

Fractional Nonuniform Multiresolution Analysis in $L^2(\mathbb{R})$

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September 19, 2020

Abstract

In order to provide a significantly richer representation of non-stationary signals appearing in various disciplines of science and engineering, we introduce here a novel fractional nonuniform multiresolution analysis (FrNUMRA) on the spectrum Λ given by $\Lambda = \left\{0, \frac{r}{N}\right\} + 2\mathbb{Z}$, where $N \geq 1$ is an integer and r is an odd integer with $1 \leq r \leq 2N-1$, such that r and N are relatively prime. The necessary and sufficient condition for the existence of nonuniform wavelets of fractional order is derived and an algorithm is also presented for the construction of fractional NUMRA starting from a fractional low-pass filter h_0^α with appropriate conditions. Moreover, we provide a complete characterization for the biorthogonality of the translates of the scaling functions of two fractional nonuniform multiresolution analyses and the associated fractional biorthogonal wavelet families.

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