Low Cost Tools for Rapid Control Prototyping and Hardware-in-the-Loop Testing

OpenSim:ProcessMonitor

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Trends in Automotive Control System Development Practices

- Tools to go rapidly and effortlessly from Off-line Simulations to Hardware-in-the-Loop (HIL) Testing and Rapid Control Prototyping (RCP) for ECU targets
- No coding (I/O drivers, Communications, etc …)
- Low Cost, Scalable, environment using COTS components
Seamless Transition from Simulation to RCP and HIL Testing

Control System Problem

- Physical Models
  - Process Model
  - Sensor Model
  - Actuators
  - A/D and D/A
  - ΔP, x, ...

- Control System Design
  - MPC
  - Adaptive
  - Nonlinear
  - Optimization
  - ...

- Control System Analysis
  - Performance
  - Stability
  - Execution
  - ...

- Code Generation
  - Auto Code
  - Embedded S/W
  - Real-time Link
  - ...

- Embedded H/W
  - Hardware-in-the-Loop
  - Rapid Prototype

- Model Based Design

- Data Analysis
  - Animation
  - Plots
  - ...

- Visualization

- H/W-in-the-loop

- Model based control design

- Non Real-time Simulation

- Real-time Simulation

- Rapid prototyping & Hardware-in-the-loop
Low Cost, Scalable, environment using COTS Components

- Open-Architecture systems (PC104, EBX, etc) or ECUs directly
- Multiple Vendors
- Increased competition
- Lower prices
- “No-Frills” interfaces
  - Cost less
  - Easy to use
- Lower unit (per test stand) costs
- Easier to replicate setups
- Better utilization of resources
- Easily upgradeable systems minimize product obsolescence risk
- “Smarter” approaches to design – Model Based Design
Benefits of Model Based Control Design

**Smarter System**
- Better understanding of the system
- Robust control

**Cost Savings**
- Reduced risk of damaging expensive hardware

**Reduced Development Time**
- Analytical control development/Off-line simulations
- Rapid control prototyping
- Hardware-in-the-loop testing

**Tools** - MATLAB/Simulink/Stateflow/..., the industry standard in physical modeling
OpenSim: ProcessMonitor

- Monitoring system developed by Pathway Technologies Inc
  - Intuitive tree view of signals and parameters
  - Real-time visualization and tuning for faster “in-process” development
  - Data collection on the host PC for post-processing
  - Control model download and target execution
  - Wide variety of virtual instruments with a Drag ‘n Drop interface
  - Distributed architectures available
  - Can be run from a remote location
OpenSim: Process Monitor

- Matlab/Simulink/Stateflow ...
- Real-time Simulation
- Hardware-in-the-loop Testing
- Rapid Control Prototyping for ECUs
OpenSim: Process Monitor Architecture

Simulink™

- GUI for Real-time visualization
- Data logging and off-line analysis

Communication Layer

- TCP/IP
- CAN
- CCP
- ...

RTW™/Embedded Coder

Target Management

C Compiler (Visual C++ 6.0, 7.0, .NET)

Target

Hardware

Ctrl + B

I/O
OpenSim: ProcessMonitor GUI

- GUI for Real-time visualization
- Data logging and off-line analysis
Rapid Prototyping with OpenSim:ProcessMonitor

Seamlessly move from Matlab/Simulink to Hardware platform without having to write a single line of code
Target Support in OpenSim: ProcessMonitor

- xPCTarget, Mathworks
- MPC555, Motorola
- MPC565, Motorola
- Custom ECU targets
- ...

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Benefits of RCP

**Benefits**

- Integrate actual hardware components in controller testing
- Automatic code generation dramatically reduces develop-test-refine cycle time
- Realistic load testing leads to finer control

**Tools**

Real-time workshop/Embedded Coder for automatic code generation

- xPC Target, MPC 555, MPC565, Custom ECU, etc for prototyping platform
- OpenSim for real-time visualization, tuning and data collection
Step 1: Open your Simulink model or locate the dlm or flash file. If using a dlm file, go to Step 4 else go to Step 2.

Reference: Power Window Control example from Simulink Demos, Matlab/Simulink software
Step 2: Press ‘Ctrl + B’ and the target selection GUI will pop up

Reference: Power Window Control example from Simulink Demos, Matlab/Simulink software
Step 3: Use the target selection GUI to select a target to build & download the code to and specify the parameters for communication between the host and the target.
Step 4: Launch the monitoring GUI and prepare a custom virtual display by selecting from the library of widgets provided with OpenSim:ProcessMonitor.

If using a dlm file, download model to the target by using the pulldown menu.
Step 5: Launch the communication layer

Step 6: Start model execution

Monitor your system, tune parameters, log data for post processing, etc
Seminars, Training and Consulting

We offer product demos, training, and free seminars at our Detroit sales office in Livonia, Michigan

Seminar topics include

1. Rapid control prototyping with OpenSim & Matlab/Simulink
2. Rapid control prototyping for ECUs
3. Model based design of distributed embedded systems
4. Hardware-in-the-Loop Simulation and Testing with OpenSim

We also offer consulting services in the area of control system design, software development for real-time applications, ECU design and development, analytical modeling and product development
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