1

Active resource allocation for reliability analysis with model bias correction [Texto impreso] / Mingyang Li, Zequn Wang

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. 051403(12-13)

To account for the model bias in reliability analysis, various methods have been developed to validate simulation models using precise experimental data. However, it still lacks a strategy to actively seek critical information from both sources for effective uncertainty reduction. This paper presents an active resource allocation approach (ARA) to improve the accuracy of reliability approximations while reducing the computational, and more importantly, experimental costs. In ARA, the Gaussian process (GP) modeling technique is employed to fuse both simulation and experimental data for capturing the model bias, and further predicting actual system responses. To manage the uncertainty due to the lack of data, a two-phase updating strategy is developed to improve the fidelity of GP models by actively collecting the most valuable simulation and experimental data. With the high-fidelity predictive models, sampling-based methods such as Monte Carlo simulation are used to calculate the reliability accurately while the overall costs of conducting simulations and experiments can be significantly reduced. The effectiveness of the proposed approach is demonstrated through four case studies.

Journal of mechanical design. -- 2019 (May), v. 141, n. 5, p. 051403(1-13)

2

Combined level-set-XFEM-density topology optimization of four-dimensional printed structures undergoing large deformation [Texto impreso] / Markus J. Geiss ... [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. 051405(13-14)

Advancement of additive manufacturing is driving a need for design tools that exploit the increasing fabrication freedom. Multimaterial, three-dimensional (3D) printing allows for the fabrication of components from multiple materials with different thermal, mechanical, and “active” behavior that can be spatially arranged in 3D with a resolution on the order of tens of microns. This can be exploited to incorporate shape changing features into additively manufactured structures. 3D printing with a downstream shape change in response to an external stimulus such as temperature, humidity, or light is referred to as four-dimensional (4D) printing. In this paper, a design methodology to determine the material layout of 4D printed materials with internal, programmable strains is introduced to create active structures that undergo large deformation and assume a desired target displacement upon heat activation. A level set (LS) approach together with the extended finite element method (XFEM) is combined with density-based topology optimization to describe the evolving multimaterial design problem in the optimization process. A finite deformation hyperelastic thermomechanical model is used together with an higher-order XFEM scheme to accurately predict the behavior of nonlinear slender structures during the design evolution. Examples are presented to demonstrate the unique capabilities of the proposed framework. Numerical predictions of optimized shape-changing structures are compared to 4D printed physical specimen and good agreement is achieved. Overall, a systematic design approach for creating 4D printed active structures with geometrically nonlinear behavior is presented which yields nonintuitive material layouts and geometries to achieve target deformations of various complexities.

Journal of mechanical design. -- 2019 (May), v. 141, n. 5, p. 051405(1-14)

3

Exploration of translational joint design using corrugated flexure units with Bézier curve segments [Texto impreso] / Nianfeng Wang ... [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. 052301(9)

In order to satisfy particular design specifications, shape variation for limited geometric envelopes is often employed to alter the elastic properties of flexure joints. This paper introduces an analytical stiffness matrix method to model a new type of corrugated flexure (CF) beam with cubic Bézier curve segments. The cubic Bézier curves are used to depict the segments combined to form CF beam and translational joint. Mohr's integral is applied to derive the local-frame compliance matrix of the cubic Bézier curve segment. The global-frame compliance matrices of the CF unit and the CF beam with cubic Bézier curve segments are further formed by stiffness matrix method, which are confirmed by finite element analysis (FEA). The control points of Bézier curve are chosen as optimization parameters to identify the optimal segment shape, which maximizes both high off-axis/axial stiffness ratio and large axial displacements of translational joint. The results of experimental study on the optimum translational joint design validate the proposed modeling and optimization method.

Journal of mechanical design. -- 2019 (May), v. 141, n. 5, p. 052301(1-9)

4

Exploring biases between human and machine generated designs [Texto impreso] / Christian E. Lopez, Scarlett R. Miller, Conrad S. Tucker

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. 021104(9-10)

The objective of this work is to explore the possible biases that individuals may have toward the perceived functionality of machine generated designs, compared to human created designs. Toward this end, 1187 participants were recruited via Amazon mechanical Turk (AMT) to analyze the perceived functional characteristics of both human created two-dimensional (2D) sketches and sketches generated by a deep learning generative model. In addition, a computer simulation was used to test the capability of the sketched ideas to perform their intended function and explore the validity of participants' responses. The results reveal that both participants and computer simulation evaluations were in agreement, indicating that sketches generated via the deep generative design model were more likely to perform their intended function, compared to human created sketches used to train the model. The results also reveal that participants were subject to biases while evaluating the sketches, and their age and domain knowledge were positively correlated with their perceived functionality of sketches. The results provide evidence that supports the capabilities of deep learning generative design tools to generate functional ideas and their potential to assist designers in creative tasks such as ideation.

