Vitesse

Simulation of Active Vehicle Systems using SIMPACK Code Export

Dr. Udo Piram
Bernd Austermann
ZF Friedrichshafen AG, TB-3

Overview
Concept and Tools
MBS-Library, Preprocessor
Interface
Goal: Simulation of vehicles with active components in chassis and power train

Multidisciplinary models

chassis

power train

hydraulics

control
Vitesse: Requirements

→ Structured model setup
  - Subsystem with varying complexity
  - Reusability, Circulation of models
  - Integrated development process

→ Different Simulation Environments

- Simulation of components
- Control strategy
- Test bed
- Driving Tests
Simulation of Coupled Systems (1)

Co-Simulation

program A

model A ← solver A

program B

model B ← solver B

time discrete data transfer

coupled equations of models

Coupled Equations

program A

model A

model B

solver

program B
Simulation of Coupled Systems (2)

Advantages of coupled equations (time continuous systems):
- Better stability of simulation
- Shorter computation time
- Rigid coupling of subsystems possible

Computation time: test example
- Chassis and power train with elastic coupling
- Co-Simulation stable up to 500 Hz sampling rate
- Coupled equations stable up to 100 Hz and lower
- Speed gain > 2
Vitesse: Concept and Tools

complete model

solver

vehicle model

interface

F77 / C

C

F77

Simulink

controller

F77 / C

C

F77
MBS-Library and Preprocessor

Vitesse – Preprocessor

SIMPACK

ZF-Tools

Dymola

power train

hydraulic

interface

C

F77
MBS-Model Library: Requirements

- Data and structure are separated
- Fully parameterized substructures
  - Body, suspension, steering, tires, …
  - No mirroring used, symmetry by dependant parameters
- Multiple usage of substructures
- Parameter names are global for complete vehicle

⇒ Local copies of substructures
MBS-Model Library: Solution

- Global library with substructures (read only)
- Local copy of substructures
  - Parameterization
  - Possibly additional elements, e.g. sensors
  - Prefix to label position (front axle, rear axle …)
  - Automatic renaming

- Rules for nomenclature of parameters
- Preprocessor for SIMPACK model
Vitesse Preprocessor

- ZF-Tool to simplify handling of substructures/parameter
  - Access to global model library
  - Interface for parameter changes for not experienced user
  - Structured display of parameters (masses, hardpoints, ...)

- Setup of new projects
  - SIMPACK model database is generated
  - Selection from templates
  - Copy of files from global library with automatic renaming

- Assembly of system in SIMPACK by expert user
Vitesse Preprozessor

- Working within a project
  - Graphic representation of structure of assembly
  - Replace input functions (.if2-files for spring, damper etc.)
  - Replace parameter files
  - Display and change of parameters
Vitesse: Interface

Vitesse – Preprocessor

SIMPACK

power train

hydraulic

ZF-Tools

Dymola

Q-State-Interface
Q-State-Interface

- SIMPACK-Model
  - (MBS-Model or F77-Code)

- SIMPACK Q-State-Interface
  - (C-Code)
  - (F77-Code)

- external equations
  - 1
  - \( \cdots \)
  - \( n \)
  - Init
  - RHS
  - Constraints
  - Root
  - State-Reset

- clutch: stick or slip?
Application Example
Simulation in Matlab/Simulink
Status of Project

SIMPACK Code Export

- First tests with V8.0
- Setup of library using V8.5 and V8.6
- Meanwhile large changes in code export
- Time delay in project plan
- Q-State-Interface in code export not yet satisfactory

Models in use at different departments (using Co-Simulation)

Distribution of tools in corporation
Summary / Comment

- MBS-Models in SIMPACK using own library
- Equation coupling using Q-State-Interface
- Consistent approach for simple and complex models

😊 Project only possible with SIMPACK
😊 Intec open for new suggestions
😊 Support

😢 Delay in delivery of Code Export
   If successful test in SIMPACK:
😢 ? Successful test in Code Export ?