Introduction to Simulink Design Optimization

Estimate and optimize Simulink model parameters

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Introduction to Simulink Design Optimization

- Estimate and tune Simulink model parameters using numerical optimization

- Perform modeling and control design tasks:
  - Increase model accuracy by calibrating model parameters with test data
  - Automatically find model parameter values to meet design requirements
Simulink Design Optimization Key Features

- Graphical user interface (GUI) that walks you through the optimization task
- Estimation of physical parameters from test data
- Optimization of time-domain responses of nonlinear Simulink models
Working with Simulink Design Optimization

- **Modeling**
  - Import and preprocess test data
  - Set up and run parameter estimation tasks

- **Control Design and Design Optimization**
  - Tune linear controllers to meet time- and frequency-domain requirements
  - Tune the response of a nonlinear Simulink model
  - Optimize system response in the presence of uncertainty
Import and Preprocessing of Test Data

- Direct import from MAT-, Excel, CSV, and ASCII files
- Preprocessing of test data
  - Detrending to remove data drift and offset
  - Filtering to remove noise and band-limited disturbances
  - Interpolating to fill in missing values
  - Excluding to remove questionable sections of the data set
Setting Up and Running Parameter Estimation

- GUI for specifying optimization problem
  - Which test data sets to use
  - Which parameters to estimate
  - Which visual indications of optimization progress to display
- Ability to set up multiple estimations for independent estimation of parameters from different model sections
- Validation of estimation results
- Faster optimization with Parallel Computing Toolbox
- Estimation of static and adaptive lookup tables
Designing Controllers to Meet Time- and Frequency-Domain Requirements

- Time-domain requirements:
  - Rise time
  - Overshoot, undershoot
  - Settling time

- Frequency-domain requirements:
  - Gain and phase margins
  - Upper and lower frequency response boundaries

- Only possible for linear systems
Optimizing the Response of Nonlinear Simulink Models with the Signal Constraint Block

- Optimize any design objective that can be expressed as a Simulink signal
- Specify desired behavior by either graphically shaping the desired response or specifying a reference signal trajectory
- Use several Signal Constraint blocks simultaneously to satisfy multiple objectives
- Perform optimization faster with Parallel Computing Toolbox
Robust Design Optimization

- Specify uncertainty or possible variations for plant parameters

- Optimize controller parameters to meet requirements in the presence of uncertainty by either:
  - Using Monte Carlo simulation of uncertainty
  - Using minimum and maximum plant model parameter values
Simulink Design Optimization Summary

- Systematically improve your plant models and design your controllers
- Automatically calibrate plant model parameters with test data
- Automatically adjust controller parameters to provide the desired system response
- Find the best combination of plant and controller parameters to provide the optimal design
Further Information

- Simulink Design Optimization Product Page
  - Demos
  - Recorded webinars
  - White papers
  - User stories

- Watch recorded webinars:
  - “Analyzing Design and Cost Tradeoffs using Optimization with Simulink”
  - “Model-Based Design for Mechatronic Systems”
  - “Accelerating Flight Vehicle Design with MATLAB and Simulink”
  - “Multi-loop Control Design in Simulink – Made Easy”
  - “Multidomain Plant Modeling in Simulink for Control System Design”