MULTI OBJECTIVE OPTIMIZATION FOR VEHICLE SECOND ROW RERAINT SYSTEM CONSIDERING VARIOUS OCCUPANT SIZES AND NCAP REQUIREMENTS
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Research and/or Engineering objective:
Rear seat occupant protection has gained importance after introduction of safety assessment for rear adult and child occupant by EuroNCAP. Design of restraint system for second row occupants is always a tricky tradeoff due to competing requirements such as having a softer seat belt to have less load on child occupants, but this would potentially expose the heavier occupant to come in contact with vehicle interiors or front seats during certain impact scenarios. The objective of the study is to develop an optimization framework which can address multiple objectives and then use the framework to identify optimal second row restraints system considering the various occupant sizes as well as multiple NCAP requirements using Computer Aided Engineering (CAE).

Methodology:
Possible variations are considered in the restraint system design, and optimal combination of these variables are obtained using LS-OPT® (Optimization tool from Livermore software Technology Corporation) for three different sizes of occupants in two crash severities. The crash scenarios considered in the study are (a) full frontal vehicle crash into rigid barrier with adult dummy (Harmonized HIII 5th Percentile female) and (b) full vehicle crash into the 40 percent offset deformable barrier with child dummies (Humanetics Q-6 year-old and Q-10 year-old) EuroNCAP requirement and adult dummy Hybrid III 5th percentile (CNACP requirement) in the rear seats. In this study, LS-OPT® in built neural network radial basis function (RBF) and Genetic Algorithm were used for metamodeling and subsequent optimization.

Results:
The results show that the LS-OPT® based optimization metamodel predicted the occupant restraint system responses very well. Finally, the set of optimum seatbelt torsion bar and web stop angle were obtained using Pareto frontier of the multi objective method. The optimum set of results are further verified for the UNECE R21 Annex-8 requirements in CAE and will be subjected to physical validation in due course of time. It is found that the second row restraint system performance can be substantially improved for meeting product development requirements through this proposed approach.

Limitations of this study:
This study is focused on mainly to identify the optimal second row seatbelt parameters under frontal impact conditions. Airbags, seat design solutions and restraint regulatory performance (as per UNECE R16) are not considered.

What does the paper offer that is new in the field including in comparison to other work by the authors?
Restraint solution in second row occupant encompassing both adult and child occupants in meeting all NCAP and Regulatory requirements.

Conclusions:
Developed an effective optimization approach to design the second row occupant restraint system. Through the sensitive analysis, the influence of noise variables were estimated. A set of Pareto optimal solutions are obtained with a trade-off between the performances of the various NCAP requirements.