1

Automated design of energy efficient control strategies for building clusters using reinforcement learning [Texto impreso] / Philip Odonkor, Kemper Lewis

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. 021704(9)

The control of shared energy assets within building clusters has traditionally been confined to a discrete action space, owing in part to a computationally intractable decision space. In this work, we leverage the current state of the art in reinforcement learning (RL) for continuous control tasks, the deep deterministic policy gradient (DDPG) algorithm, toward addressing this limitation. The goals of this paper are twofold: (i) to design an efficient charged/discharged dispatch policy for a shared battery system within a building cluster and (ii) to address the continuous domain task of determining how much energy should be charged/discharged at each decision cycle. Experimentally, our results demonstrate an ability to exploit factors such as energy arbitrage, along with the continuous action space toward demand peak minimization. This approach is shown to be computationally tractable, achieving efficient results after only 5 h of simulation. Additionally, the agent showed an ability to adapt to different building clusters, designing unique control strategies to address the energy demands of the clusters Studied.

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2

Data-driven platform design [Texto impreso] : patent data and function network analysis / Binyang Song, Jianxi Luo, Kristin Wood

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. 021101(8-10)

A properly designed product-system platform seeks to reduce the cost and lead time for design and development of the product-system family. A key goal is to achieve a tradeoff between economy of scope from product variety and economy of scale from platform sharing. Traditionally, product platform planning uses heuristic and manual approaches and relies almost solely on expertise and intuition. In this paper, we propose a data-driven method to draw the boundary of a platform-system, complementing the other platform design approaches and assisting designers in the architecting process. The method generates a network of functions through relationships of their co-occurrences in prior designs of a product or systems domain and uses a network analysis algorithm to identify an optimal core–periphery structure. Functions identified in the network core co-occur cohesively and frequently with one another in prior designs, and thus, are suggested for inclusion in the potential platform to be shared across a variety of product-systems with peripheral functions. We apply the method to identify the platform functions for the application domain of spherical rolling robots (SRRs), based on patent data.

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3

Design of a test platform for the determination of lithium-ion batteries state of health [Texto impreso] / Jules-Adrien Capitaine, Qing 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. 021702(8)

This paper presents a novel design for a test platform to determine the state of health (SOH) of lithium-ion batteries (LIBs). The SOH is a key parameter of a battery energy storage system and its estimation remains a challenging issue. The batteries that have been tested are 18,650 Li-ion cells as they are the most commonly used batteries on the market. The test platform design is detailed from the building of the charging and

discharging circuitry to the software. Data acquired from the testing circuitry are stored and displayed in LabVIEW to obtain the charging and discharging curves. The resulting graphs are compared to the outcome predicted by the battery datasheets, to verify that the platform delivers coherent values. The SOH of the battery is then calculated using a Coulomb counting method in LabVIEW. The batteries will be discharged through various types of resistive circuits, and the differences in the resulting curves will be discussed. A single battery cell will also be tested over 30 cycles and the decrease in the SOH will be clearly identified.

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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.

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5

Interpreting idea maps [Texto impreso] : pairwise comparisons reveal what makes ideas novel / Faez Ahmed, Sharath Kumar Ramachandran, Mark Fuge, Samuel Hunter, Scarlett 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. 021102(13)

Assessing similarity between design ideas is an inherent part of many design evaluations to measure novelty. In such evaluation tasks, humans excel at making mental connections among diverse knowledge sets to score ideas on their uniqueness. However, their decisions about novelty are often subjective and difficult to explain. In this paper, we demonstrate a way to uncover human judgment of design idea similarity using two-dimensional (2D) idea maps. We derive these maps by asking participants for simple similarity comparisons of the form “Is idea A more similar to idea B or to idea C?” We show that these maps give insight into the relationships between ideas and help understand the design domain. We also propose that novel ideas can be identified by finding outliers on these idea maps. To demonstrate our method, we conduct experimental evaluations on two datasets—colored polygons (known answer) and milk frother sketches (unknown answer). We show that idea maps shed light on factors considered by participants in judging idea similarity and the maps are robust to noisy ratings. We also compare physical maps made by participants on a white-board to their computationally generated idea maps to compare how people think about spatial arrangement of design items. This method provides a new direction of research into deriving ground truth novelty metrics by combining human judgments and computational methods.

