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A New Two-Dimensional Fractional Fourier Transform and the Wigner Distribution

The fractional Fourier transform $F_\theta(w)$ with an angle θ of a function $f(t)$ is a generalization of the standard Fourier transform and reduces to it when $\theta = \pi/2$. It has many applications in signal processing and optics because of its close relations with a number of time-frequency representations. It is known that the Wigner distribution of the fractional Fourier transform $F_\theta(w)$ may be obtained from the Wigner distribution of f by a two-dimensional rotation with the angle θ in the $t - w$ plane

The fractional Fourier transform has been extended to higher dimensions by taking the tensor product of one-dimensional transforms; hence, resulting in a transform in several but separable variables.

The aim of this talk is two-fold: 1) To introduce a new definition of the two-dimensional fractional Fourier transform that is not a tensor product of two copies of one-dimensional transforms. 2) To show that the Wigner distribution of the new two-dimensional fractional Fourier transform $F_{\theta,\phi}(v, w)$ may be obtained from the Wigner distribution of $f(x, y)$ by a more genuine and general four-dimensional rotation with angles $(\theta + \phi)/2$ and $(\theta - \phi)/2$ in two planes of rotations.