A SIMPLIFIED FREQUENCY DOMAIN APPROACH FOR LOCAL MODULE IDENTIFICATION IN DYNAMIC NETWORKS

VUB Department of Engineering Technology

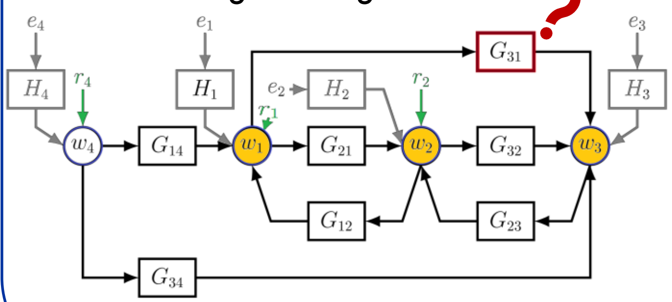
TU/e Department of Electrical Engineering

SCAN ME

PÉTER ZOLTÁN CSURCSIA KARTHIK RAGHAVAN RAMASWAMY JOHAN SCHOUKENS PAUL VAN DEN HOF

Objective

User-friendly identification of one module in an unknown network using existing toolboxes.?



- 3 inputs
- 4 nodes measured
- 4 noise sources
- 3 correlated nodes
- 1 unknown module

Assumption: independent (white) excitation $[r_4, r_1, r_2]$

Classical approach

Direct method **DM**

- all modules require a model order selection
- detrimental effect in large-scale networks

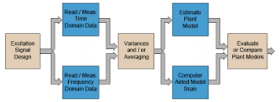
Empirical Bayes Direct Method **EBDM**

- DM + regularization technique using TC kernels

Toolboxes used in this work

Simplified Analysis for Multiple Input systems — SAMI

FDIDENT toolbox



Reference and details

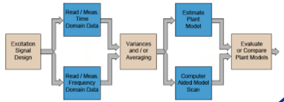
Automatica preprint: https://arxiv.org/abs/2105.10901

Website: http://homepages.vub.ac.be/~pcsurcsi/ernsi2021.html

New approach

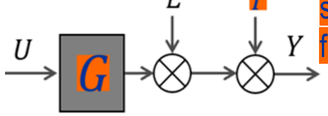
Indirect LPM (iLPM) — SAMI

1. FRF estimation via **LPM** (nonparametric transfer)
   $[r_4, r_1, r_2] \Rightarrow [w_1, w_2, w_4]$
2. Simulate signals (coping with correlation)
   $[w_1, w_2, w_4] \Rightarrow [\hat{w}_1, \hat{w}_2, \hat{w}_4]$
3. FRF estimation via **LPM** (nonparametric model)
   $[\hat{w}_1, \hat{w}_2, \hat{w}_4] \Rightarrow \hat{w}_3$
4. Post-process with **ELiS** cost function (parametric model)
   $\hat{G}_{31} \Rightarrow \hat{G}_{31|parametric}$

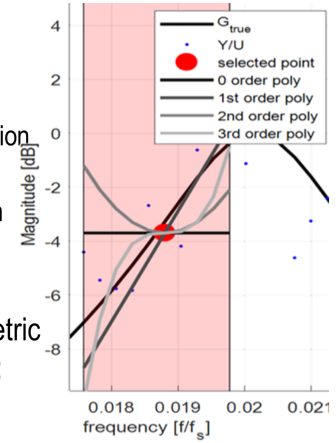


LPM: Local Polynomial Method

$$Y = GU + E + T$$



T smooth functions ▶ polynomial approximation ▶ line by line LS problem



ELIS: Estimation of Linear Systems

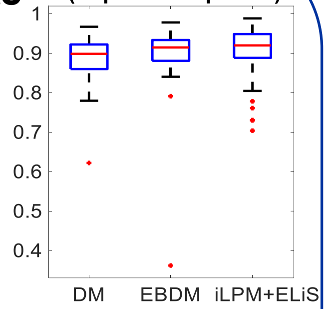
Frequency domain Maximum Likelihood parametric estimator implemented in the FDIDENT toolbox:

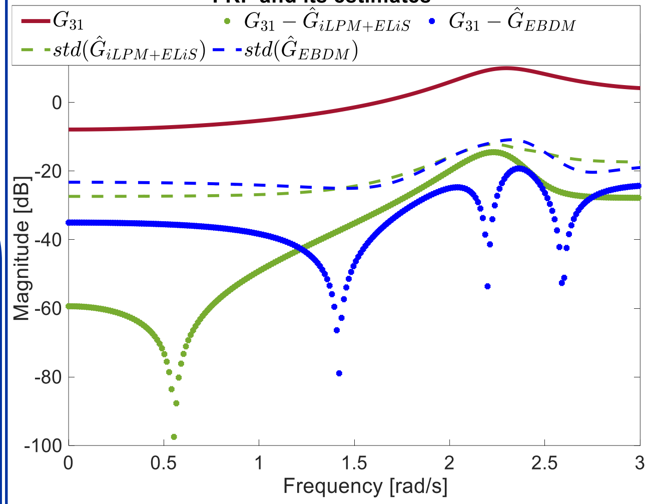
- usage of input and output noise
- asymptotically normally distributed
- works with bad SNR

In this work it is used as **FD-WLS problem on $\hat{G}_{31}$** (additional smoothing).

Results

100 MC simulations
known target model order
white noise excitation
$\sigma_r^2 = 0.1$
$\sigma_e^2 = [0.5\ \ 0.08\ \ 1\ 0.1]$
N= 500, L=50





Conclusions

The proposed method is

- simple and less complex
- avoids unnecessary model order selection
- scalable to large sized networks
- reduced bias and variance