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Constrained design optimization using MATLAB & ANSYS: Assessment of accuracy & Hessian matrix assumptions

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In this paper, a nonlinear constrained optimization problem is solved using MATAB's Optimization Toolbox and ANSYS APDL's Design Optimization. The objective is to investigate the accuracy of both methods and to assess the assumptions used in approximating the Hessian matrix in each case. The sequential quadratic programming (SQP) technique is applied through MATLAB and a subproblem approximation method using the sequential unconstrained minimization technique (SUMT) through APDL. SQP linearizes the constraints and solves the QP subproblem to form a line search to decrease the descent function whereas in SUMT the constrained problem is converted to an unconstrained problem using a transformation that applies a penalty function in place of the constraints. Comparing the two techniques it was found, based on the results that the sub problem approximation method from APDL proved more accurate since the optimum solution was a global minimum, whereas in MATLAB a local minimum result was obtained. The treatment of the Hessian matrix by the two techniques was studied in order to understand its effect on the results; the SQP method utilizes a quasi-Newtonian method, the BFGS method, to approximate the Hessian matrix while in APDL, no approximation is made since the subproblem approximation method is a zero-order method.

Recent Publications

1.   Arora J S (2016) 4th Edition, Introduction to Optimum Design, Elsevier Academic Press ISBN: 9780128009185.

2.   Belegundu A D and Chandrupatla T R (2011) 2nd Edition, Optimization Concepts and Applications in Engineering, Cambridge University Press (2011) ISBN 978-0-521-87846-3.

3.   Dai Y (2003) Convergence properties of the BFGS algorithm. SIAM J. Optimization 13:693–701.

4.   D Rao S S (2009) 4th Edition, Engineering Optimization: Theory & Practice, John-Wiley & Sons Inc. ISBN: 978-0-470-18352-6.

Biography

Farzad Hemmati has his research mainly focused on dynamic characteristic problems of high-speed turbomachinery. Continuous online monitoring is necessary to assess health conditions, to enable early detection of operation problems and to reduce possibility of downtime. Destructive excessive vibrations in rotor supported oil film journal bearing systems are mainly caused by misalignment, unbalance, and oil-induced instability phenomenon known as whirl. In many of the published works, the predictions of the instability threshold speed and dynamic response of the rotor supported by fluid-film journal bearings are based on the linearized stiffness and damping coefficients. Nevertheless, the fluid forces generated in fluid-film journal bearings are highly nonlinear so that bifurcation exists around the instability threshold speed.

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