Journal of mechanical design. -- 2019 (February), v. 141, n. 2, p. 021104(1-10)

5

A gear load distribution model for a planetary gear set with a flexible ring gear having external splines [Texto impreso] / Yong Hu, David Talbot, Ahmet Kahraman

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. 053301(12)

In order to accurately predict ring gear deformations and to investigate the effects of ring gear flexibility on quasi-static behaviors of planetary gear sets, a complete load distribution model of planetary gear sets having flexible ring gears will be formulated here based on the baseline model proposed by the same authors (Hu, Y., Talbot, D., and Kahraman, A., 2018, “A Load Distribution Model for Planetary Gear Sets,” ASME J. Mech. Des., 140(5), p. 053302). Direct comparisons to published experiments are provided to assess the accuracy of the proposed load distribution methodology. Example analyses with flexible ring gear rims are performed indicating that ring gear flexibility could influence gear mesh-level and planetary gear set system-level behaviors. Influence of spline supporting a ring gear is also investigated revealing that positions of planet branches with respect to external splines could influence ring deflections and resultant gear mesh load distributions.

Journal of mechanical design. -- 2019 (May), v. 141, n. 5, p. 053301(1-12)

6

Generating constructal networks for area-to-point conduction problems via moving morphable components approach [Texto impreso] / Bqaotong 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. 051401(15-16)

In this article, we focus on a generative design algorithm for area-to-point (AP) conduction problems in a Lagrangian framework. A physically meaningful continuous area to point path solution is generated through an adaptive growth procedure, which starts from the source point and extends spreading the whole conduction domain. This is achieved by using a set of special moving morphable components (MMCs) whose contour and skeleton are described explicitly by parameterized level-set surfaces. Unlike in the conventional methods where topology optimization was carried out in an Eulerian framework, the proposed optimizer is Lagrangian in nature, which is consistent with classical shape optimization approaches, giving great potential to reduce the total number of design variables significantly and also yielding more flexible modeling capability to control the structural feature sizes. By doing this, the growth elements are separated from the underlying finite element method (FEM) grids so that they can grow toward an arbitrary direction to form an optimized area-to-point path solution. The method is tested on an electromagnetic bandgap (EBG) power plane design example; both simulation and experiment verified the effectiveness of the proposed method.

Journal of mechanical design. -- 2019 (May), v. 141, n. 5, p. 051401(1-16)

1. Area-to-point problem 2. EBG power plane design 3. Generative algorithm 4. Moving morphable component (MMC) 5. Topology optimization

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7

High-dimensional reliability-based design optimization involving highly nonlinear constraints and computationally expensive simulations [Texto impreso] / Meng 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. 051402(13-14)

Reliability-based design optimization (RBDO) aims at optimizing the design of an engineered system to minimize the design cost while satisfying reliability requirements. However, it is challenging to perform RBDO under high-dimensional uncertainty due to the often prohibitive computational burden. In this paper, we address this challenge by leveraging a recently developed method for reliability analysis under high-dimensional uncertainty. The method is termed high-dimensional reliability analysis (HDRA). The HDRA method optimally combines the strengths of univariate dimension reduction (UDR) and kriging-based reliability analysis to achieve satisfactory accuracy with an affordable computational cost for HDRA problems. In this paper, we improve the computational efficiency of high-dimensional RBDO by pursuing two new strategies: (i) a two-stage surrogate modeling strategy is adopted to first locate a highly probable region of the optimum design and then locally refine the accuracy of the surrogates in this region; and (ii) newly selected samples are updated for all the constraints during the sequential sampling process in HDRA. The results of two mathematical examples and one real-world engineering example suggest that the proposed HDRA-based RBDO (RBDO-HDRA) method is capable of solving high-dimensional RBDO problems with higher accuracy and comparable efficiency than the UDR-based RBDO (RBDO-UDR) and ordinary kriging-based RBDO (RBDO-kriging) methods.

