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基于概率的柔性铰链机构的优化设计

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摘要 研究了具有随机参数的平面柔性铰链机构的位移放大和刚度性能的优化问题．从概率统计角度出发，将各设计参数看作随机变量，建立了基于概率的柔性铰链机构优化设计模型，并用Monte Carlo模拟法得到了柔性机构性能及一些约束函数的均值和方差．优化设计求解采用Lagrange乘子法，利用分布函数法将模型中的可靠性约束等价处理为常规约束形式．通过优化设计得到了优化设计向量．根据所得优化设计向量分别得到了机构性能的计算结果．结果表明，当设计参数分散性变大时，优化设计结果偏于保守．

关键词 随机参数 弯曲铰链 柔性机构 Monte Carlo模拟

分类号 TH112

Optimal design of flexure-based compliant mechanisms based on probability

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Abstract

Considering the randomness of the parameters of planar compliant mechanisms with single-axis flexure hinges, the mean value and variance of displacement amplification, input stiffness, output stiffness and additional restrictions are obtained by Monte Carlo simulation, on the basis of which a mathematical model for the optimal design of the planar flexure-based compliant mechanisms based on probability are built, where the optimal compound performance is taken as the objective function, meeting reliability requirements of each minimum and maximum limits of the design parameters and additional restrictions as constraints. The approach of Lagrange's multipliers is adopted during optimization. The distribution function method is used to display the reliability constraints in the optimal design model, and then the probability constraints are converted into convention constraints. Displacement amplification and stiffness are calculated according to the optimal design vectors achieved via the optimization design. It is shown that when the variances of parameters increase, the optimal design results are conservative.

Key words random parameters flexure hinge compliant mechanism Monte Carlo simulation

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