2.9 POTENTIAL IMPROVEMENTS IN SYSTEM IDENTIFICATION

Potential Improvements for Plant Testing

- *Simultaneous Excitation of Different Input Channels:* It is better to assimilate the situation a multivariable control system adjusts inputs altogether. An important issue then is

  how to coordinate inputs so that useful information is derived without causing problems to the operation.

  Perturbing each channel with an independent random signal seldom meets this requirement.

- *Control-Relevancy:* Since the ultimate purpose of a model is closed-loop control, the test should generate information that are important for control. Note that model uncertainty distribution is affected by information content in the data. Hence, the essence of the problem is

  how to distribute model uncertainty optimally for closed-loop control through data generation.

Potential Improvements for Plant Testing (Continued)

Plant-Friendliness: Plant tests during normal operations must be designed not to destroy the integrity of the on-going operation. This is particularly important when multiple input channels are to be excited simultaneously. In this case, one may lack intuition on how perturbations affect the key process variables. Plant friendliness can be achieved by incorporating

– input contraints (magnitude, rate, etc.)

– output constraints (formulated in a probabilistic manner)

Potential Improvements for Model Fitting

- *Deterministic vs. Stochastic Identification:* Deterministic identification is often adopted. However, including stochastic components can
  - improve the accuracy of the deterministic part.
  - yield a disturbance model useful for prediction.
- *SISO / MISO vs. MIMO Identification:*
  1. SISO or MISO identification is usually adopted but ignores the often-existing correlation among different output channels.
  2. MIMO identification
     - can potentially give a more accurate determinstic model, since disurbance effects are described more realistically.
     - allows *cross-channel* feedback update if the stochastic part is used for prediction.
     - is much more difficult in general.
     - suffers from identifiability problems and numerical difficulties (e.g., local minima) if time series models are used. There are so called subspace identification algorithms that allow direct construction of a state-space model in the following form:

$$\begin{aligned} x(k+1) &= Ax(k) + Bu(k) + K\varepsilon(k) \\ y(k) &= Cx(k) + \varepsilon(k) \end{aligned}$$

Use of Historical Data

- Often times, disturbance model used for control is *assumed*. This model may not be useful for control if the assumed disturbance model is unrealistic.
- Evenif disturbance model used for control is identified from plant test data, it may not be useful for control provided that the data collected during the plant test do not contain the plant's representative disturbances.
- Plant's historical data are plenty and should contain the effect of various disturbances that enter the plant. Using such data and the deterministic system model, one can construct a stochastic model for residuals in the form of

$$\begin{aligned} x(k+1) &= Ax(k) + K\varepsilon(k) \\ y(k) &= Cx(k) + \varepsilon(k) \end{aligned}$$

  This can be combined with the deterministic model.