CASE STUDY LAND ROVER: DIFF-CRASH IDENTIFIES CONTACT MODELING AS SOURCE FOR AIRBAG SCATTER

1 Maximal scatter of simulation results at time step 50 shown as fringe plot.

Fraunhofer Institute for Algorithms and Scientific Computing SCAI

Schloss Birlinghoven
53754 Sankt Augustin
Germany

Contact:
Dipl.-Math. Clemens-August Thole
phone +49 2241 14-2739
clemens-august.thole@scai.fraunhofer.de
www.scai.fraunhofer.de

Challenge

Physical effects, inappropriate modeling or numerical approximations may cause substantial scatter: Tiny changes in parameters, load case or even repeated simulations on a parallel platform may result in a huge difference of the simulation results. This is in particular a challenge for the correct design of airbags, which is a major task of the Body CAE department of Jaguar Land Rover.

Solution

DIFF-CRASH is a tool, which identifies sources of scatter during the simulation runs. Several runs are simultaneously analysed in order to compute specific statistical measures for each grid point and time step. The new version in particular supports

• Separation of impact of parameter changes and noise
• Separation of several sources of scatter
• Estimation of the influence of a scatter source on variation of a target value
• Visualisation of two extreme simulation results resulting from a single source of scatter.
• Incorporation of time history curves into the analysis

In order to evaluate the potential of DIFF-CRASH, Jaguar Land Rover chose a particular example of an airbag model, which had previously demonstrated unstable behaviour and had required a substantial amount of time to identify the source of scatter.

»Using DIFF-CRASH straight away would have pointed us directly to the source of the instability and would have saved us a lot of time analysing a large number of different simulation results.«
Richard Brown, Jaguar Land Rover
The testcase

Figure 1 shows the maximal scatter in the simulation results as a fringe plot on the deformed shape of airbag and dummy. The airbag position varies by more than 50 mm, resulting in major differences in critical parameters like the HIC value.

Results

Step 1
• DIFF-CRASH uses Principle Component Analysis in order compute the major trends of the differences between the simulation runs. Figure 3 shows the importance factors for the scatter of the neck as well as the contribution of the two most important difference modes plotted against each other. It shows that there is one dominating mode and the actual simulation results form 6 clusters.

Step 2
• Correlation analysis showed that a specific part of the airbag is correlated to this scatter.

Step 3
• Figure 4 shows the importance factors of a PCA Analysis of the airbag at different time steps. No scatter at time step 21. Correlation analysis showed that the scatter of the airbag at state 23 already explains all scatter at the dummy’s neck.

Step 4
• The engineer now visualises two extreme runs from the most distant clusters. Figure 2 shows, in the blue circle, different positions of the tethers at this state in two simulation runs.

Consequence

This area is known as being sensitive to contact definition, because the airbag interacts with the edge of its cover moving over the upper facia. Jaguar Land Rover had changed the contact model and got much more stable results.

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2 «Ribbon of the airbag« at state 23 of the two most important simulation runs
3 Results of a Principle Component Analysis for the node positions of the Neck part of the dummy.
4 Importance factors for the scatter of the airbag.