NAFEMS UK Regional Conference 2018 - Abstract Submission

Submission Date	2018-02-02 07:38:46
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Please identify the event for which your submitting?	NAFEMS UK Conference 2018
Will you be the presenting author?	Yes
Presentation Title	CAB Cushion Shape Optimization Based on Genetic Algorithm and Numerical Analysis
Relevant Themes / Keywords	Curtain airbag(CAB), Shape optimization, Genetic Algorithm(GA), BrIC(brain injury criterion)

Abstract (plain text)	Curtain airbag bag(CAB) shape optimization was studied based on a genetic algorithm(GA) and numerical analyses to meet a design requirement of driver's brain injury criterion(BrIC) value in an oblique moving deformable barrier(MDB) crash event. Deployed cushion shape of a CAB should be designed by compromise with many requirements. Started from head protection in a MDB or pole crash, ejection mitigation(FMVSS-226) had been added and most recently BrIC was introduced. To meet these requirements simultaneously, optimization of cushion shape is needed. The design factors of CAB are inflator, fabric type, cushion dimensions and so on. But after early stage of development, only the cushion shape, which can be considered by changing input data to loom machine, can be changed easily. Numerical analysis is a good solution of cushion shape optimization method especially in the early stage of development but there are three major difficulties. Firstly, it requires much workload of updating the finite element(FE) model of initial state as well as the reference state of cushion shape. Secondly, the gas leakage properties of CAB should be properly defined depending on each shape. And the last difficulty is analysis of injury results is complex and requires much time and experience. The newly introduced BrIC makes the analysis more difficult from the lack of experience.To overcome these difficulties, a cushion shape parameterization method, numerical gas leakage models and GA had been developed and used in this study. By partitioning CAB cushion into small parts, the CAB deployment pattern can be parameterized as a binary code. Each small part of the partitioned cushion is defined to be matched with a corresponding digit of the binary code and defined as 0 or 1 depending on being tethered or not. In this way, all the deployment shapes can be considered with only one finite element model. Leakage through seam line and fabric permeability are two major leakage characteristics of CAB. Their numerical models had been established as different models respectively. The leakage through seam is determined by the length of seam and the permeability characteristics through fabric are considered by deployable cushion area. The length and area can be calculated from the binary code of the CAB by simple arithmetic operations using the corresponding digit location information of partitioned cushion. Analysis of results of BrIC depending on cushion shape required much time. A change of cushion shape influences bag pressure and thickness distribution whose effect on dummy's head rotation are different in X, Y and Z direction. This makes the analysis process complicated. Furthermore, more analysis experience of BrIC was needed. A GA for optimization is a good solution in this case. It is based an evolution theory in the real world. It substitutes complex analysis processes with search procedures based on the mechanics of natural selection and natural genetics. Robustness is its strong point and especially good for complex system. The previously defined binary code of CAB can be conveniently applied as a string of GA which is genetic information. Populations which have 6~8 strings were used in the study after consideration of our computational environment. After some generations whose performance made little change, the performance successfully improved and a cushion shape which meet our design target could be obtained. And the injury mechanism had been found through many simulations. But its efficiency should be improved for practical application, as this newly introduced method took about one month for this optimization process. An optimization based on a neuron network is going to be studied to consider many requirements in a shorter time.
Please enter any additional comments or messages here	This study suggests a newly developed optimization method of airbag shape. I would like to discuss the merits and demerits of this method.
abstract id	UK18-36