Simulation, Analysis & Visualization of Data

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Simulation, Analysis & Visualization of Data

Problem statement

- Due to increase in complexity of engineering products, there is a need for quick and accurate simulation, visualization & powerful analysis techniques to reduce the product development life cycle.

- Complexity in handling the changes to computation.

- There is need for accurate results and minimal time effort spent by research engineers due to huge unconstrained data to get desired simulation results.

- To compare simulation and test bench results.
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Work flow

R& D Engineers

Reports

Test Bench
### Technology Analysis

#### Criteria

- **Performance**
- **Ease of Interface**
- **Maintainability**

#### MATLAB, MATLAB Builder JA, OPT and PCT

- Usage of Optimization and parallel computing tool, increases the execution speed
- Easy interface with Java using MATLAB Builder JA
- Matlab codes are easy to develop, track and resolve the bugs

#### MATLAB + MDCS

- Since MDCS is placed on high end server with OPT and PCT, the speed will be extremely good, High performance
- Need JNI (Java Native Interface) to interface java with Matlab and also RMI (Remote method invocation) is needed to call the MDCS
- In case of any m scripts changes, the C file accessing the Matlab may also required to be changed under some cases

#### Other Vendor solution

- Optimization and Parallel processing is challenging
- The dlls needs to be accessed from a native language like C program
- Incase of any script change, dlls needs to be replaced, which may also result in the replacement of other dll (C program dll)
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Technology and solution

Input
- CVT Geometry
- Number of rings in belt
- Length of ring
- Thickness of ring
- CVT Ring Material
- Density
- E-modulus

Process
- MATLAB
- MATLAB Builder JA
- Parallel Computing Toolbox
- Optimization Toolbox
- Curve Fitting Toolbox

Output
- Reports
- Database
- File formats
Case study- BOSCH CVT

What is CVT?

• Continuous Variable Transmission

• CVT consists of driving shaft and driven shaft each of which has a pulley splined onto it, each pulley comprises of two conical sheaves that face each other
• A metallic pushbelt runs in the V-groove between the two conical sheaves of each pulley

How CVT works

• The pushbelt forms the link between the driving and driven shaft, transmitting the driver power by means of shear force from the engine to wheels
Conti..

CVT Benefits

- CVT transmissions transfer drive power steplessly to the wheels, they deliver robust and dynamic acceleration without reducing tractive power at all
- Make driving incredibly comfortable, eliminating gear shifting and separate gears
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MATLAB GUI
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Results

Optimization Toolbox Results

<table>
<thead>
<tr>
<th>Category</th>
<th>Improvement-Execution Speed</th>
<th>Output Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Dogleg“ to “Levenberg-Marquardt“</td>
<td>15%</td>
<td>&lt;0.1%</td>
</tr>
<tr>
<td>Forward Finite to Central Finite Difference</td>
<td>6%</td>
<td>&lt;0.1%</td>
</tr>
<tr>
<td>Code Improvements</td>
<td>10%</td>
<td>&lt;0.1%</td>
</tr>
<tr>
<td>Total</td>
<td>31%</td>
<td>&lt;0.1%</td>
</tr>
</tbody>
</table>
Summary

- Simulation time is reduced by at least 40%
- Accurate analysis, easy and quick visualization
- Performance improvement in the validation of the components
- Improved look and feel in GUI
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Optimization Toolbox
- fsolve
- fzero
- quadl
- lsqlin

Parallel Computing Toolbox
- parfor
- spmd
- gpuArray
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Take away

» Processing large data set and data-intensive problems

» Easy and quick simulation

» Optimization using standard and large-scale optimization

» Parallel processing of data using Parallel Computing Toolbox

» Interfacing with database and creating reports

» Read and store data in different file formats
Thank You