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6

Investigating user emotional responses to eco-feedback designs [Texto impreso] / Qifang Bao, Edward Burnell, Ann M. Hughes, Maria C. Yang

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. 021103(13-14)

Emotional responses to a product can be critical in influencing how the product will be used. This study explores the emotions that arise from users' interaction with eco-feedback products, and investigates links between emotions and users' resource conservation behaviors. In-lab experiments were conducted with 68 participants of varying backgrounds. Each participant was shown sketches of four conceptual designs of eco-feedback products and reported how they would feel and behave in different scenarios using the products. Two styles of eco-feedback design, quantitative and figurative, were compared to each other and were compared to neutral designs, which had little or no feedback information. Results showed that taking resource conservation actions such as turning off lights was highly correlated with negative emotions toward wasting resources, such as guilt, upset, embarrassment, and annoyance. Users' evaluations of esthetics, usefulness, and overall quality of eco-feedback products, however, were highly correlated with positive emotions toward resource conservation, described as satisfied, proud, interested, and joyful. Figurative designs were observed to evoke much stronger emotions among younger participants than older ones. Ultimately, we hope our findings are useful to the designers of eco-feedback products.

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7

Is ownership bias bad? [Texto impreso] : the influence of idea goodness and creativity on design professionals concept selection practices / Xuan Zheng, 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. 021106(9-10)

Ownership bias is a decision-making bias that leads to an individual's tendency to prefer their own ideas over others' during the design process. While prior work has identified the existence of this ownership bias in design professionals, limited work has investigated how the characteristics of the idea set affects this bias. In other words, is a preference for one's own ideas a bad thing if the ideas are truly better? This paper seeks to fill this research void through two design thinking workshops conducted with 45 design professionals recruited from two engineering companies. During the study, the participants individually generated and selected ideas as part of a 2-h team design challenge. The ideas generated were then rated for: (1) their perceived future value by the design team and (2) their creativity by expert raters. The results suggest that design professionals only exhibited ownership bias for ideas that were assessed to have little to no future value in the design process (low in idea goodness). In addition, professionals showed preferences for self-generated ideas that were of high usefulness and elegance but low in creativity, indicating an impact of creativity on ownership bias. These findings provide new evidence on the negative effects of ownership bias on the design process.

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1. Conceptual design 2. Design evaluation 3. Design theory 4. Design theory and methodology

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8

Knowledge-based design of artificial neural network topology for additive manufacturing process modeling [Texto impreso] : a new approach and case study for fused deposition modeling / Hari P. N. Nagarajan ... [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. 021705(12)

Additive manufacturing (AM) continues to rise in popularity due to its various advantages over traditional manufacturing processes. AM interests industry, but achieving repeatable production quality remains problematic for many AM technologies. Thus, modeling different process variables in AM using machine learning can be highly beneficial in creating useful knowledge of the process. Such developed artificial neural network (ANN) models would aid designers and manufacturers to make informed decisions about their products and processes. However, it is challenging to define an appropriate ANN topology that captures the AM system behavior. Toward that goal, an approach combining dimensional analysis conceptual modeling (DACM) and classical ANNs is proposed to create a new type of knowledge-based ANN (KB-ANN). This approach integrates existing literature and expert knowledge of the AM process to define a topology for the KB-ANN model. The proposed KB-ANN is a hybrid learning network that encompasses topological zones derived from knowledge of the process and other zones where missing knowledge is modeled using classical ANNs. The usefulness of the method is demonstrated using a case study to model wall thickness, part height, and total part mass in a fused deposition modeling (FDM) process. The KB-ANN-based model for FDM has the same performance with better generalization capabilities using fewer weights trained, when compared to a classical ANN.

