Oral Defense Announcement
University of Missouri – St. Louis Graduate School

An oral examination in defense of the dissertation for the degree
Doctor of Philosophy in Mathematical and Computational Sciences

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Instantaneous Frequency Estimation and Signal Separation Using
Fractional Continuous Wavelet Transform

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Abstract
In the signal processing field, time-frequency representations (TFR's) have intensively been improved to provide effective and powerful tools for reliable signal analysis. One of the most valuable and frequently used tools is Fourier transform (FT) which has been used to study the frequency content of stationary signals in the Fourier domain (FD). However, FT is not sufficient to study the frequency of non-stationary signals. For this particular type of signals to be best analyzed, some transforms such as the short time Fourier transform (STFT) and the continuous wavelet transform (CWT) have been introduced to provide us with a signal representation in the time-frequency plane. Another transform based on STFT and CWT, namely, the synchrosqueezing transform (SST), was introduced to improve the sharpness of the TFR's by assigning the coefficient value to a different point in the TF plane. Also, TFR's with satisfactory energy concentration and the corresponding SST's involving both time and frequency variables were introduced; namely, the instantaneous frequency-embedded STFT (CWT) (IFE-STFT/IFE-CWT), where a rough estimation of the IF of a targeted component was used to achieve an accurate IF estimation. Recently, the STFT, the CWT and the corresponding SST's with a time-varying window width are proposed and studied. These transforms have shown the confidence in the accuracy of both sharpening the TFR and separating the components of a multicomponent non-stationary signal, which then led to obtain a more accurate component retrieval formula at any local time. In order to improve the time-frequency resolutions, the concept of fractional Fourier transform (FrFT) was introduced as a potent tool to analyze time-varying signals; however, it fails in locating the frequency content in the fractional Fourier domain (FrFD). To this regard, the short time fractional FT (STFrFT) and the fractional CWT (FrCWT) were proposed to solve this issue by displaying the time and FrFD-frequency contents jointly in the time-FrFD-frequency plane. In this dissertation, we provide a component retrieval formula for a multicomponent signal from its FrCWT with integral involving only the scale variable and then introducing the corresponding SST (FrWSST). We also introduce the first and second order SST based on the IFE-CWT (IFE-WSST) and then propose time-FrFD-frequency representations with satisfactory energy concentration; namely, IFE-FrCWT and the corresponding SST (IFE-FrWSST). Lastly, we consider the FrCWT with a time-varying window width; namely, the adaptive FrCWT (AFrCWT) and the corresponding SST (AFrWSST). We propose these TFR's in the FrFD for the purpose of not only improving the accuracy of the IF estimation and the energy concentration of these transforms, but also enhancing the separation conditions for the components of a multicomponent signal to be retrieved more accurately.

Defense of Dissertation Committee
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