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Fourier Transform deconvolution of noisy signals and partial Savitzky-Golay filtering in the transformed side

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Abstract

The use of Fourier transform for deconvolution of noisy signals and the problem of the division in the transformed side are briefly discussed. Comparison between many deconvolutions of noisy signals with and without partial Savitzky-Golay filtering of the transformed functions is presented. Simulations with analytically known functions show that a proper deconvolution method can produce correct result, at least for moderately noisy functions.

Introduction

The response $D(t)$ of a system, having the characteristic function $I(t)$ (impulse response function), when driven by an input function $E(t)$ is given by the convolution of $I(t)$ by $E(t)$, defined as follows:

$$D(t) = \int_0^t I(\tau)E(t-\tau)d\tau \qquad (1)$$

$$= \int_0^t I(t-\tau)E(\tau)d\tau$$

$$= I(t) \bullet E(t) = E(t) \bullet I(t)$$

Obtaining $D(t)$ from $I(t)$ and $E(t)$ is straightforward. If the only available signals or functions are $I(t)$ and $D(t)$, extracting $E(t)$ from them entails the so-called deconvolution process. Direct extraction of $E(t)$ from the integrals in Eq. 1 is not so easy. Fortunately, once the functions are Fourier transformed, the operation becomes simple, Eq. 1 can be written as:

$$F\{D(t)\} = F\{I(t) \bullet E(t)\} \qquad (2)$$
$$= F\{I(t)\}F\{E(t)\}$$

Hence, the deconvolution can be performed as follows: