1

Alternating direction method of multipliers as simple heuristic for topology optimization of a truss with uniformed member cross sections [Texto impreso] / Yoshihiro Kanno

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. 011403(9)

This paper presents a simple and effective heuristic for topology optimization of a truss under the constraint that all the members of the truss have the common cross-sectional area. The proposed method consists of multiple restarts of the alternating direction method of multipliers (ADMM) with random initial points. It is shown that each iteration of the ADMM can be carried out very easily. In the numerical experiments, the efficiency of the proposed heuristic is compared with the existing global optimization method based on the mixed-integer second-order cone programming (MISOCP). It is shown that even for large-scale problem instances that the global optimization method cannot solve within practically acceptable computational cost, the proposed method can often find a feasible solution having a fairly good objective value within moderate computational time.

Journal of mechanical design. -- 2019 (January), v. 141, n. 1, p. 011403(1-9)

2

Are creativity and self-efficacy at odds? [Texto impreso] : an exploration in variations of product dissection in Engineering Education / Elizabeth M. Starkey, Samuel T. Hunter, Scarlett R. Miller

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. 012001(9-11)

The purpose of product dissection is to teach students how a product works and provide them with inspiration for new ideas. However, little is known about how variations in dissection activities impact creative outcomes or engineering self-efficacy (ESE) and creative self-efficacies (CSE). This is important since the goal of engineering education is to produce capable and creative engineers. The current study was, thus, developed to address this research gap through a factorial experiment. The results showed that idea development was not impacted by dissection conditions but that ESE and CSE were increased through these activities. The results also showed that higher levels of CSE and ESE had alternate effects on novel idea development indicating they are at odds in engineering education.

Journal of mechanical design. -- 2019 (January), v. 141, n. 1, p. 012001(1-11)

3

Computational synthesis of large deformation compliant mechanisms undergoing self and mutual contact [Texto impreso] / Prabhat Kumar, Anupam Saxena, Roger A. Sauer

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. 012302(12-13)

Topologies of large deformation contact-aided compliant mechanisms (CCMs), with self and mutual contact, exemplified via path generation applications, are designed using the continuum synthesis approach. Design domain is parameterized using honeycomb tessellation. Assignment of material to each cell, and generation of rigid contact surfaces, are accomplished via suitably sizing and positioning negative circular masks using the stochastic hill-climber search. To facilitate contact analysis, boundary smoothing is implemented. Mean value coordinates are employed to compute shape functions, as many regular hexagonal cells get degenerated into irregular, concave polygons as a consequence of boundary smoothing. Both geometric and material nonlinearities are considered. The augmented Lagrange multiplier method with a formulated active set strategy is employed to incorporate both self and mutual contact. Synthesized contact-aided compliant continua trace paths with single, and importantly, multiple kinks and experience multiple contact interactions pertaining to both self and mutual contact modes.

Journal of mechanical design. -- 2019 (January), v. 141, n. 1, p. 012302(1-13)

4

Design of large single-mobility surface-deployable mechanism using irregularly shaped triangular prismoid modules [Texto impreso] / Hailin Huang ... [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. 012301(7)

This paper presents the design methodology for a single-mobility, large surface-deployable mechanism using irregularly shaped triangular prismoid units. First, we demonstrate that the spherical shell, as the deployed profile of the large deployable mechanism, cannot be filled with identical regular-shaped triangular prismoids (truncated pyramid) without gaps, which makes the design challenging because a large set of nonidentical modules should be moved synchronously. Second, we discuss the design of a novel deployable mechanism that can be deployed onto irregularly shaped triangular prismoids, which will be used as the basic module to fill the spherical shell. Owing to high stiffness and ease of actuation, a planar scissor-shape deployable mechanism is applied. Third, we study the mobile assemblies of irregularly shaped modules in large surface-deployable mechanisms. We discover that hyper kinematic redundant constraints exist in a multiloop mechanism, making the design even more difficult. In order to address this issue, a methodology for reducing these redundant constraints is also discussed. Finally, a physical prototype is fabricated to demonstrate the feasibility of the proposed design methodology.

