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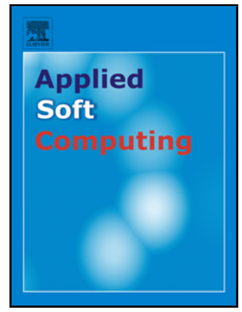

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Efficiency of Bio- and Socio-inspired Optimization Algorithms for Axial Turbomachinery Design

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Abstract

Turbomachinery design is a complex problem which requires a lot of experience. The procedure may be speed up by the development of new numerical tools and optimization techniques. The latter rely on the parameterization of the geometry, a model to assess the performance of a given geometry and the definition of an objective functions and constraints to compare solutions. In order to improve the reference machine performance, two formulations including the off-design have been developed. The first one is the maximization of the total nominal efficiency. The second one consists to maximize the operation area under the efficiency curve. In this paper five optimization methods have been assessed for axial pump design: Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Cuckoo Search (CS), Teaching Learning Based Optimization (TLBO) and Sequential Linear Programming (SLP). Four non intrusive methods and the latter intrusive. Given an identical design point and set of constraints, each method proposed an optimized geometry. Their computing time, the optimized geometry and its performances (flow rate, head (H), efficiency (η), net pressure suction head (NPSH) and power) are compared. Although all methods would converge to similar results and geometry, it is not the case when increasing the range and number of constraints. The discrepancy in geometries and the variety of results are presented and discussed.The computational fluid dynamics (CFD) is used to validate the reference and optimized machines performances in two main formulations. The most adapted approach is compared with some existing approaches in literature.

Keywords: Optimization, axial turbomachine, inverse design, Bio and Socio-inspired Optimization Algorithms, Sequential Linear Programming.

1. Introduction

Turbomachines are omnipresent in everyday domestic environment and in industry. The applications range from air conditioning to water distribution and from automotive to aeronautics and naval engines. In the turbomachines design optimization, because of the large number of variables of design parameters, which is in this case always larger than the number of equations, this can be handled by the classical design methods based on the exploitation of empirical laws like Coridier's diagram [1] [2].

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