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Monitoring LV Prosumers Operation Using Hilbert – Huang Method

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Introduction

- Accommodation of larger shares of unpredictable and stochastic electricity transfer from sources to end-users
- Evolving power systems require new control algorithms and accordingly a measurement layer with higher dynamic performances.
- Power quality measurements and associated signal processing applied in emerging control algorithms for microgrids and energy communities.
- Information in non-stationary power signals.
- Spatial and temporal variability of frequency and its potential use for event discrimination across network sections.

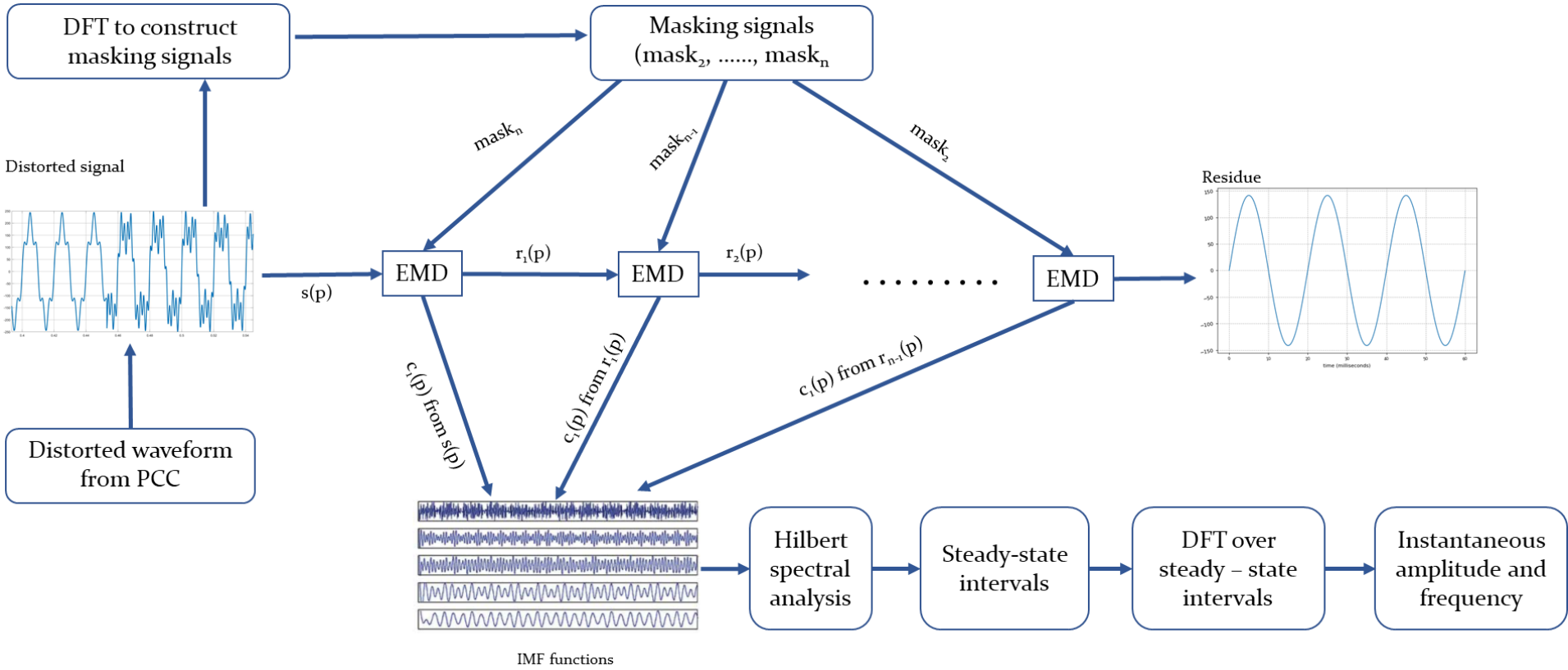
Motivation

- A new approximation model for grid characteristic quantities (voltages, currents, power) is needed.
- Many of the constraints are linked to measurement processes
- A new definition for measurement result delivery including the steady state flag derived from frequency measurements and with various application-selected thresholds and window durations.
- HHT is a powerful method to extract valuable information inside non-stationary, time-varying distorted waveforms but very few applications were investigated.