Journal of mechanical design. -- 2019 (January), v. 141, n. 1, p. 012301(1-7)

5

Efficacy investigation of virtual reality teaching module in manufacturing system design course [Texto impreso] / Junfeng Ma ... [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. 012002(12-13)

Manufacturing system design is a complex engineering field that requires cooperated and aggregated multiple-disciplinary theoretical and practical support. Thereby, the concepts and topics in manufacturing system design courses are not easy to grasp by students. Advances in virtual reality (VR) technology present a new opportunity that can provide the implementation of complex engineering theory from industrial real-life practice in a virtual 3D model. The authors developed a unique queuing theory VR teaching module that can be used in a manufacturing system design course. The module uses Oculus Rift headset, Oculus Touch, and unity 3D software package. The efficacy of this VR teaching module is measured through simulation sickness, system usability, and user experience tools. The statistical analysis shows that VR teaching module is a user-friendly and efficient tool for delivering queueing theory. Approximately 91.7% of the participants experienced below moderate level simulation sickness and none of them withdrew from the study; 91.67% had “above average” satisfaction in terms of system usability. The average user experience was found to be 3.625 out 6. The results also show that the system usability has impact on students' knowledge gain but not motivation, while user experience can affect student's knowledge gain and motivation. VR teaching module outperforms the traditional teaching module in terms of knowledge gain and motivation. Overall, the findings of the study confirm the efficacy of VR technology in teaching queuing theory.

Journal of mechanical design. -- 2019 (January), v. 141, n. 1, p. 012002(1-13)

6

Implementation of design rules for perception into a tool for three-dimensional shape generation using a shape grammar and a parametric model [Texto impreso] / Marta Perez Mata, Saeema Ahmed-Kristensen, Kristina Shea

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. 011101(10-11)

The user experience of a product is recognized as having an increasing importance in particular in consumer products. Current approaches to designing user experiences are not easily translated to languages that a computer can understand. This paper examines a particular aspect of user experience, namely perception of the aesthetics of a product, to formalize this to rules, which are embedded into a tool to generate design. Investigating the perception of consumers is key to designing for their aesthetic preferences. Previous research has shown that consumers and designers often perceive the same products differently. This paper aims to embed rules on perception into a tool to support designers during design synthesis. Aesthetic design rules connecting perceptions with aesthetic features were integrated into a set grammar and a parametric modeling tool, and applied to the particular case of vases. The generated tool targeted the creation of vases with the perception of beautiful, elegant, and exciting. Results show that it is possible to generate beautiful, elegant, and exciting vases following the three aesthetic design rules, i.e., tall, simple, and curvy. The main contribution of this paper is the method used to incorporate information on perception into the set grammar and the parametric model. The tool is additionally proposed for supporting designers during design synthesis of shapes. The results are valid for vases but the method can be applied to other perceptions and product categories.

Journal of mechanical design. -- 2019 (January), v. 141, n. 1, p. 011101(1-11)

7

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.

Journal of mechanical design. -- 2019 (January), v. 141, n. 1, p. 011401(1-13)

8

Nested and simultaneous solution strategies for general combined plant and control design problems [Texto impreso] / Daniel R. Herber, James T. Allison

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. 011402(10-11)

In this paper, general combined plant and control design or co-design problems are examined. The previous work in co-design theory imposed restrictions on the type of problems that could be posed. This paper lifts many of those restrictions. The problem formulations and optimality conditions for both the simultaneous and nested solution strategies are given. Due to a number of challenges associated with the optimality conditions, practical solution considerations are discussed with a focus on the motivating reasons for using direct transcription (DT) in co-design. This paper highlights some of the key concepts in general co-design including general coupling, the differences between the feasible regions for each strategy, general boundary conditions, inequality path

constraints, system-level objectives, and the complexity of the closed-form solutions. Three co-design test problems are provided. A number of research directions are proposed to further co-design theory including tailored solution methods for reducing total computational expense, better comparisons between the two solution strategies, and more realistic test problems.

