1

Adaptive dimensionality reduction for fast sequential optimization with gaussian processes [Texto impreso] / Seyede Fatemeh Ghoreishi, Samuel Friedman, Douglas L. Allaire

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 071404(11-12)

Available computational models for many engineering design applications are both expensive and and of a black-box nature. This renders traditional optimization techniques difficult to apply, including gradient-based optimization and expensive heuristic approaches. For such situations, Bayesian global optimization approaches, that both explore and exploit a true function while building a metamodel of it, are applied. These methods often rely on a set of alternative candidate designs over which a querying policy is designed to search. For even modestly high-dimensional problems, such an alternative set approach can be computationally intractable, due to the reliance on excessive exploration of the design space. To overcome this, we have developed a framework for the optimization of expensive black-box models, which is based on active subspace exploitation and a two-step knowledge gradient policy. We demonstrate our approach on three benchmark problems and a practical aerostructural wing design problem, where our method performs well against traditional direct application of Bayesian global optimization techniques.

Journal of mechanical design. -- 2019 (July), v. 141, n. 7, p. 071404(1-12)

2

Design and optimization of graded cellular structures with triply periodic level surface-based topological shapes [Texto impreso] / Dawei Li ... [et al.]

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 071402(13)

Periodic cellular structures with excellent mechanical properties widely exist in nature. A generative design and optimization method for triply periodic level surface (TPLS)-based functionally graded cellular structures is developed in this work. In the proposed method, by controlling the density distribution, the designed TPLS-based cellular structures can achieve better structural or thermal performances without increasing its weight. The proposed technique can be divided into four steps. First, the modified 3D implicit functions of the triply periodic minimal surfaces are developed to design different types of cellular structures parametrically and generate spatially graded cellular structures. Second, the numerical homogenization method is employed to calculate the elastic tensor and the thermal conductivity tensor of the cellular structures with different densities. Third, the optimal relative density distribution of the object is computed by the scaling laws of the TPLS-based cellular structures added optimization algorithm. Finally, the relative density of the numerical results of structure optimization is mapped into the modified parametric 3D implicit functions, which generates an optimum lightweight cellular structure. The optimized results are validated subjected to different design specifications. The effectiveness and robustness of the obtained structures is analyzed through finite element analysis and experiments. The results show that the functional gradient cellular structure is much stiffer and has better heat conductivity than the uniform cellular structure.

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3

An empirical study on the impact of design brief information on the creativity of design outcomes with consideration of gender and gender diversity [Texto impreso] / Georgios Koronis ... [et al.]

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 071102(13-14)

This study aims to understand how information in design briefs affects the creativity of design outcomes. We tested this during a Collaborative Sketching (C-Sketch) ideation exercise with first-year undergraduate student

designers. We focus on four types of stimuli—quantitative requirements, a visual example (video), a physical example, and contextual information—and we measure creativity according to three metrics—novelty, appropriateness, and usability with either the participants' gender or the gender diversity of the participants' groups. The findings suggest that the main effect of providing a video example results in high appropriateness and usability scores but low novelty scores and that physical-contextual briefs have high novelty and usability scores. In addition, we did not find any correlation between gender or gender diversity and creativity scores.

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1. Creativity and concept generation 2. Design education 3. Design of experiments

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4

Experimental investigation of the implications of model granularity for design process simulation [Texto impreso] / Jakob F. Maier, Claudia Eckert, P. John Clarkson

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 071101(16-17)

Determining a suitable level of description, or granularity, for a product or process model is not straightforward, especially since granularity can manifest in multiple ways, but it is important to capture important elements in the model without building models that are too large to understand. This article investigates the implications of model granularity choices by simulating the design process of a diesel engine on different levels of detail, comparing the results and exploring ways to account for the differences. It uses two Design Structure Matrix (DSM) models for change prediction in a diesel engine at different levels of granularity to run simulations of the design process. Changes are a major source of rework and lead to frequent rescheduling of design tasks. The incremental nature of product development as well as design changes and their propagation complicate design process planning further. Process simulation may provide support in such contexts when it is based on an appropriate description of the product. The article shows that while coarse models can give an indication of likely process behavior, they miss potentially significant iteration loops.

