Structure and parameter identification of au

October 2, 2019

1 Experimental data

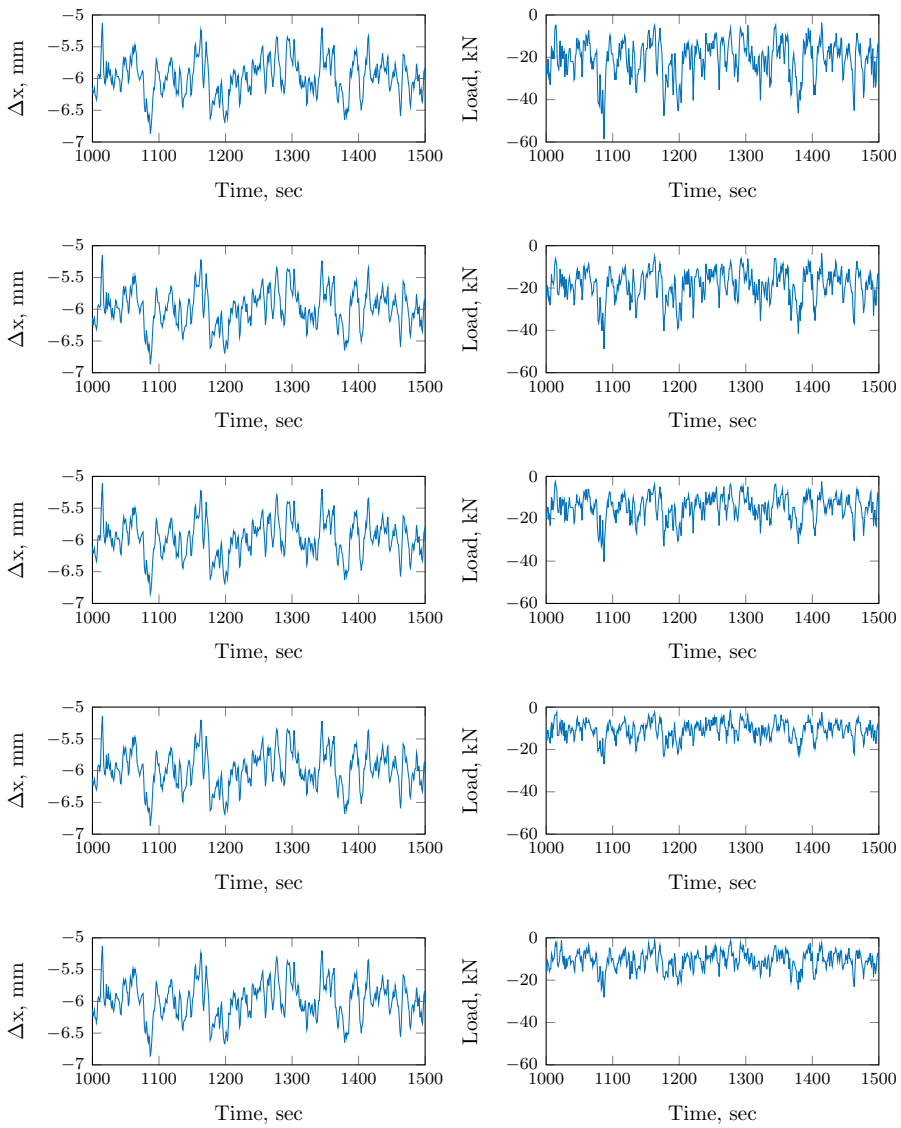

Figure 1: Experimental data.

