Effiziente Datenanalyse mit MATLAB am Beispiel eines Batteriemodells

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Agenda

• Demo: Battery Testing using MATLAB and Simulink
• Overview of Hardware Connectivity
• Data Analysis using MATLAB
• Q&A
Data Analysis Tasks

Access
- Files
- Software
  - Code & Applications
- Hardware

Explore & Discover
- Data Analysis & Modeling

Share
- Reporting and Documentation
- Outputs for Design
- Deployment

Automate
Battery Testing, Data Analysis, and Modeling Using MATLAB and Simulink
Model Correlation

Physical Hardware

Simulation
Model Correlation
Data Collection

- Data collection
  - Types of data
    - Analog/PWM/Digital
    - CAN
  - Data integrity
    - Detect intermittent connections
    - Signal threshold limits
Battery Testing Video

### Starting xPC Target build procedure for model: series_engine_phev_midsize_2wd_TM
### Generating code into build folder: C:\DATA\Demo\MATLAB\R2013a64\target\series_engine_phev_midsize_2wd_TM\build
### Generated code for 'series_engine_phev_midsize_2wd_TM.mk' which is generated
### Building series_engine_phev_midsize_2wd_TM: \.series_engine_phev_midsize_2wd_TM

C:\DATA\Demo\MATLAB\TandM\2013_BatteryTesting\TMSeminar Tool Setting environment for using Microsoft Visual Studio 2010 x64

Microsoft (R) Program Maintenance Utility Version 10.00.303
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### Linking ...
C:\MATLAB\R2013a64\sys\perl\win32\bin\perl C:\MATLAB\R2013a64\sys\perl\win32\bin\perl C:\MATLAB\R2013a64\sys\perl\win32\bin\perl C:\MATLAB\R2013a64\sys\perl\win32\bin\perl
Creating library series_engine_phev_midsize_2wd_TM_xpc

Live Webcam:
Example: Battery Testing Using MATLAB and Simulink

- Battery Testing:
  - Send control commands from xPC
  - Collect data using T&M devices
- Analyse data and create report
A Technical Computing Workflow for Battery Test and Data Analysis

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- Algorithm Development

Application Development
- Code & Applications

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Files
Software
Hardware
What hardware are you using?

Programmable instruments
- Oscilloscope
- Arbitrary waveform generator
- RF signal generator
- RF signal analyzer
- Optical spectrum analyzer

Communications interfaces
- Serial
- GPIB
- TCP/IP
- USB
- VISA
- Bluetooth

Data acquisition cards
- A/D, D/A, DIO

Frame grabbers and cameras

CAN bus devices
MATLAB Connects to Your Hardware Devices

Instrument Control Toolbox
Instruments and RS-232 serial devices

Data Acquisition Toolbox
Plug-in data acquisition devices and sound cards

Image Acquisition Toolbox
Image capture devices

Vehicle Network Toolbox
CAN bus devices using CAN and XCP protocols

MATLAB
Interfaces for communicating with everything
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  - MATLAB
  - Excel
  - .NET
  - .exe
  - C/C++
  - Java
  - .dll

Automate
Before We Can Apply the Data…
Before We Can Apply the Data…

- **Data collection**
  - Types of data
    - Analog/PWM/Digital
    - CAN
  - Data integrity
    - Detect intermittent connections
    - Signal threshold limits

- **Data analysis**
  - Data filtering
    - Curve fitting
    - Smoothing
  - Data synchronization
    - Consolidate datasets with different time scales
  - Handle Missing Data
    - Drop outs
Before We Can Apply the Data…

- **Data collection**
  - Types of data
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Data Acquisition Toolbox
Vehicle Network Toolbox
Statistic Toolbox
Curve Fitting Toolbox
Parallel Computing Toolbox
Visualizing Data with MATLAB

- **Quick look**
  - Interactively generate two- and three-dimensional visualizations
  - Navigate and annotate data

- **Explore in detail**
  - Use advanced visualizations
  - Use application-specific visualization techniques (maps, clustergrams, …)

- **Customize**
  - Customize visualization for presentation and publication
  - Automate repetitive visualization tasks

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**Access**

**Explore**

**Share**
Data Analysis, Signal Processing, Algorithm Development, and Modeling Toolboxes

Signal Processing Toolbox
- Create and apply your own filters to signals
- Estimate spectral response
- Generate custom waveforms
- Develop parametric models

DSP System Toolbox
- Advanced filter design including FIR, IIR, adaptive, and multi-rate

Statistics Toolbox
- Design experiments
- Develop linear and nonlinear models
- Compute descriptive statistics from test results
Data Analysis, Algorithm Development, and Modeling Toolboxes

Curve Fitting Toolbox

- Fit curves and surfaces to data using regression, interpolation, and smoothing
- Use pre- and post-processing analysis
  - Exclude outliers
  - Generate confidence intervals
  - Calculate integrals and derivatives
- Evaluate goodness of fit using:
  - Descriptive statistics such as $R^2$
  - Visual inspection
  - Validation

Visit [www.mathworks.com](http://www.mathworks.com) for more than 20 additional toolboxes
Sharing Results from MATLAB

- Publish MATLAB scripts
  - Quick, convenient documentation

- Automatically generate structured reports

- Export data and graphics to standard and custom file formats
Deploying Applications with MATLAB

- Give MATLAB code to other users

- Share applications with end users who do not have MATLAB
  - Use MATLAB Compiler™ to create stand-alone executables and shared libraries
  - Use Compiler add-ons to create software components
What about Real-Time Testing?

- **Challenge:** To run, test, and prove your Simulink design with your hardware under test at its normal operating frequency, speed, or timing.

- **Real-time testing includes:**
  - Rapid control prototyping (RCP)
  - Hardware-in-the-loop (HIL) simulation
  - Other applications needing real-time determinism

- **Application areas:** Aerospace test labs, automotive controls, mechatronics and robotics, industrial automation and machine controls, medical devices, office equipment

- **Solution:** Use xPC Target for real-time testing

Learn more at [www.mathworks.com/products/xpctarget](http://www.mathworks.com/products/xpctarget)
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Automate

Code & Applications

MATLAB, Excel, C/C++, Java, .NET, .exe, .dll, Package App
Summary

- One Environment for testing, data acquisition, analysis and simulation
- Efficient functions for analysis
- Use analysis results for further simulations
Q&A