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5

Free-form design of electrical machine rotor cores for production using additive manufacturing [Texto impreso] / Michele Garibaldi, Christopher Gerada, Ian Ashcroft, Richard Hague

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 071401(13)

This work presents a finite element analysis-based, topology optimization (TO) methodology for the combined magnetostatic and structural design of electrical machine cores. Our methodology uses the Bi-directional Evolutionary Structural Optimization (BESO) heuristics to remove inefficient elements from a meshed model based on elemental energies. The algorithm improves the average torque density while maintaining structural integrity. To the best of our knowledge, this work represents the first effort to address the structural-magnetostatic problem of electrical machine design using a free-form approach. Using a surface-mounted permanent magnet motor (PMM) as a case study, the methodology is first tested on linear and nonlinear two-dimensional problems whereby it is shown that the rapid convergence achieved makes the algorithm suitable for real-world applications. The proposed optimization scheme can be easily extended to three dimensions, and we propose that the resulting designs are suitable for manufacturing using selective laser melting, a 3D printing technology capable of producing fully dense high-silicon steel components with good soft magnetic properties. Three-dimensional TO results show that the weight of a PMM rotor can be slashed by 50% without affecting its rated torque profile when the actual magnetic permeability of the 3D-printed material is considered.

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6

How we solve the weights in our surrogate models matters [Texto impreso] / Daniel Correia, Daniel N. Wilke

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.

References: p. 074501(5)

The construction of surrogate models, such as radial basis function (RBF) and Kriging-based surrogates, requires an invertible (square and full rank matrix) or pseudoinvertible (overdetermined) linear system to be solved. This study demonstrates that the method used to solve this linear system may result in up to five orders of magnitude difference in the accuracy of the constructed surrogate model using exactly the same information. Hence, this paper makes the canonic and important point toward reproducible science: the details of solving the linear system when constructing a surrogate model must be communicated. This point is clearly illustrated on a single function, namely the Styblinski–Tang test function by constructing over 200 RBF surrogate models from 128 Latin Hypercubed sampled points. The linear system in the construction of each surrogate model was solved using LU, QR, Cholesky, Singular-Value Decomposition, and the Moore–Penrose pseudoinverse. As we show, the decomposition method influences the utility of the surrogate model, which depends on the application, i.e., whether an accurate approximation of a surrogate is required or whether the ability to optimize the surrogate and capture the optimal design is pertinent. Evidently the selection of the optimal hyperparameters based on the cross validation error also significantly impacts the utility of the constructed surrogate. For our problem, it turns out that selecting the hyperparameters at the lowest cross validation error favors function approximation but adversely affects the ability to optimize the surrogate model. This is demonstrated by optimizing each constructed surrogate model from 16 fixed initial starting points and recording the optimal designs. For our problem, selecting the optimal hyperparameter that coincides with the lowest monotonically decreasing function value significantly improves the ability to optimize the surrogate for most solution strategies.

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7

A hybrid computational and analytical model of inline drip emitters [Texto impreso] / Jaya Narain, Amos G. Winter V

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.

References: p. 071405(13)

This paper details a hybrid computational and analytical model to predict the performance of inline pressure compensating drip irrigation emitters. Pressure compensating emitters deliver a constant flow rate over a range of applied pressures to accurately meter water to crops. Flow rate is controlled within the emitter via a fixed resistance tortuous path, and a variable flow resistance composed of a flexible membrane that deflects under changes in pressure, restricting the flow path. A pressure resistance parameter was derived using an experimentally validated computational fluid dynamics (CFD) model to describe the flow behavior in tortuous paths. The bending mechanics of the membrane were modeled analytically and refined by deriving a correction factor using finite element analysis (FEA). A matrix formulation that calculates the force applied by a line or a patch load of any shape on a rectangular membrane, along which there is a prescribed deflection, was derived and was found to be accurate to be 1%. The combined hybrid computational–analytical model reduces the computational time of modeling emitters from hours to less than 30 min, dramatically lowering the time required to iterate and select optimal designs. The model was validated experimentally using three commercially available drip emitters and was accurate to within 12% of the experimental results.

