Effiziente Datenanalyse mit MATLAB am Beispiel eines Batteriemodells

Dr.-Ing. Rainer Mümmler
Senior Application Engineer
Application Engineering Germany
The MathWorks GmbH
Agenda

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

Access
- Files
- Software
- Hardware

Explore & Discover
- Data Analysis & Modeling

Share
- Reporting and Documentation
- Outputs for Design

Deployment
- MATLAB
- Excel
- C/C++
- Java

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_eng
#### Generating code into build folder: C:\DATA\Demo\MATLAB\2013_BatteryTesting\TMSession\build\.
#### Generated code for 'series_engine_phev_midsize_2wd_TM' file
#### Patch bio and pt MATLAB files
#### Create sorted BIO
#### Create sorted PT
#### Patch xml-file

#### Processing Template Makefile: C:\MATLAB\R2013a64\templates\...
#### series_engine_phev_midsize_2wd_TM.mk which is generated
#### Building series_engine_phev_midsize_2wd_TM: \.

C:\DATA\Demo\MATLAB\TandM\2013_BatteryTesting\TMSession\build

Microsoft (R) Program Maintenance Utility Version 10.00.3034
Copyright (C) Microsoft Corporation. All rights reserved.

#### 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 C:\MATLAB\R2013a64\sys\perl\win32\bin\perl
Creating library series_engine_phev_midsize_2wd_TM_xpcbuild
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

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Code & Applications

MATLAB, Excel, C/C++, Java, .dll

MathWorks
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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Automate

Examples:
- MATLAB
- Excel
- C/C++
- Java
- .NET
- .exe
- .dll

Code:
```matlab
for k=1:max
    x = fft(dat)
    y = 20*log1
```

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

- Data collection
  - Types of data
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- Data analysis
  - Data filtering
    - Curve fitting
    - Smoothing
  - Data synchronization
    - Consolidate datasets with different time scales
  - Handle Missing Data
    - Drop outs
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Data Acquisition Toolbox
Vehicle Network Toolbox

Statistic Toolbox
Curve Fitting Toolbox
Parallel Computing Toolbox
Visualizing Data with MATLAB

Access

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

Explore

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

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

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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  - .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