Proceedings of the 31st Conference
on Decision and Control
Tucson, Arizona • December 1992

On low-noise modeling: A summary

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Given is a number of noiseless, discrete-time, input-output measurements $\mathbf{D} = \{(u(t) \in \mathbf{R}^m, y(t) \in \mathbf{R}^p),\ t = 1, 2, \ldots, n\}$. For the purpose of modeling (cf. [2], [3]) this set can be equivalently represented in terms of a pair of matrices, namely,

$$H = \begin{bmatrix} u(0) & u(1) & \ldots & u(n) \\ y(0) & y(1) & \ldots & y(n) \end{bmatrix} \in \mathbf{R}^{(m+p)\times n},\quad F = J \in \mathbf{R}^{n\times n}.$$

where J is the nilpotent matrix with ones on the superdiagonal and zeros everywhere else.

As shown in [2] and [3], the main result affirms that the *observability indices* of the pair H, F, and the corresponding *linear dependences* of the rows of the observability matrix provide a parametrization of all solutions of the exact (noiseless) linear modeling problem. Furthermore additional constraints like complexity or stability can also be taken care of in this framework.

The goal is now to extend these results to the *noisy* case. If the noise is low, it is shown in [1] how to define *noisy* versions of the observability indices and of the corresponding linear relationships of the rows of the observability matrix of the pair H, F, so that the results of the noiseless case are generalized. A criterion for the correct definition of these noisy quantities is that the noiseless results be recovered as the noise goes to zero.

References

[1] A.C. Antoulas and B.D.O. Anderson, *On low noise modeling*, Technical Report #92-14, Dept. of ECE, Rice University, (1992).

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[3] A.C. Antoulas, J.A. Ball, J. Kang, and J.C. Willems, *On the solution of the minimal partial interpolation problem*, Linear Algebra and Applications, **137/138**: 511-573 (1990).