Received: 13 October 2021 | Revised: 17 September 2022 | Accepted: 15 December 2022

DOI: 10.1002/mma.8994

RESEARCH ARTICLE

WILEY

The two-sided short-time quaternionic offset linear canonical transform and associated convolution and correlation

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Communicated by: Q. Chen

Funding information
JKST&IC, UT of J&K, India, Grant/Award Number: JKST&IC/SRE/J/357-60

In this paper, we introduce the two-dimensional short-time quaternion offset linear canonical transform (ST-QOLCT), which is a generalization of the classical short-time offset linear canonical transform (ST-OLCT) in quaternion algebra setting. Several useful properties of the ST-QOLCT are obtained from the properties of the ST-QOLCT kernel. Based on the properties of the ST-QOLCT and the convolution and correlation operators associated with QOLCT, we derive convolution and correlation theorems for the ST-QOLCT. Finally, some potential applications of the ST-QOLCT are introduced.

KEYWORDS

convolution operator, correlation operator, quaternion offset linear canonical transform, short-time quaternion offset linear canonical transform

MSC CLASSIFICATION

42C30, 42C40, 43A30

1 | INTRODUCTION

The linear canonical transform (LCT) with four parameters (a, b, c, d)[1–3] has been generalized to a six parameter transform (a, b, c, d, p, q) known as offset LCT (OLCT).[4–7] Due to the time shifting parameter p and frequency modulation parameter q, the OLCT has gained more flexibility over classical LCT and hence has found wide applications in image and signal processing (see previous studies[4,5,8–10]). On the other side, the convolution has some applications in various areas of mathematics like linear algebra, numerical analysis, and signal processing. On the otherhand, correlation is an important tool in signal processing, optics and detection applications. In the domains of LCT, Wigner–Ville distribution (WVD) and OLCT the convolution and correlation operations and their applications have been studied (see previous studies[9,11–17]).

In quaternionic analysis, the quaternion Fourier transform (QFT) is the most basic and important time-frequency analysis tool for multidimensional quaternionic signals. 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.[18–21] The QFT is regarded as the generalization of the real and complex FT to the quaternionic case. As in recent times the generalization of integral transforms to quaternion setting is popular, in this regard, the classical LCTs have generalized to quaternion-valued signals (QLCT) by some authors, which is more effective signal processing tool than QFT due to its extra parameters. The QLCT was firstly studied by Kou et al[22] including prolate spheroidal wave signals and uncertainty principles.[23] Recently, based on the (two-sided) QLCT,[22–27] the quaternion windowed LCT (QWLCT) and quaternion linear canonical S-transform (QLCST) of 2D quaternion signals has been introduced in Gao and Li[28] and Bhat and Dar,[29] which generalizes the quaternion windowed Fourier transform[30] and linear canonical S-transform.[2]

