MODEL REDUCTION TECHNIQUES APPLIED TO A PHYSICAL VEHICLE MODEL FOR HIL TESTING

INTRODUCTION

MORSE (MOdel based Real-time System Engineering) is a 2-year project in collaboration with Ford and AVL. The aim of the project is to develop predictive engine and vehicle models enabling virtual calibration of driveability control features and validation of On Board Diagnostics (OBD) fault paths.

DETAILED PHYSICAL VEHICLE MODEL

In order to satisfy the requirements of the project, physical models with a high level of detail are needed. The vehicle is modelled based on physical equations and uses multibody components. However, it is too slow to be usable in Hardware-in-the-Loop, we thus need to reduce it.

MODEL REDUCTION

The model reduction tool automatically reduces the gear set model. The physical gear set is run over a wide range of operating points and the losses and inertias are automatically collected from the set of results. They are then used to parameterise the reduced gear set.

To reduce the driveline, suspensions and wheels, we have used a half car model. This approach is valid since the vehicle is only tested on a straight line.

DYMOLA & HIL TESTING RESULTS

<table>
<thead>
<tr>
<th>Level</th>
<th>Simulation time (s)</th>
<th>Number of events</th>
<th>Overrun</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Full model)</td>
<td>62.2</td>
<td>46</td>
<td>&gt;50</td>
</tr>
<tr>
<td>2</td>
<td>42.5</td>
<td>26</td>
<td>&gt;50</td>
</tr>
<tr>
<td>3</td>
<td>36.2</td>
<td>28</td>
<td>&gt;50</td>
</tr>
<tr>
<td>4</td>
<td>33.8</td>
<td>27</td>
<td>&gt;50</td>
</tr>
<tr>
<td>5 (Fully reduced model)</td>
<td>16</td>
<td>16</td>
<td>12</td>
</tr>
</tbody>
</table>

5 levels of reduction from the fully detailed model to the fully reduced one.

CONCLUSION AND FUTURE WORK

- Model reduction techniques for all the vehicle subsystems have been implemented and tested.
- The accuracy of the results is satisfying and the improvement in performance significant.
- The vehicle needs to be validated over manoeuvres other than Tip-In/Tip-Out.
- More testing is needed in Hardware-in-the-Loop.
- Try to run the model on several cores.

IN DYMOLA

Comparison of the results generated by the detailed and reduced vehicle models run over a Tip-In/Tip-Out manoeuvre, in Dymola and in Hardware-in-the-Loop, in terms of accuracy and simulation speed.

IN HARDWARE-IN-THE-LOOP

The turnaround time of the reduced vehicle (in blue, bottom graph) is smaller than the targeted step size (in red), only one overrun has to be got rid of.