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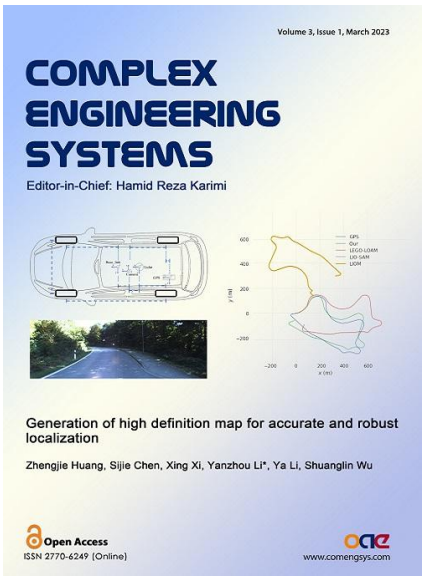
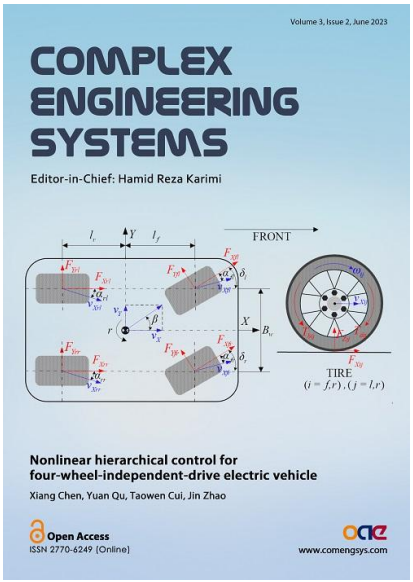
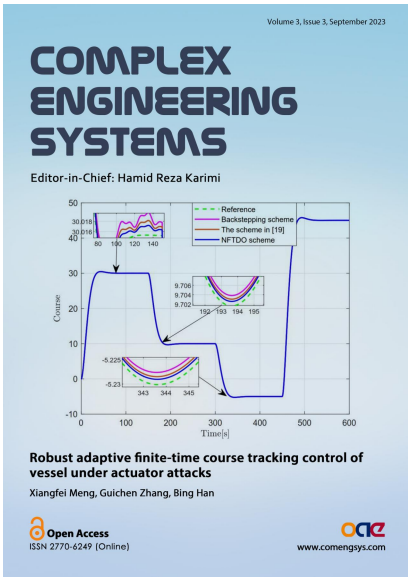
September 2023







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CONTENTS

Review

1. Review on key technologies of green power supply for port microgrid

Guangdi Li, Tong Wang, Bowen Zhou, Zhaoxia Xiao, Shijie Yan, Boyu Liu

Read PDF DOI: 10.20517/ces.2022.46

Abstract:
With the development of ship electrification, the demand for energy in ports is increasing. The location and natural resources of ports also create conditions for the development of ship electrification. This paper firstly analyzes the current development status of floating solar power generation technology and offshore wind power generation technology, summarizes the obstacles facing the development of offshore power generation platforms, introduces the materials and structures that can be used for floating power generation platforms, and then introduces the port microgrid topology from three aspects of AC microgrid (AC), DC microgrid (DC) and AC/DC hybrid microgrid (AC/DC) hybrid structure, and compares the three structures. Then the existing control methods are reviewed from the perspective of port capacity planning and the application of distributed control in port energy planning is emphasized. Finally, port energy management strategies are introduced from the perspective of multiple time scales, and relevant cases are listed, and the advantages and disadvantages of management strategies under different time scales are compared. At the end of the paper, several advanced smart ports are given as examples, and the new energy used by each port and its development scale are analyzed, and the future clean and efficient ports are envisioned.

Keywords: Floating power supply platform, ports, microgrid topology, capacity planning, energy management

Cite this article
Li G, Wang T, Zhou B, Xiao Z, Yan S, Liu B. Review on key technologies of green power supply for port microgrid. *Complex Eng Syst* 2023;3:1.

Research Article

1. Generation of high definition map for accurate and robust localization

Zhengjie Huang, Sijie Chen, Xing Xi, Yanzhou Li, Ya Li, Shuanglin Wu

Read PDF DOI: 10.20517/ces.2022.43

Abstract
This paper presents a framework for generating high-definition (HD) map, and then achieves accurate and robust localization by virtue of the map. An iterative approximation based method is developed to generate a HD map in Lanelet2 format. A feature association method based on structural consistency and feature similarity is proposed to match the elements of the HD map and the actual detected elements. The feature association results from the HD map

are used to correct lateral drift in the light detection and ranging odometry. Finally, some experimental results are presented to verify the reliability and accuracy of autonomous driving localization.
Keywords: High definition map, factor graph optimization, localization, reprojection error

Cite this article
Huang Z, Chen S, Xi X, Li Y, Li Y, Wu S. Generation of high definition map for accurate and robust localization. *Complex Eng Syst* 2023;3:2.

