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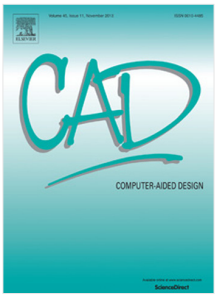

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Sampling CAD Models via an Extended Teaching-Learning-Based Optimization Technique

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Abstract

The Teaching-Learning-Based Optimization (TLBO) algorithm of Rao et al. has been presented in recent years, which is a population-based algorithm and operates on the principle of teaching and learning. This algorithm is based on the influence of a teacher on the quality of learners in a population. In this study, TLBO is extended for constrained and unconstrained CAD model sampling which is called Sampling-TLBO (S-TLBO). Sampling CAD models in the design space can be useful for both designers and customers during the design stage. A good sampling technique should generate CAD models uniformly distributed in the entire design space so that designers or customers can well understand possible design options. To sample N designs in a predefined design space, N sub-populations are first generated each of which consists of separate learners. Teaching and learning phases are applied for each sub-population one by one which are based on a cost (fitness) function. Iterations are performed until change in the cost values becomes negligibly small. Teachers of each sub-population are regarded as sampled designs after the application of S-TLBO. For unconstrained design sampling, the cost function favors the generation of space-filling and Latin Hypercube designs. Space-filling is achieved using the Audze and Eglais' technique. For constrained design sampling, a static constraint handling mechanism is utilized to penalize designs that do not satisfy the predefined design constraints. Four CAD models, a yacht hull, a wheel rim and two different wine glasses, are employed to validate the performance of the S-TLBO approach. Sampling is first done for unconstrained design spaces, whereby the models obtained are shown to users in order to learn their preferences which are represented in the form of geometric constraints. Samples in constrained design spaces are then generated. According to the experiments in this study, S-TLBO outperforms state-of-the-art techniques particularly when a high number of samples are generated.

Keywords: Teaching-Learning-Based Optimization, Design Sampling, Computer-Aided Design, Generative Design

1. Introduction

Engineering and industrial product design is a goal-oriented, constraint-based decision making process. The product obtained after this process should satisfy the consumers' needs, not just in its functional performance, but also its external appearance. The design process becomes more complex and time consuming if the products appearance is valuable to the consumers. At the initial stage of the design process, there may be no or few CAD models available for prototyping or design validation analysis. Design engineers form the design space for the CAD model using design specifications. The CAD model is modified to obtain geometric variations, some of which are inspected visually and

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