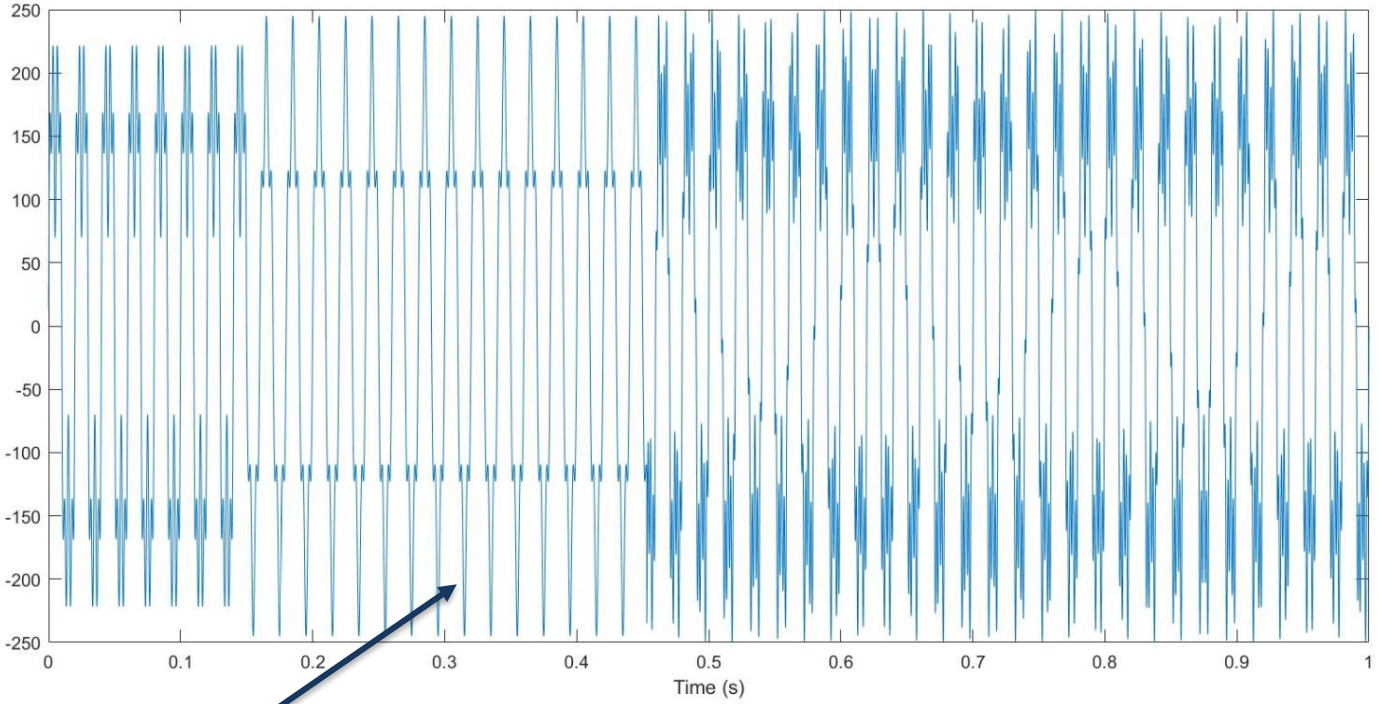
New Contributions

- An estimation technique of occurrence of events in time varying, non-stationary, non-linear waveforms characteristic to energy transfer in a prosumer environment based on HHT method.
- Decomposition of distorted signals with variable components whose frequencies are not spread over the whole window.
- Versatile version of the hybrid algorithm for constructing masks signals
- Post-processing technique by splitting the digitized original signal into steady-state time interval.
- The identification of steady-state intervals is part of a new paradigm for the representation of a measurement result.

Method of Analysis



Results (1/2)



