



Review

Parameterised time-frequency analysis methods and their engineering applications: A review of recent advances



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ABSTRACT

It is well known that time-frequency analysis (TFA) characterises signals in time-frequency plane. Theoretically, traditional non-parameterised TFA can analyze any signal, but it is unable to provide the best representation for complex signals. On the other hand, parameterised TFAs provide a better representation of signal by parameterising kernel functions using additional parameters. Recently, parameterised TFAs have attracted widespread attention. In this paper, we first briefly revisit non-parameterised TFAs, then further discuss adaptive TFAs developed from non-parameterised TFAs, and then review four types of recent parameterised TFAs: Warped TFAs, Chirplet transforms, parameterised atomic decomposition, and parameterised TFA affine. From underlying principles and implementation point of view, we introduced the relationships, advantages and disadvantages of different types of parameterised TFAs. At the same time, we summarized the application of parameterised TFA in various fields and discussed research directions and trends in parameterised TFA study. This review focuses on a class of methods in TFA, parameterised TFA, summarizing its latest research progress and related engineering applications, so as to provide reference and guidance for researchers applying parametric TFA in different fields.

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Nomenclature

BWT	Bionic wavelet transform
CQ-NSGT	Constant-Q nonstationary Gabor transform
CQT	Constant-Q transform
CT	Chirplet transform
CWT	Continuous wavelet transform
D-STFT	Dispersion-based short-time Fourier transform
EWT	Empirical wavelet transform
FChT	Fan-chirp time-warping transform
FFT	Fast Fourier transform
FrFT	Fractional Fourier transform
GDS	group delay shift
GPTF	General parameterised time-frequency transform
GSS	Generalised synchrosqueezing
GWD	Generalized warped Wigner distribution
GWT	Generalised warplet transform
HC	Hyperbolic class
IF	instantaneous frequency
NDE	Non-destructive evaluation
PC	Power classes
PCT	Polynomial chirplet transform
PPS	Polynomial phase signal
QTFR	Quadratic time-frequency representation
S-transform	Stockwell transform
SCT	Spline chirplet transform
SPWVD	Smooth pseudo Wigner-Ville distribution
SST	Synchrosqueezed transform
STFT	Short-time Fourier transform
SWT	Synchrosqueezed wavelet transform
TFA	Time-frequency analysis
TFR	Time-frequency representation
WFT	Warped Fourier transform
WT	Wavelet transform
WVD	Wigner-Ville distribution

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