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ABSTRACTS

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Towards Optimal Design of Engineering Systems

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ABSTRACT

This paper presents a review on methods, algorithms and tools available for robust optimal design of engineering systems. The focus primarily is put on methods and algorithms for global sensitivity analysis (GSA) and solution of Pareto optimization problems (POP) for multidimensional nonlinear mechanical systems. The computer code SAMO, developed at Chalmers University of Technology, is presented as an efficient toolbox for optimal design of engineering systems with different applications. At this stage, the toolbox SAMO includes two modules: SAMO-GSA and SAMO-POP. The module SAMO-GSA is developed based on the multiplicative version of the dimensional reduction method (M-DRM) [1]. In the SAMO-GSA an efficient approximation is employed to simplify the computation of variance-based sensitivity indices associated with a general function of n-random variables. The GSA results of the engineering system in question are then presented as a mapping of the design parameters and total sensitivity indices of the objective functions. These results might be used as an input to the SAMO-POP for multi-objective optimization. The module SAMO-POP works based on genetic algorithm (GA). The GA settings include lower and upper bounds for variation of the design parameters, population size, number of generations, elite count, and Pareto fraction settings. The results of SAMO-POP are presented in terms of Pareto fronts and corresponding Pareto sets for further analysis and decision making by the user. The efficiency of the proposed algorithms and developed toolbox is illustrated, first on scholar applications (thermally induced stress intensity factor and quarter car vehicle model), and second by GSA and solutions of several multi-objective optimization problems for a nonlinear multidimensional mechanical system which represents bogie suspension components of a high-speed train [2-3]. Finally, based on the literature review and the results obtained the paper presents the outlook of the future research in developing of computationally efficient algorithms for extension of the toolbox SAMO for robust optimal design of engineering systems. References 1. Zhang, X. and M. D. Pandey, (2014), An effective approximation for variance-based global sensitivity analysis, Reliability Engineering and System Safety, 121, 164-174. 2. Mousavi Bideleh, M.S. and V. Berbyuk, (2016), Global sensitivity analysis of bogie dynamics with respect to suspension components, Multibody System Dynamics, 37, No. 2, 145-174, DOI: 10.1007/s11044-015-9497-0, http://dx.doi.org/10.1007/s11044-015-9497-0 3. Mousavi-Bideleh, M.S., and V. Berbyuk, (2016), Multiobjective optimisation of bogie suspension to boost speed on curves, Vehicle System Dynamics, 54, No 1, 58-85, DOI: 10.1080/00423114.2015.1114655 http://dx.doi.org/10.1080/00423114.2015.1114655