Rolf Steinbuch
Simon Gekeler Editors

Bionic Optimization in Structural Design

Stochastically Based Methods to Improve the Performance of Parts and Assemblies

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Bionic Optimization in Structural Design Rolf Steinbuch,Simon Gekeler,2015-11-04 The book provides suggestions on how to start using bionic optimization methods including pseudo code examples of each of the important approaches and outlines of how to improve them The most efficient methods for accelerating the studies are discussed These include the selection of size and generations of a study s parameters modification of these driving parameters switching to gradient methods when approaching local maxima and the use of parallel working hardware Bionic Optimization means finding the best solution to a problem using methods found in nature As Evolutionary Strategies and Particle Swarm Optimization seem to be the most important methods for structural optimization we primarily focus on them Other methods such as neural nets or ant colonies are more suited to control or process studies so their basic ideas are outlined in order to motivate readers to start using them A set of sample applications shows how Bionic Optimization works in practice From academic studies on simple frames made of rods to earthquake resistant buildings readers follow the lessons learned difficulties encountered and effective strategies for overcoming them For the problem of tuned mass dampers which play an important role in dynamic control changing the goal and restrictions paves the way for Multi Objective Optimization As most structural designers today use commercial software such as FE Codes or CAE systems with integrated simulation modules ways of integrating Bionic Optimization into these software packages are outlined and examples of typical systems and typical optimization approaches are presented The closing section focuses on an overview and outlook on reliable and robust as well as on Multi Objective Optimization including discussions of current and upcoming research topics in the field concerning a unified theory for handling stochastic design processes **Stochastic Structural Optimization** Makoto Yamakawa,Makoto Ohsaki,2023-08-08 Stochastic Structural Optimization presents a comprehensive picture of robust design optimization of structures focused on nonparametric stochastic based methodologies Good practical structural design accounts for uncertainty for which reliability based design offers a standard approach usually incorporating assumptions on probability functions which are often unknown By comparison a worst case approach with bounded support used as a robust design offers simplicity and a lower level of sensitivity Linking structural optimization with these two approaches by a unified framework of non parametric stochastic methodologies provides a rigorous theoretical background and high level of practicality This text shows how to use this theoretical framework in civil and mechanical engineering practice to design a safe structure which accounts for uncertainty Connects theory with practice in the robust design optimization of structures Advanced enough to support sound practical designs This book provides comprehensive coverage for engineers and graduate students in civil and mechanical engineering Makoto Yamakawa is a Professor at Tokyo University of Science and a member of the Advisory Board of the 2020 Asian Congress of Structural and Multidisciplinary Optimization Makoto Ohsaki is a Professor at Kyoto University Japan treasurer of the International Association for Shell Spatial Structures and former