Journal of mechanical design. -- 2019 (May), v. 141, n. 5, p. 051402(1-14)

1. Design under high-dimensional uncertainty 2. High-dimensional reliability analysis 3. Kriging 4. Reliability-based design optimization 5. Univariate dimensional reduction

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8

Model discrepancy quantification in simulation-based design of dynamical systems [Texto impreso] / Zhen Hu, Chao Hu, Zissimos P. Mourelatos, Sankaran Mahadevan

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. 011401(12-13)

Discrete-time state-space models have been extensively used in simulation-based design of dynamical systems. These prediction models may not accurately represent the true physics of a dynamical system due to potentially flawed understanding of the system, missing physics, and/or numerical approximations. To improve the validity of these models at new design locations, this paper proposes a novel dynamic model discrepancy quantification (DMDQ) framework. Time-instantaneous prediction models are constructed for the model discrepancies of “hidden” state variables, and are used to correct the discrete-time prediction models at each time-step. For discrete-time models, the hidden state variables and their discrepancies are coupled over two adjacent time steps. Also, the state variables cannot be directly measured. These factors complicate the construction of the model discrepancy prediction models. The proposed DMDQ framework overcomes these challenges by proposing two discrepancy modeling approaches: an estimation-modeling approach and a modeling-estimation approach. The former first estimates the model discrepancy and then builds a nonparametric prediction model of the model discrepancy; the latter builds a parametric prediction model of the model discrepancy first and then estimates the parameters of the prediction model. A subsampling method is developed to reduce the computational effort in building the two types of prediction models. A mathematical example and an electrical circuit dynamical system demonstrate the effectiveness of the proposed DMDQ framework and highlight the advantages and disadvantages of the proposed approaches.

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9
Model-based reliability analysis with both model uncertainty and parameter uncertainty [Texto impreso] / Zhimin Xi

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. 051404(10-11)

Model-based reliability analysis may not be practically useful if reliability estimation contains uncontrollable errors. This paper addresses potential reliability estimation errors from model bias together with model parameters. Given three representative scenarios, reliability analysis strategies with representative methods are proposed. The pros and cons of these strategies are discussed and demonstrated using a tank storage problem based on the finite element model with different fidelity levels. It is found in this paper that the confidence-based reliability analysis considering epistemic uncertainty modeling for both model bias and model parameters can make reliability estimation errors controllable with less conservativeness compared to the direct reliability modeling using the Bayesian approach.

Journal of mechanical design. -- 2019 (May), v. 141, n. 5, p. 051404(1-11)
1. Epistemic uncertainty 2. Model uncertainty 3. Parameter uncertanty 4. Reliability analysis 5. Reliability estimation errors

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10
Quantifying the resilience-informed scenario cost sum [Texto impreso] : a value-driven design approach for functional hazard assessment / Daniel Hulse, Christopher Hoyle, Kai Goebel, Irem Y. Tumer

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. 021403(15-16)

Complex engineered systems can carry risk of high failure consequences, and as a result, resilience—the ability to avoid or quickly recover from faults—is desirable. Ideally, resilience should be designed-in as early in the design process as possible so that designers can best leverage the ability to explore the design space. Toward this end, previous work has developed functional modeling languages which represent the functions which must be performed by a system and function-based fault modeling frameworks have been developed to predict the resulting fault propagation behavior of a given functional model. However, little has been done to formally

optimize or compare designs based on these predictions, partially because the effects of these models have not been quantified into an objective function to optimize. The work described herein closes this gap by introducing the resilience-informed scenario cost sum (RISCS), a scoring function which integrates with a fault scenario-based simulation, to enable the optimization and evaluation of functional model resilience. The scoring function accomplishes this by quantifying the expected cost of a design's fault response using probability information, and combining this cost with design and operational costs such that it may be parameterized in terms of designer-specified resilient features. The usefulness and limitations of using this approach in a general optimization and concept selection framework are discussed in general, and demonstrated on a monopropellant system design problem. Using RISCS as an objective for optimization, the algorithm selects the set of resilient features which provides the optimal trade-off between design cost and risk. For concept selection, RISCS is used to judge whether resilient concept variants justify their design costs and make direct comparisons between different model structures.

