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

<table>
<thead>
<tr>
<th>Criteria</th>
<th>MATLAB, MATLAB Builder JA, OPT and PCT</th>
<th>MATLAB +MDCS</th>
<th>Other Vendor solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>Usage of Optimization and parallel computing tool, increases the execution speed</td>
<td>Since MDCS is placed on high end server with OPT and PCT, the speed will be extremely good, High performance</td>
<td>Optimization and Parallel processing is challenging</td>
</tr>
<tr>
<td>Ease of Interface</td>
<td>Easy interface with Java using MATLAB Builder JA</td>
<td>Need JNI (Java Native Interface) to interface Java with Matlab and also RMI (Remote method invocation) is needed to call the MDCS</td>
<td>The dlls needs to be accessed from a native language like C program</td>
</tr>
<tr>
<td>Maintainability</td>
<td>Matlab codes are easy to develop, track and resolve the bugs</td>
<td>In case of any m scripts changes, the C file accessing the Matlab may also required to be changed under some cases</td>
<td>Incase of any script change, dlls needs to be replaced, which may also result in the replacement of other dll (C program dll)</td>
</tr>
</tbody>
</table>
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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
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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
## 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><strong>Total</strong></td>
<td><strong>31%</strong></td>
<td><strong>&lt;0.1%</strong></td>
</tr>
</tbody>
</table>
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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