

FFT-BASED METHODS FOR SIMULATING FLICKER FM

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During the past several years, a new method for simulating stationary processes has been developed. This FFT-based method, "circulant embedding" of the covariance, gives exact simulations of many (but not all) stationary processes. Circulant embedding allows exact realizations of flicker FM phase noise models to be generated by two cumulative sums of certain stationary processes. Following is a brief description of two approximate methods and two exact methods.

DS: discrete spectrum. Generate white noise in the frequency domain, multiply by the square root of the desired discrete spectrum ($1/f^3$ in this study), take the inverse FFT.

IR: impulse response, an approximate simulation method for the FD(3/2) process (described next). Convolve a formal impulse response with white noise, using an FFT-based technique to speed up the computation.

FD: an exact simulation of FD(3/2), fractionally differenced white noise with parameter 3/2. Generate exact FD(-1/2) by circulant embedding, take two cumulative sums.

PPL: pure power law, an exact simulation of samples of continuous-time pure $1/f^3$ noise. Generate an exact simulation of the second increments of this process by circulant embedding, take two cumulative sums.

The methods are compared using two measures: Allan variance and calibrated mean square time interval error. The Allan variance shows only the slight differences one would expect from the different spectral contents of the underlying models. On the other hand, the MSTIE of the IR method is significantly less than that of the other methods. Also, the first and second halves of an IR output behave differently; this is not true for the other methods.

The exact methods are approximately as fast and easy to program as the approximate methods. Moreover, to obtain reasonably accurate results from the approximate methods, one should generate at least twice the number of points needed for the application; in particular, only the second half of an IR output should be used.

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