Modern Control Theory

Model Predict Control - MPC – Lecture 5

Dynamic Prediction Models

Free response and forced response

- Free response –
- Check if the system with current input can reach to the set-point or
- Find out how close it can take it to the set-point or objective

- Forced response –
- Don’t make any control action if the system can reach to the set-point or
- Compute control actions that can take it to the set-point or objective over and above the free response.

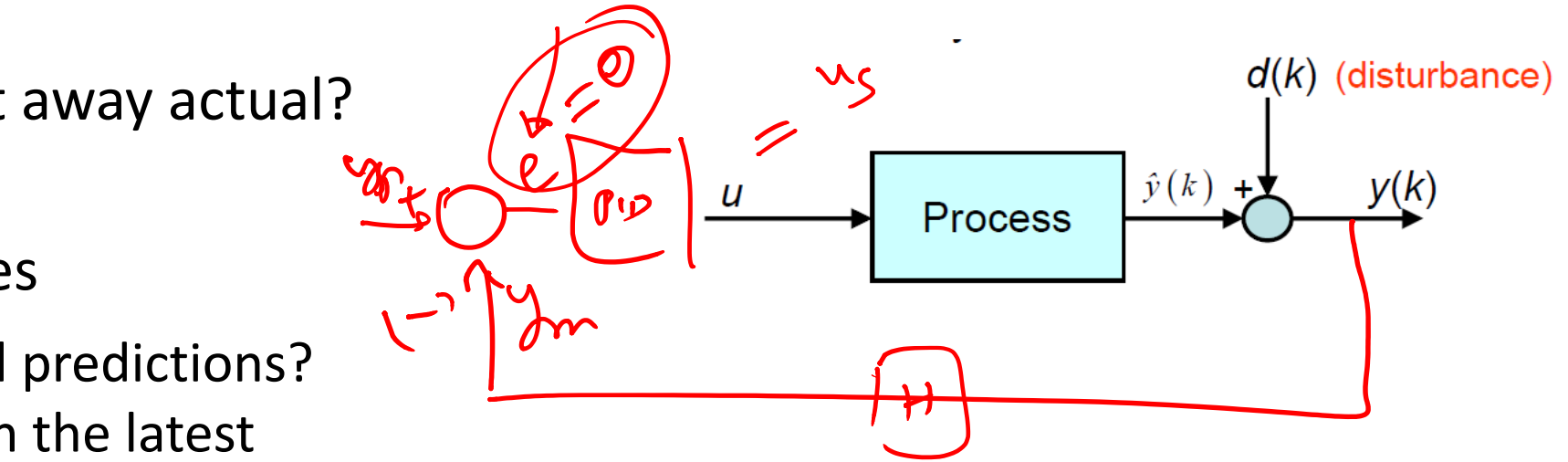
Correcting for model prediction errors

When can predictions drift away actual?

- Inaccurate model
- Unmeasured disturbances

How do we correct the model predictions?

Output feedback based on the latest measurement



$$\tilde{y}(k+j) \triangleq \hat{y}(k+j) + \left[y(k) - \hat{y}(k) \right]$$

Bias term or
correction term or
Estimated disturbance

MIMO Model prediction with bias correction

'r' inputs $\mathbf{u} = [u_1 \; u_2 \; \cdots \; u_r]^T$

'm' outputs $\mathbf{y} = [y_1 \; y_2 \; \cdots \; y_m]^T$

$$\tilde{\mathbf{Y}}(k+1) = \mathbf{S}\Delta\mathbf{U}(k) + \hat{\mathbf{Y}}^o(k+1) + \mathbf{\Phi}\left[\mathbf{y}(k) - \hat{\mathbf{y}}(k) \right]$$

$\mathbf{\Phi}$ is matrix of '1' with dimension mP xm

Dynamic prediction models

- Model types
  - Physics based or data-based (or empirical) models
  - Linear or non-linear relationships
- Types of Linear models
  - Impulse response coefficients
  - Step response coefficients – Most process industry implementations
  - Transfer function
  - State-space – Recent applications such autonomous vehicles, robots, satellite systems, etc

State space models - Motivation

- 5 CVs * 5 MVs
- Each model has 30 coefficients
- Total - ?
- Mixed time scale – what is this?
- Unstable system? Can I represent as step coefficients?
- Type of disturbances that can be modeled?