PNLSS Identification

Post TRC Institute Meeting 5

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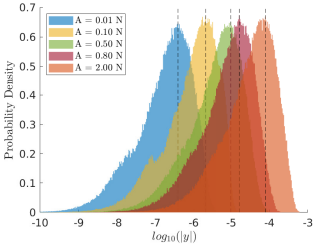
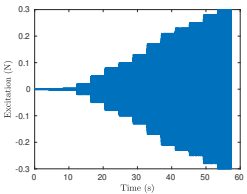
Overview



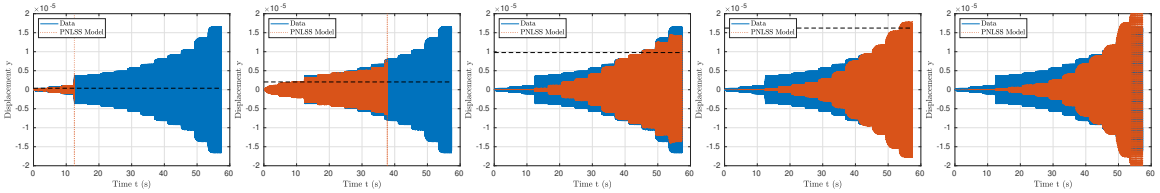
(a) Multisine Data Extent



(b) PLL Excitation

- Current set of slides contain results for **benchmark 4**, the beam with elastic dry-friction element
- The left shows a histogram of the magnitude of the multi-sine response data
- PNLSS models using this data is used to train the initial guesses for the identification on the PLL data
- PNLSS optimization is conducted using the **FULL DATA** from the simulated experiments, i.e., **this includes the transients** inherent
- This procedure was adopted since it maximized the amount of data we used for PNLSS

Multi-sine PNLSS models: Performance on PLL data I

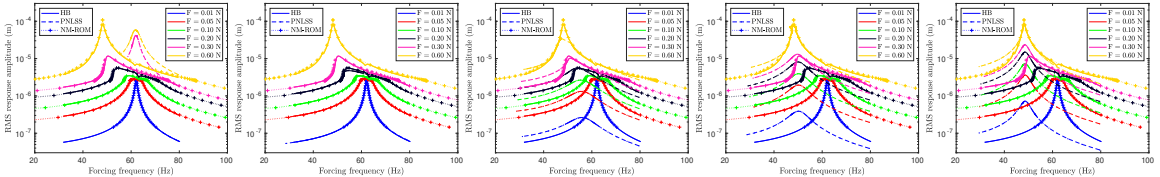


(a) A = 0.01 N (b) A = 0.10 N (c) A = 0.50 N (d) A = 0.80 N (e) A = 2.00 N

Figure: Time domain performance on PLL excitation

- Note that identification was carried out on **multisine data**. We're now just looking at how those models perform on the pll data
- Black dashed line indicates "mode" of the multi-sine response amplitude used for training the PNLSS models in each case
- Note that the models identified with the lower levels (A = 0.01 N, 0.1 N) seem to be unstable beyond a certain point

Multi-sine PNLSS models: Performance on PLL data II



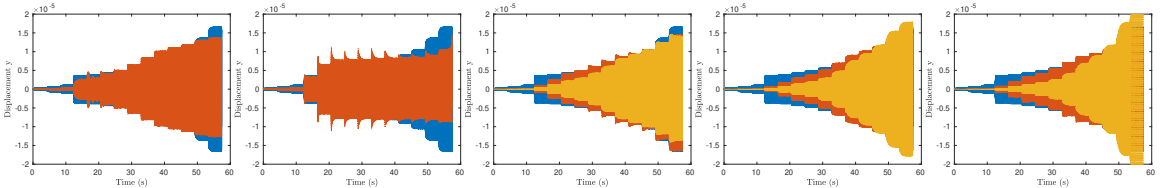
(a) A = 0.01 N (b) A = 0.10 N (c) A = 0.50 N (d) A = 0.80 N (e) A = 2.00 N

Figure: Corresponding frequency responses of the PNLSS models employed before

- The procedure used for training these PNLSS modes was:
  - BLA from A = 0.01 N data set as initial guess model for PNLSS on A = 0.01 N data set
  - PNLSS on A = 0.01 N set as initial guess model for PNLSS on A = 0.10 N data set, etc.

⋮

PNLSS Trained on PLL data with different multisine PNLSS models as initial guesses I

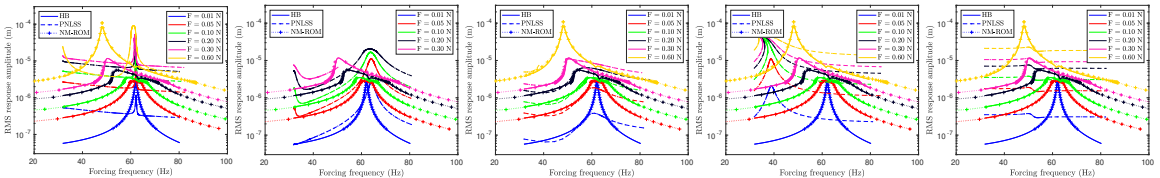


(a) A = 0.01 N (b) A = 0.10 N (c) A = 0.50 N (d) A = 0.80 N (e) A = 2.00 N

Figure: PNLSS optimization on PLL data

- We're now looking at the performance of PNLSS models trained with PLL data.
- **Top**: Yellow is initialized model; orange is PNLSS-optimized model
- Note that the jacobian apparently has NAN's for PNLSS models trained with very low amplitude data (A = 0.01 N, 0.10 N). I had to re-initialize the non-linear coefficients in this case

PNLSS Trained on PLL data with different multisine PNLSS models as initial guesses II



(a) A = 0.01 N (b) A = 0.10 N (c) A = 0.50 N (d) A = 0.80 N (e) A = 2.00 N

Figure: Frequency responses of PNLSS models optimized on PLL data. Different subfigures indicate different initializations.

- Although, the model initialized at A = 0.50 N seems to capture the stiffness non-linearity, it does not represent the amplitudes very well.
- *I am not sure if this is indication that the elastic-dry friction non-linearity may not be captured using the polynomial bases in PNLSS.*

Shift in Natural Frequency of Underlying Linear Systems

Comparison between linear part of PNLSS model identified from Multi-sine data and PLL data

Multisine Amplitude (N)	PNLSS from Multisine data (MSPNLSS)	PNLSS from PLL data initialized with MSPNLSS
0.01	62.0921 Hz	62.1493 Hz
0.10	62.2387 Hz	62.1510 Hz
0.50	56.2641 Hz	59.9767 Hz
0.80	50.3833 Hz	38.8631 Hz
2.00	48.7089 Hz	51.4134 Hz

Table: Eigenfrequencies from the linear part of the PNLSS models identified from the multisine data and the PLL data respectively.