President of the Asian Society for Structural and Multidisciplinary Optimization **Designing Engineering Structures using Stochastic Optimization Methods** Levent Aydin,H. Seçil Artem,Selda Oterkus,2020-04-27 Among all aspects of engineering design is the most important step in developing a new product A systematic approach to managing design issues can only be accomplished by applying mathematical optimization methods Furthermore due to the practical issues in engineering problems there are limitations in using traditional methods As such stochastic optimization methods such as differential evolution simulated annealing and genetic algorithms are preferable in finding solutions in design optimization problems This book reviews mechanical engineering design optimization using stochastic methods It introduces students and design engineers to practical aspects of complicated mathematical optimization procedures and outlines steps for wide range of selected engineering design problems It shows how engineering structures are systematically designed Many new engineering design applications based on stochastic optimization techniques in automotive energy military naval manufacturing process and fluids heat transfer are described in the book For each design optimization problem described background is provided for understanding the solutions There are very few books on optimization that include engineering applications They cover limited applications and that too of well known design problems of advanced and niche nature Common problems are hardly addressed Thus the subject has remained fairly theoretical To overcome this each chapter in this book is contributed by at least one academic and one industrial expert researcher **Stochastic Structural Optimization** Makoto Yamakawa,2024 Stochastic Structural Optimization presents a comprehensive picture of robust design optimization of structures focused on nonparametric stochastic based methodologies Good practical structural design accounts for uncertainty for which reliability based design offers a standard approach usually incorporating assumptions on probability functions which are often unknown By comparison a worst case approach with bounded support used as a robust design offers simplicity and a lower level of sensitivity Linking structural optimization with these two approaches by a unified framework of non parametric stochastic methodologies provides a rigorous theoretical background and high level of practicality This text shows how to use this theoretical framework in civil and mechanical engineering practice to design a safe structure which accounts for uncertainty Connects theory with practice in the robust design optimization of structures Advanced enough to support sound practical designs This book provides comprehensive coverage for engineers and graduate students in civil and mechanical engineering Makoto Yamakawa is a Professor at Tokyo University of Science and a member of the Advisory Board of the 2020 Asian Congress of Structural and Multidisciplinary Optimization Makoto Ohsaki is a Professor at Kyoto University Japan treasurer of the International Association for Shell Spatial Structures and former President of the Asian Society for Structural and Multidisciplinary Optimization An Introduction to Structural Optimization Peter W. Christensen,A. Klarbring,2008-10-14 This book has grown out of lectures and courses given at Link ping University Sweden over a period of 15 years It gives an introductory treatment of problems and methods of structural

optimization The three basic classes of geometrical timization problems of mechanical structures i e size shape and topology op mization are treated The focus is on concrete numerical solution methods for d crete and nite element discretized linear elastic structures The style is explicit and practical mathematical proofs are provided when arguments can be kept e mentary but are otherwise only cited while implementation details are frequently provided Moreover since the text has an emphasis on geometrical design problems where the design is represented by continuously varying frequently very many variables so called rst order methods are central to the treatment These methods are based on sensitivity analysis i e on establishing rst order derivatives for jectives and constraints The classical rst order methods that we emphasize are CONLIN and MMA which are based on explicit convex and separable appro mations It should be remarked that the classical and frequently used so called op mality criteria method is also of this kind It may also be noted in this context that zero order methods such as response surface methods surrogate models neural n works genetic algorithms etc essentially apply to different types of problems than the ones treated here and should be presented elsewhere   Structural Optimization ,2008   **Structural Optimization,** S. Jendo,1985   **Optimum Structural Design in a Stochastic Environment** Allan Ross Lamb,1985

   Computer Aided Optimum Design of Structures III Santiago Hernández,C. A. Brebbia,1993 Examines the new research on optimization taking place within the scientific community Emphasis is placed on the numerous applications of the technique in industry for a variety of design problems in fields as diverse as offshore mechanical civil and aerospace engineering   Stochastic Optimization Formulations for Structure Design Shivanandini Tanuku,2007   **Multiscale Structural Topology Optimization** Liang Xia,2016-04-27 Multiscale Structural Topology Optimization discusses the development of a multiscale design framework for topology optimization of multiscale nonlinear structures With the intention to alleviate the heavy computational burden of the design framework the authors present a POD based adaptive surrogate model for the RVE solutions at the microscopic scale and make a step further towards the design of multiscale elastoviscoplastic structures Various optimization methods for structural size shape and topology designs have been developed and widely employed in engineering applications Topology optimization has been recognized as one of the most effective tools for least weight and performance design especially in aeronautics and aerospace engineering This book focuses on the simultaneous design of both macroscopic structure and microscopic materials In this model the material microstructures are optimized in response to the macroscopic solution which results in the nonlinearity of the equilibrium problem of the interface of the two scales The authors include a reduce database model from a set of numerical experiments in the space of effective strain Presents the first attempts towards topology optimization design of nonlinear highly heterogeneous structures Helps with simultaneous design of the topologies of both macroscopic structure and microscopic materials Helps with development of computer codes for the designs of nonlinear structures and of materials with extreme constitutive properties Focuses on the simultaneous design of both macroscopic structure and microscopic materials

