SIM PACK Code Export

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SIM PACK Code Export

Agenda

- What is Code Export?
- Functionality
- Fields of Application
- Example
- Outview
**SIMPACK Code Export**
Generating equations of motion

What is Code Export?

Functionality
- Internally: equations are not visible for user
  - easy model access for GUI - pre-/post processor, solver
  - various analysing tools available
    - (linear system analysis, kinematics, equilibrium calc)
  - no compile or link necessary
- dependent on software installation
- difficult to integrate to other systems
- higher calculation time
- model verification, analysing subsystems ➔ offline simulation

Externally: equations are written to file in programming language
- direct access to equations for user
- easy to integrate into other systems
- reduced calculation time
- external pre-/postprocessor necessary
- costly model modification
- integration of verified subsystems in global simulation ➔ online simulation

SIMPACK combines both possibilities of processing equations of mechanical systems and with that offers a unique process patency.
SIMPACK Code Export

What is Code Export?

Functionality

Fields of Applications

Example

Outview

What Are You Intending To Do?

- read model data
- version consistency check
- allocate data ("a(..)") field
- eliminate 0/1 entries
- perform one right-hand-sidecall
  - write called matrix operations \( a(i) = a(k) + a(j) \)
  - write calls to library elements
- perform one y-output call
  - write called matrix operations \( a(i) = a(k) + a(j) \)
  - write calls to library elements
- perform forward/backward optimization for rhs and yout
- copy data_base and scripts
- perform compile and link
SIMPACK Code Export

Code Generation

What is Code Export?

Functionality

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Example

Overview

new created directory: <model>.sym

$ m, I_{ij}, \text{com} $

$ P(t) $

$ x(t=0) $

$ nx, nv, nu $

$ x = f(x, u, t) $

$ y = g(x, u, t) $
**SIMPACK Code Export**

**Code Execution**

**SIMPACK USER**

- Elements DLL

**SIMPACK Library**

- licensed DLL

**Calls at runtime**

- **Code Export**

**SIMPACK USER**

- Reads at initialisation

**Parameter & Initial State Files**

- Database Parameter & Initial State Files

- **F90 src**

- $\int x \, dt$

**USER**

- What Are You Intending To Do?
**SIMPACK Code Export**

**What is Code Export?**

**Functionality**

**Fields of Applications**

**Example**

**Outview**

**What Are You Intending To Do?**

**Code Export functionality was originally designed to handle time intensive applications like Parameter Variations and Optimizations**

**SIMPACK Symbolic Code (ceased with v8.0)**

**SIMPACK Code Export**

- replaces external Symbolic Code to be used with arbitrary solver systems
- offered in several stages of functionality range
- functionality will be expanded according to customer needs
- Stage 0 available since 11/2002 with v8.5
- Stage 1 first minor release available since 04/2003 with v8.6

**SIMPACK Symbolic Accelerator (not yet available)**

- replaces internal Symbolic Code for time intensive applications
**SIM PACK Code Export**

**Code Export Stages**

What is Code Export?

Code Export will be offered in different stages

**Functionality**

Stage 0: functionality of v8.0 Symbolic Code

+ standard SIM PACK elements supported
+ static parameters
+ locally defined Input Functions
+ ...

Stage 1: expanded Stage 0 functionality according to customer requests

+ Automotive Elements (Tyre 49, Track Joint, ...)
+ Functions from Data Base (Input Functions, IPF Arrays, Track)
+ dynamic parametrisation (elements, rigid body data, initial state)
+ elastic bodies
+ array base description of axis (elasto) kinematics
+ DAE-free macro-description of axis (elasto) kinematics
+ ...
  - Wheel Rail
  - Contact
  - Root Functions
**SIM PACK Code Export**

**Special functionality Stage 1**

What is Code Export?

**Functionality**

**Fields of Applications**

**Example**

**Output**

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**Conventional**

SIM PACK ODE/DAE Model

**DAE - free**

Macro joint for (elasto) kinematics

**Physical wheel**

(elasto) kinematic

**DAE - free**

(elasto) kinematics using pre-calculated arrays
What Are You Intending To Do?

What is Code Export?

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SIM PACK Code Export

Licensing

- Model specific exported code is customer’s property
- Code Generation: generation of code depending on stage level
- Code Execution: Usage of SIM PACK element library depending on stage level
- Source Code of Element Library: available within special agreement
- Solver: may be used with solver license
SIM PACK Code Export
Advantages of model based on exported Code

What is Code Export?

Functionality

Fields of Application

Example

Overview

- Independent from any SIM PACK installation
- For execution no SIM PACK modelling/user experience is necessary
- Expandable to user needs, e.g. Post Processing
- Reduced calculation time according to code optimisation
- No modelling know how is disclosed when model is handed on
- Code can be linked to arbitrary solvers: - User specific
  - external SIM PACK Solvers
  - commercial Solver systems, e.g. MATLAB

- Several options of coupling and communication to solver system are possible:
  - static or dynamic linking
  - function call or co-simulation
  - one or two process communication (socket, shared memory)

- Integrated modeling in offline (SIM PACK) and online (exported code) simulation
SIM PACK Code Export

What is Code Export?

Functionality

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Example

Outview

Environment
Cartographic Road Track
Road Surface

Joints
19: Automotive Track Joint
...

Constraints
28: Massless Link

Force Elements
49: Automotive Tyre
Pacejka Similarity
...

Control Elements
168: Automotive Track Sensor

Input Function Set
Suspension Stiffness

Input Function Array
Tyre Friction Coefficient
SIMPACK Code Export

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MATLAB Steering control sensor using SIM PACK
Automotive track sensor in exported code
SIM PACK Code Export

What is Code Export?

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Outview

Supported Platforms
- by now: Windows, HP UX, Silicon Graphics
- soon: IBM, SUN
- possible Linux/ i386

Code Export is offered in several stages of functionality.
Stage 1 shipped in minor releases

Source Code available within special agreements

Options for Hardware in the Loop Platforms; still to be investigated
- Linux based HIL platforms now supported
- re-build to f77 -> f2c -> f90
- creating f90 objects/binaries on target platform
  * which CPU/O S combinations?
  * binary compatibility?