Journal of mechanical design. -- 2019 (February), v. 141, n. 2, p. 021403(1-16)

11

A review of high-speed electro-hydrostatic actuator pumps in aerospace applications [Texto impreso] : challenges and solutions/ Qun Chao ... [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. 050801(1-13)

The continued development of electro-hydrostatic actuators (EHAs) in aerospace applications has put forward an increasing demand upon EHA pumps for their high power density. Besides raising the delivery pressure, increasing the rotational speed is another effective way to achieve high power density of the pump, especially when the delivery pressure is limited by the strength of materials. However, high-speed operating conditions can lead to several challenges to the pump design. This paper reviews the current challenges including the cavitation, flow and pressure ripples, tilting motion of rotating group and heat problem, associated with a high-speed rotation. In addition, potential solutions to the challenges are summarized, and their advantages and limitations are analyzed in detail. Finally, future research trends in EHA pumps are suggested. It is hoped that this review can provide a full understanding of the speed limitations for EHA pumps and offer possible solutions to overcome them.

Journal of mechanical design. -- 2019 (May), v. 141, n. 5, p. 050801(1-13)

1. Cavitation 2. EHA pump 3. Electro-hydrostatic acuator 4. Flow and pressure ripples 5. Heat problem 6. High-speed pump 7. Tilting motion

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12

Understanding the role of additive manufacturing knowledge in stimulating design innovation for novice designers [Texto impreso] / Sheng Yang, Thomas Page, Yaoyao Fiona Zhao

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. 021703(11-12)

Additive manufacturing (AM) is recognized as a disruptive technology that offers significant potentials for innovative design. Prior experimental studies have revealed that novice designers provided with AM knowledge (AMK) resources can generate a higher quantity and quality of solutions in contrast with control groups. However, these studies have adopted coarse-grain evaluation metrics that fall short in correlating AMK with radical or architectural innovation. This deficiency directly affects the capturing, modeling, and delivering AMK so that novel opportunities may be more efficiently utilized in ideation stage. To refine the understanding of AMK's role in stimulating design innovation, an experimental study is conducted with two design projects: (a) a mixer design project, and (b) a hairdryer redesign project. The former of which aims to discover whether AMK inspiration increases the quantity and novelty of working principles (WP) (i.e., radical innovation), while the latter examines the influence of AMK on layout and feature novelty (i.e., architectural innovation). The experimental study indicates that AMK does have a positive influence on architectural innovation while the effects on radical innovation are very limited if the example illustrating the AMK is functionally irrelevant to the design problem. Two

strategies are proposed to aid the ideation process in maximizing the possibility of identifying AM potentials to facilitate radical innovation. The limitations of this study and future research plans are discussed.

Journal of mechanical design. -- 2019 (February), v. 141, n. 2, p. 021703(1-12)

1. Additive manufacturing 2. Design for additive manufacturing (DfAM) 3. Design innovation 4. Knowledge modeling

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13
Investigation on the backlash of roller enveloping hourglass worm gear [Texto impreso] : theoretical analysis and experiment / Xingqiao Deng ... [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. 053302(11)

This paper proposes a single-roller enveloping hourglass worm gear design and verifies its advantages compared to the existing double-roller worm gear system and the conventional worm gear set. Our hypothesis is that the single-roller worm gear with appropriate configurations and parametric values can eliminate the backlash in mating gear transmission while maintaining advantages of the double-roller worm gears. Also, the self-rotation of the rollers when they are in the worm tooth space (TS) will help the gear system to avoid jamming and gear tooth scuffing/seizing problems caused by zero backlash and thermal expansion. In order to test that hypothesis, a mathematical model for the single-roller enveloping hourglass worm gear is developed, which includes a gear engagement equation and a tooth profile equation. Using that model, a parametric study is conducted to inspect the influences of center distance, roller radius, transmission ratio, and the radius of base circle on the worm gear meshing characteristics. It is found that the most effective way in eliminating the backlash is to adjust the roller radius and the radius of base circle. Finally, a single-roller enveloping hourglass worm gear set is manufactured and scanned to generate a 3D computer model. That model is compared with a theoretical model calculated from the developed mathematical model. Comparison results show that both models match very well, which verifies the accuracy of the developed mathematical model and our initial hypothesis that it is possible to achieve transmissions with zero backlash by adjusting the design parameters.

Journal of mechanical design. -- 2019 (May), v. 141, n. 5, p. 053302(1-11)
