Identification of Origin of Numerical Scatter in Crash Simulation in Parallel Computing Environment

Seung-Hoon Paik[1], Jong-Geun Moon[1], Seung-Jo Kim[1], and Kyeong-Hee Han[2]

1) *School of Mechanical and Aerospace Engineering, Seoul National University, Seoul 151-744, KOREA*
2) *Hyundai Motor Company, Whsung-si, Gyunggi-Do, KOREA*

Corresponding Author: Seung-Jo Kim, sjkim@snu.ac.kr

ABSTRACT

Nowadays the car manufacturing industry relies heavily on simulation results. These computing simulations treat large deformations, complex contact, nonlinear material behavior and include many time step. So, small changes of input parameters in the car crash simulation may result in huge changes in the results. Likewise variations of computing environment can cause differences in results. Recently, parallel versions of commercial crash codes are widely used in many crash applications. Among the car crash simulation engineers, it is well known facts that the difference results are produced depending on the hardware platforms and number of CPUs used. Sometimes, the results are also random from run to run in parallel environments. In this research, data clustering algorithm is used to identify the origin of the numerical scatter in the calculation results obtained from parallel computing environment.

Clustering Algorithm

The Clustering Algorithm[1] used for crash simulation analysis is performed in the following steps:

1. Select a reference time step, a minimal cluster size and a threshold.
2. Perform a pre-clustering for this time step:
    (1) Perform clustering for this time step.
    (2) Find the center node for each cluster
    (3) Perform the second Cluster to check for all related nodes to these center nodes.
    (4) Sort center nodes by the size of clusters to get a new node sequence.
3. For each time step.
    (1) Perform Cluster by the new node sequence.
4. Result

Main Results

Applying the clustering algorithm to the full car model, we identified the origin point having a important effect on the difference of the parallel computing simulation results. In the result of identification, we found that the car model has a initial penetration at the origin point of scatters. After removing a initial penetration in the car model and reanalyzing the modified full car model, we could find that the difference between the parallel computing simulation results decreases.

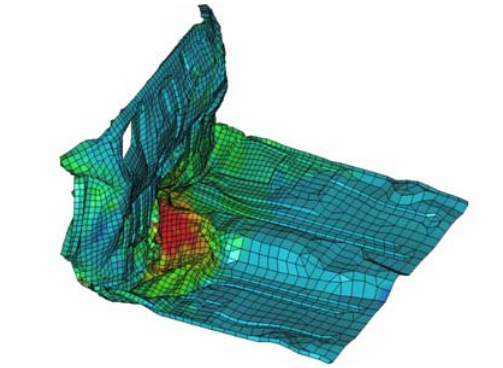

Figure 1. Numerical Differences in Parallel Computing Environment

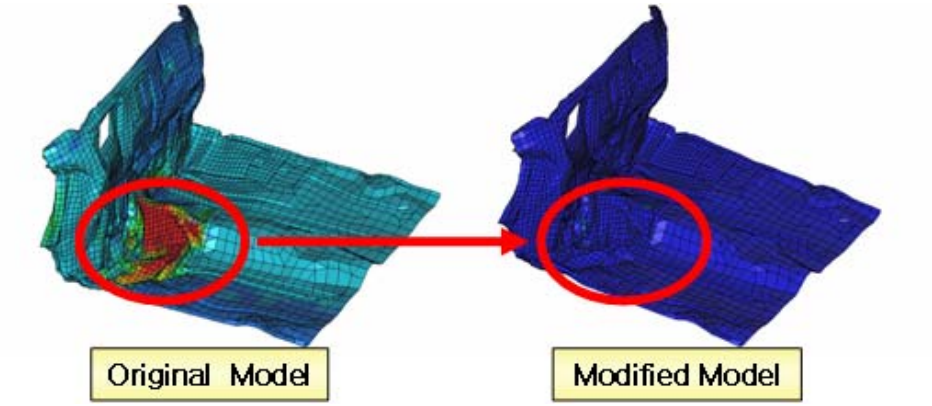

Figure 2. Decrease of Numerical Scatter in Crash Simulations

REFERENCES

(1) Paper in Conference Proceedings

1. Clemens-August Thole, Liquan Mei, "Reasons for Scatter in Crash Simulation Results", NAFEMS Seminar: Use of Stochastics in FEM Analyses, Wiesbaden, Germany, May 7-8.