NMD Toolbox v2.00*: Instruction

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Basic use

The main function implementing Nonlinear Mode Decomposition is **nmd.m**; it contains detailed documentation of all properties inside the file, while few examples are listed below.

NM=nmd(sig,fs);
Given a signal **sig** sampled at **fs** Hz, extracts all physically meaningful modes from it and returns them in rows of **NM**.

NM=nmd(sig,fs,'ModeNum',1);
Extracts only one oscillatory mode (not necessarily physically meaningful) from the signal.

NM=nmd(sig,fs,'Template','Fast');
Uses the set of parameters which improves speed of the procedure but slightly decreases its accuracy.

NM=nmd(sig,fs,'fmin',1,'fmax',8);
Extracts all physically meaningful modes which have at least one harmonic lying in the frequency range [1,8] Hz.

Alternative use

Almost each function contained in the NMD Toolbox can be used separately for different purposes, with such "stand-alone" use being usually quite clear. However, an important alternative application of NMD – removing the oscillatory activity corresponding to one signal from another one – is more complicated and thus should be illustrated in more detail. Consider one has a signal **sig** (e.g. EEG), which contains oscillatory activity related to some other (reference) signal **refsig** (e.g. ECG), both sampled at **fs** Hz. To extract the corresponding oscillations from **sig**, the following procedure can be used:

[WT,freq,wopt]=wt(refsig,fs);
Calculate wavelet transform **WT** of the reference signal. It might be useful to restrict the frequency range of WT to that in which the fundamental harmonic of reference oscillation lies, e.g. to [0.5,1.5] Hz if **refsig** is ECG (to do this, use **wt(refsig,fs,'fmin',0.5,'fmax',1.5)**). NOTE: one can alternatively utilize signal's WFT by using **wft(...)** instead of **wt(...)**.

tfsupp=ecurve(WT,freq,wopt);
Find the time-frequency support **tfsupp** in the wavelet transform **WT** corresponding to the main harmonic of the reference oscillations.

[ntfsupp,nWT,nfreq,nwopt,signif,rho]=imcurve(sig,tfsupp,WT,freq,wopt);
Calculate the wavelet transform **nWT** of the original signal **sig** and find there the time-frequency support **ntfsupp** of the main harmonic associated with the reference oscillations. IMPORTANT: if **signif**<0.95 OR **rho**<0.5, then one should stop, as the original signal **sig** most probably either does not contain the oscillations related to the reference signal **refsig**, or these oscillations are very small, being buried under the noise.

*Latest version is available at http://www.physics.lancs.ac.uk/research/nbmphysics/diats/nmd

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[hid,hamp,hphi,hfreq]=eharm(sig,ntfsupp,nTFR,nfreq,nwopt);
Extract all harmonics associated with the "image" of the reference oscillations in **sig**.

NM=recnm(hid,hamp,hphi,hfreq);
Recover the full Nonlinear Mode, which represents the oscillations in **sig** that are associated with the reference signal **refsig** (e.g. cardiac artifacts in EEG).

List of functions

A brief introductory description of all functions contained in the NMD Toolbox is presented below (for a more thorough description see a detailed documentation provided inside of each file).

nmd.m
Main function, applies Nonlinear Mode Decomposition to the signal.

wft.m
Calculates windowed Fourier transform (WFT) of the signal.

wt.m
Calculates wavelet transform (WT) of the signal.

ecurve.m
Finds the time-frequency support of the most dominant component in the signal's WFT or WT.

rectfr.m
Reconstructs the parameters of the component (amplitude, phase and frequency) from its associated time-frequency support in the WFT or WT.

bestest.m
Same as **rectfr.m**, but reconstructs the parameters using different methods and then selects the optimal estimates for each characteristic.

imcurve.m
Finds the time-frequency support of the component that is associated with some reference oscillation.

eharm.m
Extracts all harmonics corresponding to the same mode.

recnm.m
Reconstructs the full Nonlinear Mode from based on the parameters of the associated harmonics.

noisetest.m
Tests whether the extracted component is meaningful (or it is just formed from the filtered noise parts).

Changelog

v2.00
The basic idea remained the same, but its realization changed substantially. Thus, all algorithms are now based on the second version of the NMD paper (arXiv:1207.5567).

v1.01
Some minor changes.