Radar maneuvering target detection method based on fast and high resolution sparse fractional Fourier transform

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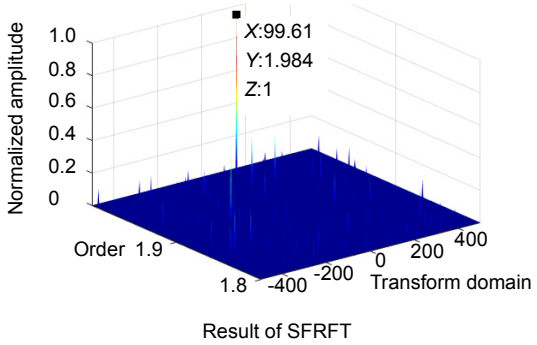

Result of SFRFT

Overview: Fast and effective detection of moving targets within a complex environment is always a challenging subject in the field of radar signal processing, which is also important in both military and civil fields. What they have in common is that due to the strong background, low radar resolution, far range and other factors, the signal-to-noise/clutter ratio (SNR/SCR) is so low in both time and frequency domains that detection performance is seriously descended. In general, radar signals can be classified as a kind of nonstationary signals and their frequencies are changing over time, so time-frequency analysis methods are studied to improve the detection performance of nonstationary signals. Radar echo of moving target with constant acceleration can be modeled as a linear frequency modulation (LFM) signal in some circumstances. The fractional Fourier transform (FRFT), which is the generalised formula for the Fourier transform (FT), has a good energy concentration property of LFM signal and it is feasible to the moving target detection and parameter estimation in low SCR environment. However, due to the wide observation range of radar and large amount of echo data caused by the new system radar, more requirements are put forward for radar target detection technology. It is urgent to study the valid signal analysis methods with high time-frequency resolution and suitable for large data volumes. Hence, more effective and higher efficiency FRFT-based methods for moving target detection are desired to improve the radar moving target detection performance under complex background. Recently, a novel sub-linear algorithm for discrete Fourier transform (DFT) named sparse Fourier transform (SFT) was developed by Hassanieh et al. SFT is a new discrete Fourier transform algorithm for sparse signals, which is more efficient than the traditional fast Fourier transform (FFT). Assuming that a LFM signal has a sparse characteristic in the fractional domain, in order to improve the time-frequency analysis speed, professor Tao of Beijing Institute of Technology redesigned Pei's discrete FRFT (DFRFT) method on the basis of SFT and studied a new fast algorithm, namely sparse FRFT (SFRFT). So the complexity of DFRFT is further reduced. The radar echo of target can be regarded as a superposition of a few strong scattering center echoes, which has a property of sparsity. This paper illustrates the implementation of SFRFT, then the SFRFT algorithm is applied to radar signal processing and a SFRFT-based fast and high resolution maneuvering target detection method is proposed. The effectiveness of the detection method is validated by simulation results. It is proved that the SFRFT-based detection method can achieve low computational complexity with good clutter suppression and parameter estimation ability.

Citation: Yu X H, Chen X L, Chen B X, *et al*. Radar maneuvering target detection method based on fast and high resolution sparse fractional Fourier transform[J]. *Opto-Electronic Engineering*, 2018, **45**(6): 170702

Supported by National Natural Science Foundation of China (61501487, U1633122, 61471382, 61531020), the National Defense Technology Fund (2102024), University Scientific Research Development Plan of Shandong Province (J17KB139), and the Special Funds of Taishan Scholars of Shandong and Young Talents Program of CAST (YESS20160115)

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