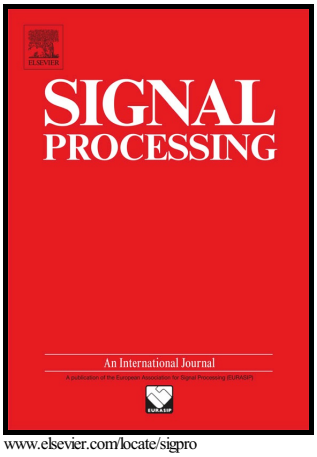

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An Automatic Fast Optimization of Quadratic Time-frequency Distribution Using the Hybrid Genetic Algorithm

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Abstract

This paper presents a novel framework for a fully automatic optimization of Quadratic Time-frequency Distributions (QTFDs). This 'black box' approach automatically adjusts the QTFD kernel parameters by using a hybrid genetic algorithm (HGA). This results in an optimal use of QTFDs suitable for non-specialist users without requiring any additional input except for the signal itself. This optimization problem has been formulated as the minimization of the cost function of a modified energy concentration measure. The efficiency of the proposed method has been demonstrated by representing selected non-stationary signals in the time-frequency domain and testing robustness under different SNR conditions by estimating the instantaneous frequency. A fast implementation of QTFD optimization reduces computation time significantly; e.g., the computation time of a real world bat signal of 400 samples reduces to 3.5885 ± 0.3942 Sec from its standard implementation (53.0910 ± 1.1445 Sec).

Keywords: Energy concentration measure, Gradient descent, HGA, QTFD, Time-frequency optimization.

1. Introduction

Time-frequency Representations (TFRs) are able to improve the characterisation of many non-stationary signals compared with classical time (t) domain or frequency (f) domain representations. The most popular TFDs are the spectrogram at one end and the Wigner-Ville distribution (WVD) at the other end. The spectrogram is sensitive to the chosen analysis window whereas the WVD is almost free from analysis window considerations and provides superior component concentration; but it suffers from cross-terms potentially leading to confusion and misinterpretation (due to the quadratic nature of the transform) [1, Ch.3]. A well-known technique is to smooth or