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FORM-FINDING OF TENSEGRITY STRUCTURES VIA RANK MINIMIZATION FORMULATIONS

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A distribution of force densities in a tensegrity structure must satisfy stability and equilibrium conditions. The form-finding process for tensegrity structures usually seek such a distribution of force densities while the topology is given in advance. There are several general approaches available on the market, which are usually based on singular value decomposition [1]. Recently, alternative from-finding approach is proposed based on new ideas from convex analysis. A rank minimization problem regarding the force density matrix can yield feasible distributions of force densities [2]. However, a direct evaluation of the matrix rank is not practical. Therefore, optimization with the matrix rank objective is avoided in favour of numerous relaxations also called heuristics. The trace heuristic is used on this stage in original publication [2]. The trace heuristic, as any other heuristic, does not guarantee recovery of the globally minimal rank. Insufficient rank deficiency makes recovery of proper geometry of tensegrity impossible, i.e. it leads to a degenerated geometry of the tensegrity. In this contribution, the form-finding approach is extended to log-det heuristic initially proposed to other applications [3]. Additionally, robustness of the form-finding procedure for tensegrities using trace and log-det heuristics is compared. Robustness of the form-finding procedure is understood here as the ability to recover at least one feasible tensegrity design. Several examples show that the robustness is mainly influenced by the topology of the structure, constraints on force densities and the admissible set for force densities. Furthermore, the proposed extension with log-det heuristic outperforms the original method based on the trace heuristic in terms of robustness. However, the proposed extension increases the computational cost. Considered examples are implemented in the open-source Matlab package for disciplined convex programming CVX paired to two open-source semi-define program solvers: SDPT3 and SeDuMi [4]. These results are submitted to publication in [5].

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