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Design and optimization of nylon coated display unit cabin

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Abstract

The purpose of this research was to develop a method of optimization that may be applied to the existing layout of the display cabinet at the grocery store in order to make it more functional. This method can be applied to either continuous or discrete design variable values, depending on the context. It is also possible to take into account a large number of different design variables. As finite element analysis (FEA) is a common analysis tool for engineers, an optimization procedure was developed in order to reach the objective by combining the orthogonal array experimentation technique with FEA. This was done in order to create the best possible solution. In order to produce a combined optimised design for the purpose of reducing the amount of material used and the associated costs, topology, topography, and size optimization were all performed. The aim is not necessarily to obtain the actual optimum value, if such a thing even exists; rather, the objective is to devise a more practical approach that will, with a reasonable amount of effort, produce a result that is close to the optimum.

Introduction

Millions more vehicles have been sold as a result of the significant economic impact that automobile styling has had over the past century. Compared to fine art or other commercial or industrial arts, not a lot of research has been done on car interior design [1], [2], [3]. However, compared to many other topics, automobile design has a greater ergonomic, economic, and cultural impact on the travel of millions of passengers [4]. The design team's work is typically divided into three main categories: exterior design, interior design, and colour and trim design. The optimization of the display unit cabin is related to optimising the existing generic design and results in a design that is lighter and stiffer in terms of secondary deformation [5], [6], [7], [8].The optimization technique used here in this paper presentation is based on the following techniques:

- Optimization of topology
- Optimization of topography
- Optimization of size

An approximation of the interface that exists within each element is achieved by employing a structured grid that is fixed in place and using a linear approximation. The optimization method takes into account linear materials and does not make use of non-linearities that are related to contact [9], [10], [11], [12]. The optimization programme analyses the design and modifies the model in order to locate the optimal solution that fulfils the criteria for both the optimal characteristics and the design (see Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5, Fig. 6, Fig. 7, Fig. 8, Fig. 9, Fig. 10 and Table 1).

It is a mathematical method for making the best use of the space in a package by distributing the materials of a structure in the best way possible.

An advanced form of shape optimization known as topography optimization involves defining a design region for a particular part and then generating an optistruct pattern of shape variable-based reinforcements within that region [13], [14], [15], [16], [17]. Topography optimization is a subset of shape optimization.

It's a process that changes the structure's parameters, like its thickness, 1D property, and material properties, in order to find the best design.

The study was carried out in the following manner.

Initial validation of the baseline design—Radioss.

Optimization framework: Optistruct.

Bead study.

CAD model creation in CREO.

Validation of the final optimized model in ANSYS classic.

Section snippets

Baseline model and study

The initial baseline model with the conventional design weighed an approximate 150 kg and was structurally rigid to carry the entire weight [18], [19], [20], [21]. The baseline model was run for load carrying, with half the load applied as force and 735 N applied and evaluated for deformation, with the design having half symmetry. Half symmetry is evaluated henceforth, and the design is being optimized. The model is evaluated for the SI unit system.

Optimization study

Below, the optimization pattern for topography optimization is shown, and it shows a clear bead requirement near the load-carrying path. Also, clearly, the other locations that are away from the load path show material removal results in topology optimization.

Using the topography optimization technique, optistruct provided areas, as shown in the images below, about where to add the beads on the components (the red regions being the preferred locations). Hence, by providing features at such

Conclusion

- The new optimised design has an overall weight reduction of 35 kg and weighs 115 kg as compared with the conventional design, which weighs around 150 kg.
- The new design is well within the criteria limit and exhibits less deformation pattern due to reinforcement added at the load-carrying path despite material removal in other locations.
- The material cost reduction for 35 kg is approximately Rs. 3150 and has a major advantage in overall setup cost reduction as well.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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