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自适应差分进化算法在气动优化设计中的应用

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Application of Adaptive Differential Evolutionary Algorithms to Aerodynamic Optimization Design

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摘要 以实数编码的差分进化（DE）算法为基础，引入种群熵估计方法分析种群个体的分散程度，自适应地调整设计变量的搜索范围。采用Navier-Stokes方程作为主控方程计算翼型气动性能，分别采用标准遗传算法（SGA）、基本DE算法和自适应差分进化（ARDE）算法作为气动性能优化算法进行了针对翼型的气动优化设计。函数测试实例表明,ARDE算法具有更好的收敛稳定性和收敛速度。并针对翼型气动优化问题的特点，分析了参数设置对ARDE算法优化结果的影响。实验结果对比表明，ARDE算法得到了更好的优化结果。

关键词： 差分进化算法 熵估计 自适应 气动优化 参数设置 翼型

Abstract： Based on real-coded differential evolutionary (DE) algorithm, a population entropy estimating method is introduced into DE to analyze the distribution of individuals in the population. Search range in this algorithm is adaptively changed according to individual distribution. Function optimization test suggests that this algorithm has better convergence stability and convergence speed. The Navier-Stokes equations are adopted for calculating the airfoil aerodynamic performances. Three optimization algorithms, i.e., the standard genetic algorithm（SGA）, the DE algorithm, and the adaptive range differential evolutionary （ARDE） algorithm, are tested on an airfoil shape aerodynamic optimization problem. Comparison of the optimization results from the three different algorithms demonstrates that the ARDE algorithm has better search capability. According to the characteristics of the aerodynamic optimization problem, influences from the control parameters in the algorithm on optimization results are analyzed and studied.

Keywords： differential evolutionary algorithm entropy estimate adaptive control aerodynamic optimization parameter setting airfoil

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