$f_f = 50\ Hz$

$f_s = 20\ kHz$

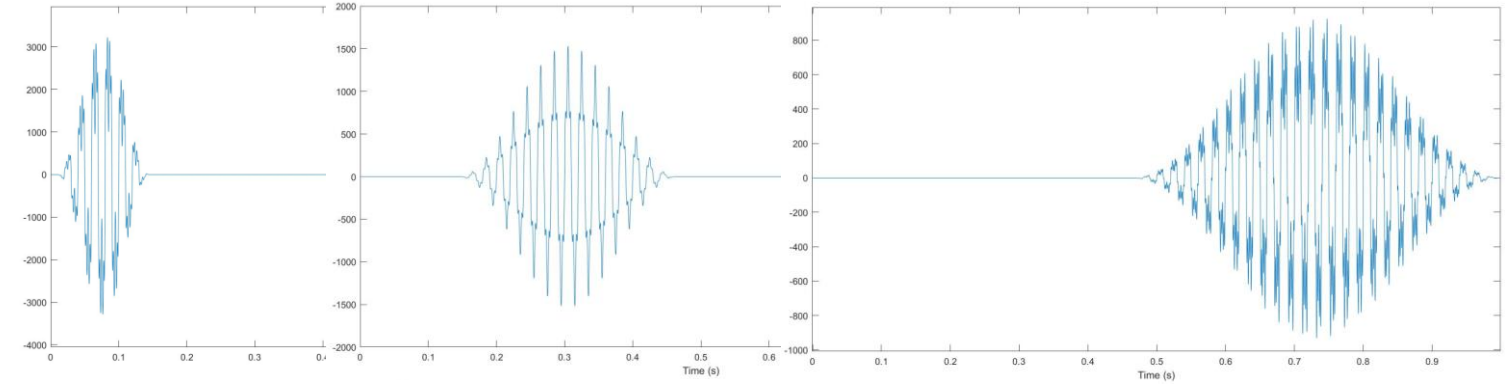
$T_a = 1s$

Plotted signal

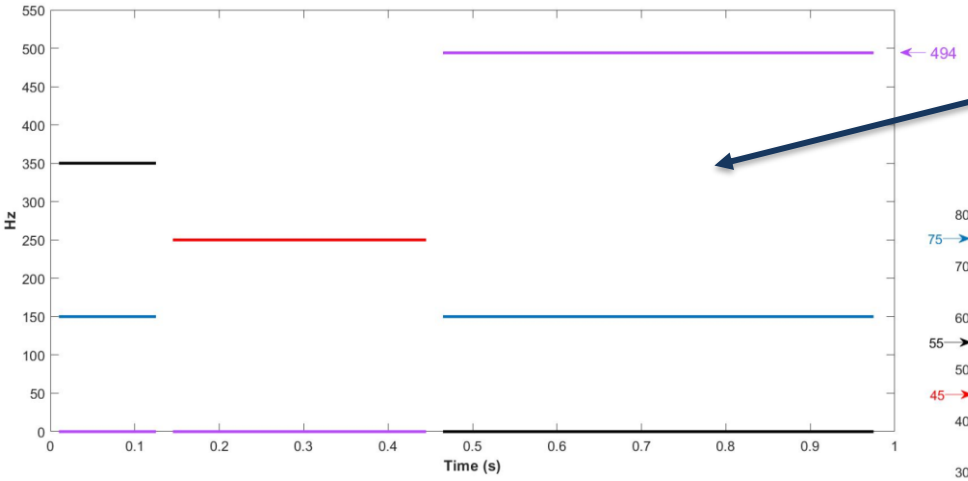
Time varying components

Time (s)	Component Magnitude							
	150 Hz		250 Hz		350 Hz		494 Hz	
	%	mA	%	mA	%	mA	%	mA
0–0.15	35	75	0	0	25	55	0	0
0.15–0.453	0	0	20	45	0	0	0	0
0.453–1.0	35	75	0	0	0	0	25	55

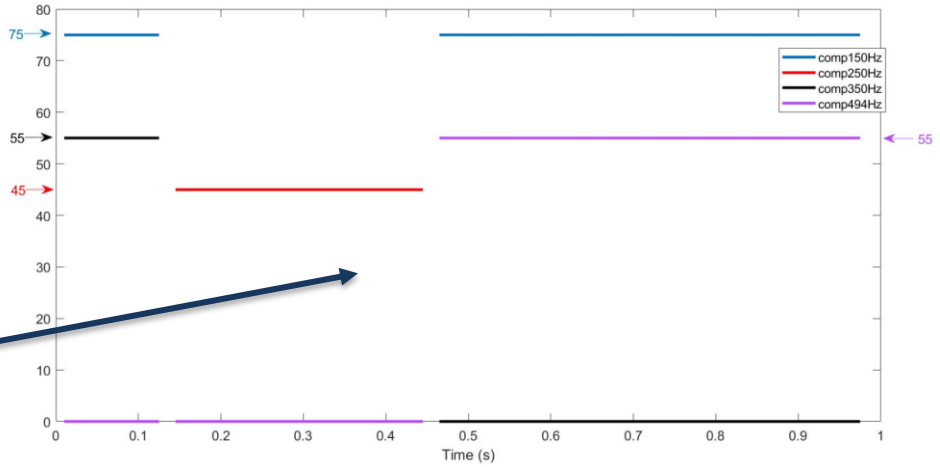
Results (2/2)



Steady-State Intervals



Instantaneous Frequencies



Instantaneous Amplitudes

Discussion

- The technique is an adaptation of the improved Hilbert-Huang method and the steady-state identification as presented in the Rapid Voltage Changes algorithm.
- The Hybrid method has shown to efficiently separate the modes existing within a signal that only appears on certain time intervals inside the investigation window.
- The main goal is to split the signal in quasi steady state intervals.
- The inclusion of the analysis in a new paradigm for measurement results representation.

Conclusions

- The method was tested on a synthetic signal with clearly defined frequency spectrum and variation intervals.
- Prospective applications of the method can include load and generation frequency signature patterns, prosumers system events detection and planning microgrids operation.
- Easier transition to the future sampled-values-waveform measurements and information retrieval.
- The next steps in validating the method, real-time measured waveforms from low voltage prosumers systems (including household appliances (e.g. microwave, air conditioning), PV generation systems, storage systems and charging points for electric vehicles.