Multivariable Centralized Control and MPC

In class activities

Ranjeet Utikar

2023-10-02

# 1. Activities

1. Explain the advantages and limitations of Model Predictive Control compared to the conventional decentralized PID control system.
2. Consider the process given by

Design the decouplers and and comment whether the systems are physically realizable or not.

|  |
| --- |
| Solution |
| The code for calculating decoupler transfer function is given in [Matlab file](./decoupler_for_multivariable_system.m)/ [mlx file](./decoupler_for_multivariable_system.mlx). |

1. The discrete-time step response model of a process is given in [Table 1](#tbl-1).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 1: Discrete-time step response model   | t | i |  | y(t) | ai | | --- | --- | --- | --- | --- | | 0 | 0 | 1 | 0 | 0 | | 1 | 1 | 0 | 0.3 | 0.3 | | 2 | 2 | 0 | 0.6 | 0.6 | | 3 | 3 | 0 | 0.7 | 0.7 | | 4 | 4 | 0 | 0.8 | 0.8 | | 5 | 5 | 0 | 0.86 | 0.86 | | 6 | 6 | 0 | 0.88 | 0.88 | | 7 | 7 | 0 | 0.89 | 0.89 | |

Suppose that the process is subjected to a consecutive step changes in the input: at t=0, at t=2 and at t=4, determine the values of y5 and y9.

|  |
| --- |
| Solution |
| The code for calculating decoupler transfer function is given in [Matlab file](./discrete_timestep_response_model.m)/ [mlx file](./discrete_timestep_response_model.mlx). The data in [Table 1](#tbl-1) can be downloaded from [discrete\_time\_response.csv](./discrete_time_response.csv). |

1. Develop a DTSRM for the following transfer function

|  |
| --- |
| Solution |
| For the given transfer cunction, - = 2 - = 5 - = 2 seconds 1.1 Apply a Unit Step Input To develop the step response model, apply a unit step change in the input :  Let’s use = 1 second. 1.2 Calculate the Step Response Coefficients The step response coefficients represent the fraction of the process response that occurs in each discrete time interval. The response of the system is delayed by seconds, so no change is observed in the output until after .  The response to the step input for a FOPDT system is:  The discrete response coefficients are then calculated as:  first few coefficients:   |  | Time (s) |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | 1 | 1 | 0 | 0 | | 2 | 2 | 0 | 0 | | 3 | 3 |  | 0.3625 | | 4 | 4 |  | 0.6594 | | 5 | 5 |  | 0.9024 | | 6 | 6 |  | 1.1013 |  1.3 Construct the DTSRM The DTSRM uses the coefficients to predict future outputs based on past input changes:  For example,  The code for calculating is given in [Matlab file](./dtsrm_from_fopdt.m)/ [mlx file](./dtsrm_from_fopdt.mlx). |

1. Second-Order Plus Dead-Time (SOPDT) Model to DTSRM

For the following transfer function

develop DTSRM.

|  |
| --- |
| Tip |
| The code for calculating is given in [Matlab file](./dtsrm_from_sopdt.m)/ [mlx file](./dtsrm_from_sopdt.mlx). |