Journal of mechanical design. -- 2019 (January), v. 141, n. 1, p. 011402(1-11)

9

A new type of planar two degree-of-freedom remote center-of-motion mechanism inspired by the Peaucellier–Lipkin straight-line Linkage [Texto impreso] / Genliang Chen, Jiepeng Wang, Hao 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. 015001(9)

Benefiting from small incisions, reduced risk of infection, less pain, and fast recovery, minimally invasive surgery has shown tremendous advantages for patients. In these kinds of procedures, remote center-of-motion (RCM) mechanisms play an important role in performing operations through small incisions. Inspired by the Peaucellier–Lipkin straight-line cell, this paper presents the design and verification of a new type of planar two degree-of-freedom (DOF) RCM mechanism. A synthesized planar RCM mechanism is realized by a symmetric linkage actuated by two circular motion generators. The main merit of the proposed 2DOF RCM mechanism is its straightforward kinematics, which results in a simple control scheme. One of the candidate mechanisms, which is simple in structure and easy to fabricate, is intensively investigated. A prototype was built, on which preliminary experiments have been conducted, to verify the feasibility of the proposed new mechanism. The experimental results show that the fabricated 2DOF prototype has a nearly stationary remote center of motion. Therefore, the prototype has potential applicability in robot-assisted minimally invasive surgeries.

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1. Mechanism design 2. Minimally invasive surgery 3. Planar parallel manipulators 4. Remote center-of-motion

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Synthesizing constant torque compliant mechanisms using precompressed beams [Texto impreso] / Ishit Gandhi, Hong Zhou

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. 014501(7)

A constant torque compliant mechanism (CM) generates an output torque that keeps invariant in a large range of input rotation. Because of the constant torque feature and the merits of CMs, they are used in automobile, aerospace, medical, healthcare, timing, gardening, and other devices. A common problem in the current constant torque CMs is their preloading range that is a certain starting range of the input rotation. In the preloading range, the output torque of a constant torque CM does not have the desired constant torque. It increases from zero to a value. The preloading range usually accounts for one-third of the entire input rotation range, which severally weakens the performance of constant torque CMs. In this paper, the preloading problem is eradicated by using precompressed beams as building blocks for constant torque CMs. It is challenging to synthesize constant torque CMs composed of precompressed beams because of the integrated force, torque, and deflection characteristics. The synthesis of constant torque CMs is systemized as parameter optimization of the composed precompressed beams. The presented synthesis method is demonstrated by synthesizing constant torque CMs with different numbers of precompressed beams and validated by experimental results.

Journal of mechanical design. -- 2019 (January), v. 141, n. 1, p. 014501(1-7)

1. Beam 2. Beam buckling 3. Compliant mechanism 4. Constant torque 5. Mechanism synthesis 6. Precompressed

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11
Theoretical analysis and design of a variable delivery external gear pump for low and medium pressure applications [Texto impreso] / Srinath Tankasala, Andrea Vacca

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. 013401(11)

This paper describes a unique design concept that is capable of electronically controlling the flow delivered by an external gear pump (EGP). The principle used for varying the flow relies on the variable timing concept which has been previously demonstrated by the author's research team for EGP's operating at high pressures (HPs) (p>100 bar). This principle permits to vary the flow within a certain range, without introducing additional sources of power loss. In this paper, the above concept has been applied to formulate a design for a variable delivery EGP for low pressure (LP) applications (p<30 bar), suitable for direct electric actuation. Specific design principles for the gear and the flow variation mechanisms are introduced to limit the force required by the electric actuation, and for maximizing the flow variation range. Also, the low target pressure allows the variable timing principle to be realized with an asymmetric solution, with only one variable timing element present at one side of the gears. A detailed analysis concerning the relationship between the electrically commanded position of the flow varying element and the theoretical flow delivered by the pump is also presented. This analysis is used to formulate analytical expressions for the instantaneous flow rate and the flow nonuniformity of the pump. The paper details the design principle of the proposed variable flow pump and describes the multi-objective optimization approach used for sizing the gears and flow variation mechanism. The paper also discusses the experimental activity performed on a prototype of the proposed unit, able to achieve a flow variation of 31%.

Journal of mechanical design. -- 2019 (January), v. 141, n. 1, p. 013401(1-11)