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8
Reflections over the dual ring [Texto impreso] : applications to Kinematic Synthesis / Bruno Belzile, Jorge Angeles

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 072302(9)

Least-square problems arise in multiple application areas. The numerical algorithm intended to compute offline the minimum (Euclidian)-norm approximation to an overdetermined system of linear equations, the core of least squares, is based on Householder reflections. It is self-understood, in the application of this algorithm, that the coefficient matrix is dimensionally homogeneous, i.e., all its entries bear the same physical units. Not all applications lead to such matrices, a case in point being parameter identification in mechanical systems involving rigid bodies, whereby both rotation and translation occur; the former being dimensionless and the latter bearing units of length. Because of this feature, dual numbers have found extensive applications in these fields, as they allow the analyst to include translations within the same relations applicable to rotations, on dualization2 of the rotation equations, as occurring in the geometric, kinematic, or dynamic analyses of mechanical systems. After recalling the basic background on dual numbers and introducing reflection matrices defined over the dual ring, we obtain the dual version of Householder reflections applicable to the offline implementation of parameter identification. For the online parameter identification, recursive least squares are to be applied. We provide also the dual version of recursive least squares. Numerical examples are included to illustrate the underlying principles and algorithms.

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9
Structural synthesis of Baranov trusses with up to 13 links [Texto impreso] / Peng Huang, Huafeng Ding

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 072301(15-16)

The structural synthesis of Baranov trusses is still an open problem, although Baranov trusses are widely used in the design and analysis of mechanisms and robots. This paper proposes a systematic method for the structural synthesis of Baranov trusses. First, the definition review and the graph-form representations of Baranov trusses are proposed. Second, seven propositions on structural characteristics of Baranov trusses are concluded. Then, based on the set of constraint equations and a rigid subchain detection algorithm, a systematic method is presented to synthesize the complete set of Baranov trusses with a specified number of links. Finally, the synthesis results of contracted graphs (including valid and rigid contracted graphs) and topological graphs of Baranov trusses with up to 13 links are provided, and the synthesis methods and results between ours and the ones in the existing literature are compared and discussed in detail.

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10
Topology optimization of periodic structures with substructuring [Texto impreso] / Junjian Fu ... [et al.]

Este artículo se encuentra disponible en su edición impresa y electrónica. Los datos para su localización están accesibles a través del enlace al título de la publicación. Su acceso electrónico es a través del enlace de 'Acceso al documento'.
References: p. 071403(8-9)

Topology optimization of macroperiodic structures is traditionally realized by imposing periodic constraints on the global structure, which needs to solve a fully linear system. Therefore, it usually requires a huge computational cost and massive storage requirements with the mesh refinement. This paper presents an efficient topology optimization method for periodic structures with substructuring such that a condensed linear system is to be solved. The macrostructure is identically partitioned into a number of scale-related substructures represented by the zero contour of a level set function (LSF). Only a representative substructure is optimized for the global periodic structures. To accelerate the finite element analysis (FEA) procedure of the periodic structures, static

condensation is adopted for repeated common substructures. The macrostructure with reduced number of degree of freedoms (DOFs) is obtained by assembling all the condensed substructures together. Solving a fully linear system is divided into solving a condensed linear system and parallel recovery of substructural displacement fields. The design efficiency is therefore significantly improved. With this proposed method, people can design scale-related periodic structures with a sufficiently large number of unit cells. The structural performance at a specified scale can also be calculated without any approximations. What's more, perfect connectivity between different optimized unit cells is guaranteed. Topology optimization of periodic, layerwise periodic, and graded layerwise periodic structures are investigated to verify the efficiency and effectiveness of the presented method.

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