Includes a reduce database model from a set of numerical experiments in the space of effective strain **Optimization and Anti-optimization of Structures Under Uncertainty** Isaac Elishakoff,Makoto Ohsaki,2010 The volume presents a collaboration between internationally recognized experts on anti optimization and structural optimization and summarizes various novel ideas methodologies and results studied over 20 years The book vividly demonstrates how the concept of uncertainty should be incorporated in a rigorous manner during the process of designing real world structures The necessity of anti optimization approach is first demonstrated then the anti optimization techniques are applied to static dynamic and buckling problems thus covering the broadest possible set of applications Finally anti optimization is fully utilized by a combination of structural optimization to produce the optimal design considering the worst case scenario This is currently the only book that covers the combination of optimization and anti optimization It shows how various optimization techniques are used in the novel anti optimization technique and how the structural optimization can be exponentially enhanced by incorporating the concept of worst case scenario thereby increasing the safety of the structures designed in various fields of engineering Optimal Design of Flexural Systems G. I. N. Rozvany,2013-10-22 Optimal Design of Flexural Systems Beams Grillages Slabs Plates and Shells deals with the optimal design of flexural systems with emphasis on beams grillages slabs plates and shells Analytical methods plastic design plane systems and static problems are covered together with optimal solutions for all boundary conditions that may be of practical or theoretical interest Comprised of nine chapters this book begins with an introduction to the fundamental concepts of mechanics the calculus of variations and optimal design The next chapters discuss theories of optimal plastic design along with elastic and prestressed systems the theory of optimal flexure fields that give an absolute minimum statically admissible moment volume for plane systems and slabs and grillages optimized within various types of geometrical constraints The final chapter reviews experimental work and certain practical aspects of the optimization of flexural systems This monograph should be of interest to graduate students and research workers in structural engineering architectural science aerospace technology solid mechanics and applied mathematics as well as to practicing engineers and architects engaged in large scale projects **Optimum Design of Structures** Lahbib Chibani,2012-12-06 This book presents the integrated approach of analysis and optimal design of structures This approach which is more convenient than the so called nested approach has the difficulty of generating a large optimization problem To overcome this problem a methodology of decomposition by multilevel is developed This technique which is also suitable for implementation on parallel processing computers has the advantage of reducing the size of the optimization problem generated The geometric programming for both equality and inequality constraints is used in the optimization Advanced Techniques in the Optimum Design of Structures Santiago Hernández,1993 **Structural Optimization with Uncertainties** N.V. Banichuk,Pekka Neittaanmäki,2009-12-16 Structural optimization is currently attracting considerable attention Interest in search in optimal design has grown in connection with the rapid development of aeronautical and space

technologies shipbuilding and design of precision mach ery A special eld in these investigations is devoted to structural optimization with incomplete information incomplete data The importance of these investigations is explained as follows The conventional theory of optimal structural design sumes precise knowledge of material parameters including damage characteristics and loadings applied to the structure In practice such precise knowledge is seldom available Thus it is important to be able to predict the sensitivity of a designed structure to random uctuations in the environment and to variations in the material properties To design reliable structures it is necessary to apply the so called gu anteed approach based on a worst case scenario or a more optimistic probabilistic approach if we have additional statistical data Problems of optimal design with incomplete information also have consid able theoretical importance The introduction and investigations into new types of mathematical problems are interesting in themselves Note that some ga theoretical optimization problems arise for which there are no systematic techniques of investigation This monograph is devoted to the exposition of new ways of formulating and solving problems of structural optimization with incomplete information We recall some research results concerning the optimum shape and structural properties of bodies subjected to external loadings **Optimal Structural Design Under Stability Constraints** Antoni Gajewski,Michal Zyczkowski,1988-06-30 **Robust Design Optimization of Structures Under Uncertainties** Zhan Kang,2005 Stochastic Optimization of Structural Topology Anton Evgrafov,2002 First Order Structural Design and Optimization Afshin Mikaili,1989

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