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1. Additive manufacturing 2. Dimensional analysis 3. Empirical learning 4. Fused deposition modeling 5. Knowledge-based artificial neural networks

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9

Mass collaboration project recommendation within open-innovation design networks [Texto impreso] / Zachary Ball, Kemper Lewis

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. 021105(10-11)

Mass collaboration within the design engineering process supports the inclusion of unique perspectives when working on complex problems. Increasing the number of individuals providing input and support into these perplexing challenges can increase innovation, decrease product development times, and provide solutions that truly encompass the needs of the market. One of the greatest challenges within mass collaboration engineering projects is the organization of individuals within these large design efforts. Understanding which projects would most effectively benefit from additional designers or contributors is paramount to supporting mass collaboration design networks. Within such networks, there exists a large number of contributors as well as a large pool of potential projects. Matching individuals with the projects that they can provide the greatest benefit to or building a team of individuals for newly developed projects requires the consideration of previous performance and an understanding of individual competencies and design abilities. This work presents a framework which recommends individual project placement based on individual abilities and the project requirements. With this work, a pool of individuals and potential projects are simulated, and the application of a hybrid recommender system is explored. To complement the simulation, an additional case study with empirical data is performed to study the potential applicability of the proposed framework. Overall, it was found that recommended team compositions greatly outperform the baseline team development, most notably as greater consideration is placed on collaborative recommendations.

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10

Pulling at the digital thread [Texto impreso] : exploring the tolerance stack up between automatic procedures and expert strategies in scan to print processes / Tobias Mahan, Nicholas Meisel, Christopher McComb, Jessica Menold

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. 021701(11-12)

While the combination of 3D scanning and printing processes holds much promise for the field of new product development, problems with repeatability and accuracy have limited the wider spread adoption of some digital prototyping tools, such as 3D scanners. Studies have explored the errors inherent in higher fidelity scan to print (S2P) processes, yet few have explored the errors in S2P processes that leverage affordable rapid noncontact

scanners. Studies have yet to explore the strategies that designers, who are experienced with additive manufacturing, employ to mitigate errors. To address these gaps, a controlled study was conducted using data from 27 scans collected with a prototypical off-the-shelf noncontact optical scanner. The geometric and dimensional integrity of the digital models was found to be significantly out of tolerance at various phases of the S2P process, as compared to the original physical model. Larger errors were found more consistently in the data acquisition phase of the S2P process, but results indicate these errors were not sufficiently filtered out during the remainder of the process. A behavioral study was conducted with 13 experienced designers in digital fabrication to determine strategies for manually cleaning Point Clouds. Actions such as increase or decrease in brush size and select or de-select points were recorded. These actions were analyzed using hidden Markov modeling, which revealed distinct patterns of behavior. Designer strategies were not beneficial and digital models produced by designers were found to be significantly smaller than original physical models.

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11

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.

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12

Reliability analysis using second-order saddlepoint approximation and mixture distributions [Texto impreso] / Dimitrios I. Papadimitriou, Zissimos P. Mourelatos, Zhen Hu

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. 021401(10)

This paper proposes a new second-order saddlepoint approximation (SOSA) method for reliability analysis of nonlinear systems with correlated non-Gaussian and multimodal random variables. The proposed method overcomes the limitation of current available SOSA methods, which are applicable to problems with only Gaussian random variables, by employing a Gaussian mixture model (GMM). The latter is first constructed using the expectation maximization (EM) method to approximate the joint probability density function (PDF) of the input variables. Expressions of the statistical moments of the response variables are then derived using a second-order Taylor expansion of the limit-state function and the GMM. The standard SOSA method is finally integrated with the GMM to effectively analyze the reliability of systems with correlated non-Gaussian random variables.

The accuracy of the proposed method is compared with existing methods including a SOSA based on Nataf transformation. Numerical examples demonstrate the effectiveness of the proposed approach.

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13

Uncertainty analysis for time- and space-dependent responses with random variables [Texto impreso] / Xinpeng Wei, Xiaoping Du

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. 021402(6)

The performance of a product varies with respect to time and space if the associated limit-state function involves time and space. This study develops an uncertainty analysis method that quantifies the effect of random input variables on the performance (response) over time and space. The combination of the first order reliability method (FORM) and the second-order reliability method (SORM) is used to approximate the extreme value of the response with respect to space at discretized instants of time. Then the response becomes a Gaussian stochastic process that is fully defined by the mean, variance, and autocorrelation functions obtained from FORM and SORM, and a sequential single loop procedure is performed for spatial and random variables. The method is successfully applied to the reliability analysis of a crank-slider mechanism, which operates in a specified period of time and space.

Journal of mechanical design. -- 2019 (February), v. 141, n. 2, p. 021402(1-6)

14

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.

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

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