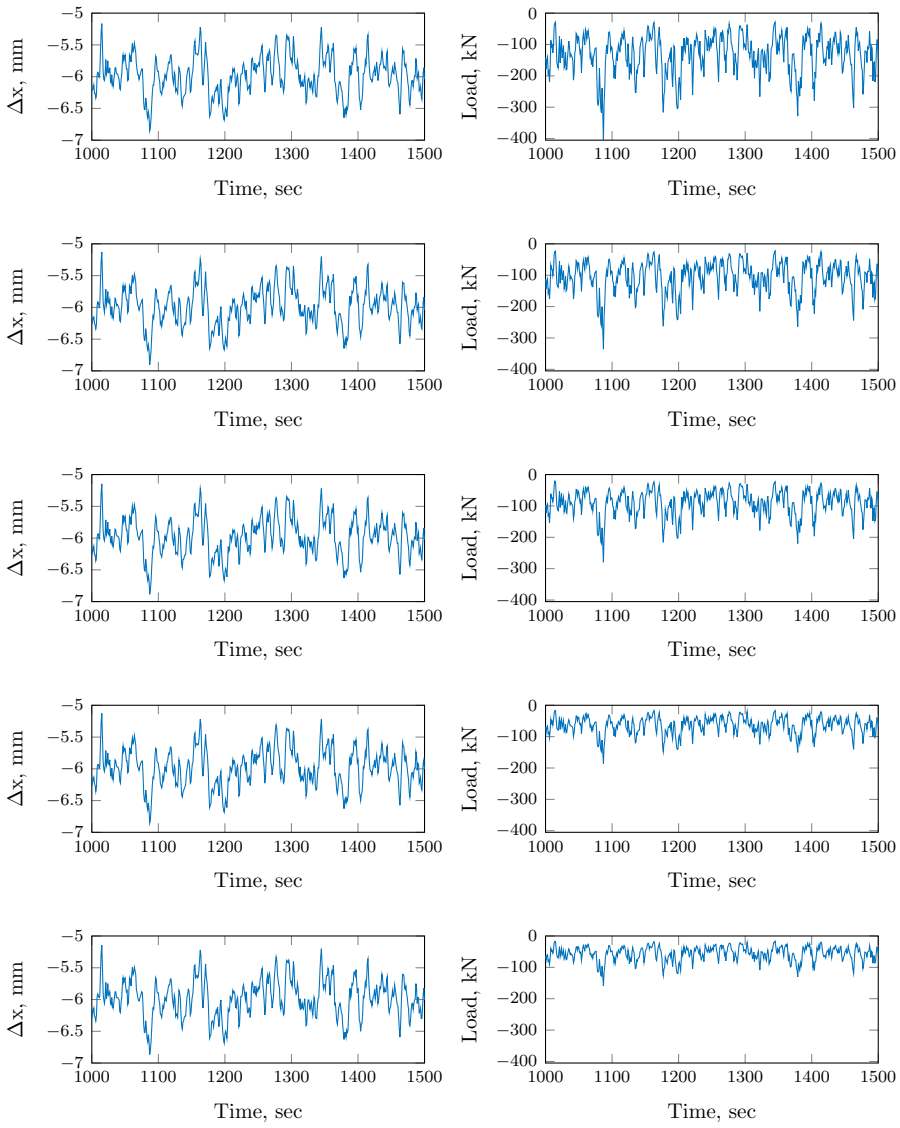

Figure 2: Experimental data.

2 Structure identification

The following model structure is assumed. The output of the NARX model $\boldsymbol{y}(t)$ is the measured load. The input vector is composed as

$$\boldsymbol{x}(t) = \{x_i(t)\}_{i=1}^{d} = \left[\{y(t-k+1)\}_{k=1}^{n_y} \quad \{u(t-k+n_y+1)\}_{k=n_y+1}^{n_y+n_u}\right] \top, \tag{1}$$

where n_u is the length of the input lag and n_y is the length of the output lag in discrete time, and where $d = n_u + n_y$. In this case, the identification is performed under the following assumptions:

- only the input signal affects the output ($n_y = 0$).
- the input signal has a lag of length $n_u = 4$.

The unknown model is approximated with a sum of polynomial basis functions up to second degree ($\lambda = 2$), rendering the following structure

$$\boldsymbol{y}(t) = \theta^0 + \sum_{i=1}^{d} \theta_i x_i(t) + \sum_{i=1}^{d} \sum_{j=1}^{d} \theta_{i,j} x_i(t) x_j(t) + e(t). \tag{2}$$

The number and order of significant terms are identified within the EFOR-CMSS algorithm based on the data from 8 out of 10 datasets. Figure 3 illustrates the relationship between the number of model terms and the selected criterion of significance, AAMDL.

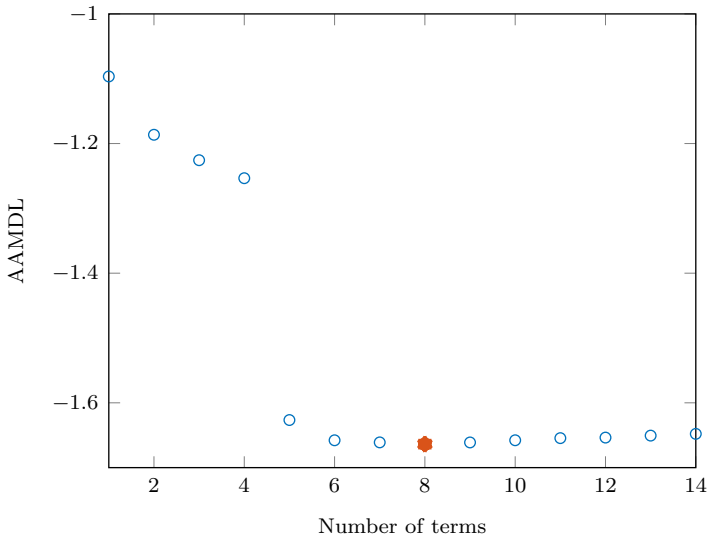

Figure 3: AAMDL evolution with the growing number of terms.

3 Parameter estimation

Table 1: Tuning parameters of the dynamical model.

Iteration	Terms	Parameters	AEERmax	AAMD
1	x_4	-124.7 -99.04 0 -59.03 -49.98 -961.09 -799.64 0 -460.45 -335.35	0	-1.096
2	x_3	82.76 66.04 0 61.26 24.7 670.41 549.96 0 336.32 204.96	0	-1.186
3	x_2	-28.77 -34.71 0 -46.65 -7.71 -252.83 -203.3 0 -131.84 -48.29	0	-1.226
4	x_1	53.78 54.59 0 36.88 24.52 431.37 362.1 0 205.64 138.7	0	-1.253
5	$x_4 \times x_4$	-25 -19.95 0 -11.47 -10.22 -192.41 -159.57 0 -91.27 -67.87	0	-1.627
6	$x_3 \times x_4$	16.89 13.52 0 11.12 5.54 137.99 113.52 0 67.92 43.63	0	-1.658
7	$x_2 \times x_4$	-5.06 -5.95 0 -7.38 -1.28 -49.8 -40.6 0 -25.14 -10.39	0	-1.661
8	$x_1 \times x_4$	9.75 9.65 0 6.16 4.25 81.62 68.36 0 38.21 26.28	0	-1.664