

Software Lab:

Automatic post-processing of crash simulation data

Description

Rapid progress of computational power during last few years has enabled engineers to employ more detailed, and at the same time, greater number of simulations to tackle challenges in design of crashworthy cars. We deal with high dimensional data, considering all types of outputs written by a crash solver for each node at FE models (e.g., displacements, stresses, strains, etc.). Additionally, many different scenarios with different input parameters sets are necessary to be simulated for tasks such as optimization or robustness analysis. Simulation results should be analyzed by engineers to determine effect of parameters on crash behavior of components. State-of-the-art methods are becoming more and more necessary to analyze huge amount of data generated from crash simulations.

Dimensionality reduction techniques and clustering are used frequently in various fields of engineering. Dimensionality reduction finds a representation of high dimensional data in a lower dimension space while preserving main characteristic of data. Subsequently, clustering algorithms can be used to cluster data in groups based on similarities in their main characteristics. There have been already successful implementations of similar ideas for automatic post-processing of crash results. [1] [2] [3]

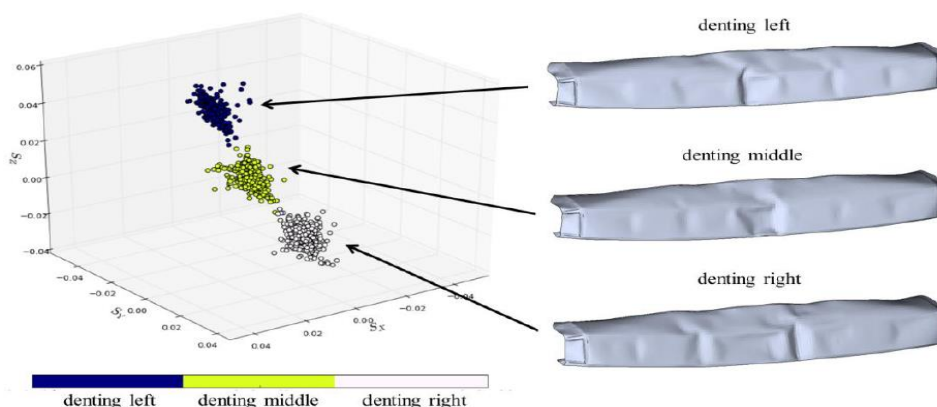


Figure 1- Clustering of 100 simulations, 3 major deformation modes are identified [1].

Task

Implement a code based on mentioned techniques from machine learning community in order to evaluate physical behavior of components in a crash simulation in an automatic manner. To this end:

- Familiarize yourself with the topic and existing solution approaches in the literature.
- Make an interface to automatically extract data from output files from crash solver,
- Map simulation results to lower dimension space
- Objective evaluation of the quality of dimensionality reduction
- Cluster simulation results based on low dimensional data
- Once your method is working in the first phase, make your code mesh independent using proposed method or better ideas of your own!

- Apply your developed code on a set of simulation results to cluster and identify main behavior patterns of the components.

Supervisor

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References

- [1] C. Diez, "Machine learning process to analyze big-data from crash simulations," *7th BETA CAE International Conference*, 2017.
- [2] D. J. G. A. S. Kracker, "Automatic analysis of crash simulations with dimensionality reduction algorithms such as PCA and t-SNE," *16th International LS-DYNA® Users Conference*, 2020.
- [3] G. Sharma, "<https://www.linkedin.com/pulse/machine-learning-application-analyzing-crash-data-girish-sharma>," [Online].