convolution theorems, a kind of the multiplicative filtering model of the band-limited signal is designed by choosing an appropriate filter function in canonical sine and cosine transform domain. And the complexity of this scheme is analyzed. The results indicate that this filtering model is particularly suitable for handling odd and even signals, and can effectively improve computational efficiency by reducing computational complexity.

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