2. Parameters optimization of electro-hydraulic power steering system based on multi-objective collaborative method

Taowen Cui, Shuaiyin Wang, Yuan Qu, Xiang Chen

Read PDF DOI: 10.20517/ces.2022.57

Abstract:
Electro-hydraulic power steering (EHPS) systems are widely used in commercial vehicles due to their adjustable power assist and energy saving advantages. In this paper, a dynamic model of the EHPS system is developed, and quantitative expressions for three evaluation indexes, steering road feel, steering sensibility and steering energy loss, are derived for the first time. A multi-objective collaborative optimization model of the EHPS system is then established, which consists of one total system and three parallel subsystems, based on collaborative optimization theory. Considering the coupled variables of each subsystem, the total system is optimized by a multi-objective algorithm, while the subsystems are optimized by a single-objective algorithm. The optimization results demonstrate that the average frequency domain energy of the steering road feel is increased by 69.1%, the average frequency domain energy of steering sensitivity is reduced by 19.2%, and steering energy consumption is reduced by 10.8% compared to the initial value. The non-dominated sorting genetic algorithm-II (NSGA-II) shows superior comprehensive performance compared to the other two multi-objective algorithms, and the optimization performance can be further improved by setting appropriate algorithm parameters.
Keywords: Electro-hydraulic power steering, multi-objective optimization, collaborative optimization, non-dominated sorting genetic algorithm-II

Cite This Article
Cui T, Wang S, Qu Y, Chen X. Parameters optimization of electro-hydraulic power steering system based on multi-objective collaborative method. *Complex Eng Syst* 2023;3:3.

3. Formal verification of Fuzzy-based XAI for Strategic Combat Game

Nicholas Ernest, Timothy Arnett, Zachariah Phillips

Read PDF DOI: 10.20517/ces.2022.54

Abstract:

Explainable AI is a topic at the forefront of the field currently for reasons involving human trust in AI, correctness, auditing, knowledge transfer, and regulation. AI that is developed with reinforcement learning (RL) is especially of interest due to the non-transparency of what was learned from the environment. RL AI systems have been shown to be "brittle" with respect to the conditions it can safely operate in, and therefore ways to show correctness regardless of input values are of key interest. One way to show correctness is to verify the system using Formal Methods, known as Formal Verification. These methods are valuable, but costly and difficult to implement, leading most to instead favor other methodologies for verification that may be less rigorous, but more easily implemented. In this work, we show methods for development of an RL AI system for aspects of the strategic combat game Starcraft 2 that is performant, explainable, and formally verifiable. The resulting system performs very well on example scenarios while retaining explainability of its actions to a human operator or designer. In addition, it is shown to adhere to formal safety specifications about its behavior.
Keywords: Explainable AI, reinforcement learning, formal verification, starcraft, genetic algorithm, fuzzy logic, genetic fuzzy trees, formal methods

Cite This Article
Ernest N, Arnett T, Phillips Z. Formal verification of Fuzzy-based XAI for Strategic Combat Game. *Complex Eng Syst* 2023;3:4.

4. Decentralized tracking control design based on intelligent critic for an interconnected spring-mass-damper system
Wenqian Fan, Ao Liu, Ding Wang

Read PDF DOI: 10.20517/ces.2023.04

Abstract:
In this paper, the decentralized tracking control (DTC) problem is investigated for a class of continuous-time nonlinear systems with external disturbances. First, the DTC problem is resolved by converting it into the optimal tracking controller design for augmented tracking isolated subsystems (ATISs). %It is investigated in the form of the nominal system. A cost function with a discount is taken into consideration. Then, in the case of external disturbances, the DTC scheme is effectively constructed via adding the appropriate feedback gain to each ATIS. %Herein, we aim to obtain the optimal control strategy for minimizing the cost function with discount. In addition, utilizing the approximation property of the neural network, the critic network is constructed to solve the Hamilton-Jacobi-Isaacs equation, which can derive the optimal tracking control law and the worst disturbance law. Moreover, the updating rule is improved during the process of weight learning, which removes the requirement for initial admission control. Finally, through the interconnected spring-mass-damper system, a simulation example is given to verify the availability of the DTC scheme.
Keywords: Adaptive dynamic programming, discounted cost function, decentralized tracking control, disturbance rejection, interconnected spring-mass-damper systems, neural networks, optimal control

Cite This Article
Fan W, Liu A, Wang D. Decentralized tracking control design based on intelligent critic for an interconnected spring-mass-damper system. *Complex Eng Syst* 2023;3:5.

5. Decentralized control for interconnected semi-markovian jump systems with partially accessible transition rates: a dynamic memory event-triggered mechanism

Yushun Tan, Xiaoming Cheng, Xinrui Li, Jie Bai, Jinliang Liu

Read PDF DOI: 10.20517/ces.2023.10

Abstract:
This paper investigates the issue of decentralized control for interconnected semi-Markovian systems with partially accessible transition rates (TRs). Firstly, a dynamic system model with a memory event-triggered mechanism (METM) is designed, which can effectively improve the fault tolerance of the event-triggering mechanism by employing the historical trigger data. Then a state feedback control model with dynamic METM is constructed, in which the semi-Markovian parameters with completely unknown and partially known transition probabilities are considered. Some sufficient conditions that insure the stochastic stability of the interconnected semi-Markovian systems can be obtained by utilizing the Lyapunov function and suitable model transformations method. Meanwhile, the parameters and the controller gain matrices of dynamic METM are also solved simultaneously by applying the linear matrix inequalities (LMIs). Finally, a simulation example is given to verify the effectiveness of the proposed method.

Keywords: Decentralized control method, interconnected semi-Markovian jump systems, partially accessible transition rate, dynamic memory event-triggered mechanism

Cite This Article
Tan Y, Cheng X, Li X, Bai J, Liu J. Decentralized control for interconnected semi-markovian jump systems with partially accessible transition rates: a dynamic memory event-triggered mechanism. *Complex Eng Syst* 2023;3:6.

6. Secure consensus control for multi-agent systems under communication constraints via adaptive sliding mode technique

Meng Ding, Bei Chen

Read PDF DOI: 10.20517/ces.2023.06

Abstract:
The consensus tracking problem is investigated for a class of multi-agent systems (MASs) under communication constraints. In particular, as a result of the impact of amplitude attenuation and random interference, communication among followers may inevitably suffer from the fading phenomenon. Meanwhile, the controllers may also be subject to malicious deception attacks, which will disrupt the correct operation of the MASs. