Introduction to Model-Based System Design

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Course Details

Description

Introduction to Model-Based System Design: Model-in-the-Loop (MIL), Software-in-The-Loop Simulations (SIL), Hardware-in-the-Loop (HIL), Real-Time Simulations, Targeting, Verification and Validation, Design of Experiments, Model Refinement.

Objectives

After successfully completing this course the student should be able to:

- Build mathematical models for components in a system.
- Follow a process of continuous refinement and improvement to generate accurate models.
- Connect component models together to model a larger more complex system.
- Setup and run Model-in-the-Loop Simulations (MIL).
- Setup and run real-time simulations for a physical system.
- Setup and run Hardware-in-the-Loop Simulations (HIL).
- Apply basic control algorithms to a real physical system.
- Deploy a control algorithm on a real-time target.
- Apply verification and validation methods to a model of a physical systems.
- Use Design of Experiment methods to create models of physical systems.

Original Course Documents

Source file URL

Course Contents

- Model-Based Design for a small system  
  - Motor Model  
  - Generator Model
- Controller Model
- SimDriveline Intro

- Simulink Simulations
  - Explore the system response using different control methods.
  - Tune the system
  - Explore system limitations
  - Understand and refine motor models.

- Real-time simulations with xPC
  - Plant and Controller Implement on Single Target

- Implement controller on MPC566 or MPC5554 target
  - Install hardware and software.
  - Use Freescale RAppID Toolbox or MathWorks 555 Toolbox
  - Wire up system to familiarize students with pin outs
  - Explore analog inputs, digital and PWM outputs

- Processor In The Loop Real-Time Simulations
  - Controller on Freescale Target
  - Plant on Real-Time Target
  - Display Performance on Virtual Gauge Display
  - Data Collection of Performance

- Test controller on real system
  - Observe system performance
  - Observe the effect of different control methods.
  - Tune the system

- Model Verification
  - Data Collection of Physical Model Response
  - Comparison of Physical Plant Response to Model Response

- Design of Experiments to Collect Experimental Data on Motor and Generator
  - Automatically Generate Test Schedule to Obtain Data
  - Run Experiments and Collect Data
  - Generate Models for Components
    - Table-Lookup
    - Curve Fits

- Model Refinement and Re-Verification
  - Update Models to Include Measured Data
  - Comparison of Updated Physical Plant to Model

- Further Exploration of Alternate Control Methods as Time Permits

**Problem Sets**

**Resources**

- [Models, Drive Cycle Files, and Component Information](#)
- [MPS555x Demo Board Manual](#)
- [MPS555x Demo Board Schematic](#)
- [MPS555x Demo Board Silkscreen](#)