Contribution ID: **39** Type: **Poster**

On the time-frequency representation of nonstationary signals

The time-frequency analysis of nonlinear and nonstationary processes is, in general, a challenging task. Standard techniques, like short time Fourier transform, and wavelet transform are limited in addressing the problem. An alternative way to tackle the problem is to first decompose the signal into simpler components and then analyze them separately. This is the idea behind what is called the Hilbert Huang Transform (HHT), published originally in 1998. HHT has had and is still having a big impact on many fields of research.

HHT is made of two stages: the decomposition of the signal into simple oscillatory components, called Intrinsic Mode Functions (IMFs), obtained via the Empirical Mode Decomposition (EMD) method, and the time-frequency representation of these components obtained 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 Fast Iterative Filtering (FIF), was proposed a few years ago [1]. Furthermore, the Hilbert Transform, even though mathematically sound, has limitations when applied to real-life data, especially strongly nonstationary or noisy ones.

In this talk, we review the mathematical properties of FIF and the decomposition it produces. In particular, we will talk about the energy preservation and orthogonality of this decomposition. Furthermore, we introduce an alternative method for the time-frequency representation of the IMFs called IMFogram, showing its robustness to noise, locality, and ability to produce, in a fast manner, crisp and artifact-free time-frequency plots [2]. We conclude by presenting applications of this approach to real-life signals and future directions of research.

1. A. Cicone, H. Zhou. Numerical Analysis for Iterative Filtering with New Efficient Implementations Based on FFT. Numerische Mathematik, 147 (1), pages 1-28, 2021.
2. A. Cicone, W. S. Li, H. Zhou. New theoretical insights in the decomposition and time-frequency representation of nonstationary signals: the IMFogram algorithm. Applied and Computational Harmonic Analysis, 71, 101634, 2024.

Primary author: CICONE, Antonio (Università degli Studi dell'Aquila)

Presenter: CICONE, Antonio (Università degli Studi dell'Aquila)

Session Classification: Poster Session