Inverse problems in signal processing: a Numerical Linear Algebra prospective

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In signal processing the time-frequency analysis of nonlinear and non-stationary processes, as well as the determination of the unknown number of active sub-signals of a blind-source composite signal are, in general, challenging inverse problem tasks. Standard techniques, like short-time Fourier transform, and wavelet transform are limited in addressing the problem. An alternative approach, proposed in 1998 in the Hilbert Huang Transform (HHT), is to first decompose the signal into simpler components and then analyze them separately. HHT is having a big impact in many filed of research (15300 citations in Scopus). HHT is made of two stages: the signal decomposition into simple oscillatory components via the Empirical Mode Decomposition (EMD) method, and their time-frequency representation via the Hilbert Transform. However, the mathematical properties of EMD and its generalizations, like the Ensemble EMD, are still under investigation. For this reason, an alternative technique, called Iterative Filtering (IF), was recently proposed. In this talk, we review IF mathematical properties, and the ones of its recently developed generalization, which is called Risampled Iterative Filtering (RIF) [1]. Furthermore, we show how Numerical Linear Algebra allows to guarantee a priori convergence of these methods and to speed up calculations, producing what is called the Fast Iterative Filtering (FIF) and Fast Risampled Iterative Filtering (FRIF) techniques [1]. Some applications will be presented, as well as open problems that are waiting to be tackled.

Joint work with G. Barbarino *and* H. Zhou

References

[1] G. Barbarino and A. Cicone, *Stabilization and Variations to the Adaptive Local Iterative Filtering Algorithm: the Fast Resampled Iterative Filtering Method*, submitted (2021), ArXiv:2111.02764