Analysis of PC6 window function using fractional Fourier transform

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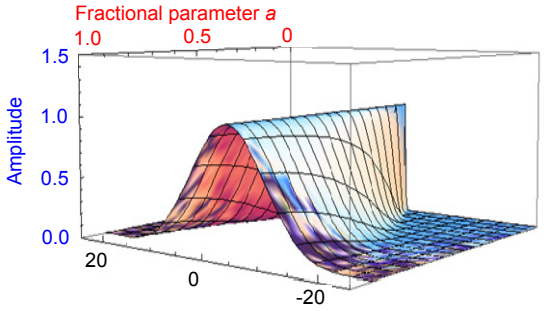

The continuum of FRFT of Parzen window function

Overview: Fractional Fourier transform (FRFT) is a linear transform generalizing Fourier transform (FT) that plays an important role in the field of signal processing and analysis. FRFT contains an adjustable parameter α, with which it rotates the signal in the time frequency plane and represents the signal in an intermediate domain between time and frequency. FRFT provides a measure about the angular distribution of signal's energy in time frequency plane. FT is a special case of FRFT when angle α is equal to $\pi/2$. Window functions have also played an important role in digital signal processing and analysis, digital filter design and speech processing. These are used in harmonic analysis to reduce the effects of spectral leakage. A window function which gives a spectrum that has minimum leakage is preferred. In signal processing, a window function also known as an apodization function or tapering function is a mathematical function that is zero valued outside of some chosen interval. When a signal or function is multiplied by window function it also becomes zero outside the chosen interval. A complete review of window functions and their properties using discrete FT (DFT) was presented by Harris. Over time, many window functions, have derived to optimize some features of a new window and for easy implementation. A practical window usually has a trade-off between the width of its main lobe and attenuation of its side lobes. No window function is found to be best in all aspects, so one should select a window function according to the requirement of a particular application.

This paper presents mathematical model for obtaining FRFT of PC6 window function. The different parameters of this window function are also obtained with the help of simulation results. A comparison of window function parameters is presented using FT and FRFT. Also comparison of this window function with Hanning window function is presented in terms of Side Lobe Fall off Rate (SLFOR). For different values of FRFT order, PC6 window function shows variation in different parameters. Thus by changing the FRFT order, the minimum stop band attenuation of the resulting window function can be controlled. The FRFT analysis of PC6 window function has been carried out for different values of FRFT order a. For PC6 window function, when θ is 1, Parzen window results, and when θ is 0, $\cos^6(\pi t)$ window results and for PC6 window θ is taken 1.29. As FRFT order a is decreased, MSLL starts building up, HMLW, -3 dB BW and -6 dB BW are decreasing which is good for spectral analysis and SLFOR is decreasing. CG is decreasing and ENBW is increasing which is undesirable. The CG should be high and ENBW should be low to minimize spectral leakage.

Also comparison plots show that combinational window provide better far end attenuation as compared to Hanning window function. Thus this study reveals that there are variations in window parameters with variations in FRFT order. Using FRFT best solution can be obtained for variety of practical applications. So the choice of window function should be as per the concluded benefit and drawbacks to get optimum performance for specific applications.

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