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Wavelet packets associated with linear canonical transform on spectrum

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The linear canonical transform (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. Using this fascinating property of LCT, we, in this paper, constructed associated wavelet packets. First, we construct wavelet packets corresponding to nonuniform Multiresolution analysis (MRA) associated with LCT and then those corresponding to vector-valued nonuniform MRA associated with LCT. We investigate their various properties by means of LCT.

Keywords: Vector-valued nonuniform multiresolution analysis; linear canonical transform; vector-valued nonuniform wavelet packet; scaling function.

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1. Introduction

Multiresolution analysis (MRA) is an important mathematical tool since it provides a natural framework for understanding and constructing discrete wavelet systems. A MRA is an increasing family of closed subspaces $\{V_j : j \in \mathbb{Z}\}$ of $L^2(\mathbb{R})$ such that $\bigcap_{j\in\mathbb{Z}} V_j = \{0\}, \bigcup_{j\in\mathbb{Z}} V_j$ is dense in $L^2(\mathbb{R})$ and which satisfies $f \in V_j$ if and only if $f(2\cdot) \in V_{j+1}$. Furthermore, there exists an element $\varphi \in V_0$ such that the collection of integer translates of function $\varphi, \{\varphi(\cdot - k) : k \in \mathbb{Z}\}$ represents a complete orthonormal system for V_0. The function φ is called the *scaling function* or the *father wavelet*. The concept of MRA has been extended in various ways in recent years. These concepts are generalized to $L^2(\mathbb{R}^d)$, to lattices different from $\mathbb{Z}^d$, allowing the subspaces of MRA to be generated by Riesz basis instead of orthonormal basis, admitting a finite number of scaling functions, replacing the dilation factor 2 by an