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Original Research Article

Octonion spectrum of 3D short-time LCT signals

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ABSTRACT

This work is devoted to the development of the octonion linear canonical transform (OLCT) theory proposed by Gao and Li in 2021 that has been designated as an emerging tool in the scenario of signal processing. The purpose of this work is to introduce octonion linear canonical transform of real-valued functions. Further more keeping in mind the varying frequencies, we used the proposed transform to generate a new transform called short-time octonion linear canonical transform (STOLCT). The results of this article focus on the properties like linearity, reconstruction formula and relation with 3D-short-time linear canonical transform (3D-STLCT). The crux of this paper lie in establishing well known uncertainty inequalities and convolution theorem for the proposed transform.

1. Introduction

The generalized integral transform called the linear canonical transform (LCT) has been designated as an emerging tool in the scenario of signal, image and video processing recently. The LCT provides a unified treatment of the generalized Fourier transforms in the sense that it is an embodiment of several well-known integral transforms including the Fourier transform, fractional Fourier transform, Fresnel transform. However, LCT has a drawback. Due to its global kernel it is not suitable for processing the signals with varying frequency content. The short-time linear canonical transform (STLCT) [1] with a local window function overcome this drawback. For nonstationary signals, STLCT has been used widely and successfully in signal separation and linear time frequency representation.

The hyper-complex Fourier transform (FT) is of the great interest in the present era. It treats multi-channel signals as an algebraic whole without losing the spectral relations. Presently, many hyper-complex FTs exists in literature which are defined by different approaches, see [2,3]. The developing interest in hyper-complex FTs includes applications in watermarking, color image processing, image filtering, pattern recognition and edge detection [4–9]. Among the various hyper-complex FTs, the most basic ones are the quaternion Fourier transforms(QFTs). QFTs are most widely studied in recent years because of its wide applications in optics and signal processing. Various properties and applications of the QFT were established in [10–13]. The generalization of quaternion Fourier transform (QFT)is quaternion linear canonical transform (QLCT), which is more effective signal processing tool than QFT due to its extra parameters, see [14–20]. Later, the quaternion linear canonical transform (QLCT) with four parameters has been generalized to short-time quaternion linear canonical transform (STQLCT) [21]. It is useful in quaternion valued signals and is an alternative to 2D complex STLCT. Hence has found wide applications in image and signal processing, see [22–25].

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