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The novel Clifford-valued quadratic-phase wave packet transform and its applications

M. Younus Bhat[1] · **Shahbaz Rafiq**[1]

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Abstract
In order to represent the Clifford valued signals more efficiently in the time-frequency plane, we propose a novel integral transform known as Clifford quadratic-phase wave packet transform based on the convolution operator associated with the Clifford quadratic-phase Fourier transform. The article begins by deriving the fundamental properties of the proposed transform such as linearity, parity, dilation, and orthogonality relation. Furthermore, some vital results of harmonic analysis have been established like energy conservation, inversion formula, and characterization of range. Then we proceed by obtaining the uncertainty principles for the transform including Heisenberg's and logarithmic uncertainty principles. The essential part of the paper deals with the discussion of an illustrative example and several potential applications.

1 Motivation and introduction

The quadratic-phase Fourier transform (QPFT) is one of the most latest and salient signal processing tool in the universe of time-frequency analysis. Introduced by Castro et al. [13], the QPFT analyses both the transient and non-transient signals in an excellent fashion. This transform has an exponential kernel with five real parameters and is defined in the following way [14]

$$\mathcal{Q}_\nu[f](w) = \int_{\mathbb{R}} f(t)\mathcal{K}_\nu(t, w)dt, \tag{1.1}$$

where $\mathcal{K}_\nu(t, w)$ is the quadratic-kernel defined as

✉ M. Younus Bhat
gyounusg@gmail.com

Shahbaz Rafiq
rafiqshahbaz04@gmail.com

[1] Department of Mathematical Sciences, Islamic University of Science and Technology, Kashmir, Awantipora 192122, Jammu & Kashmir, India

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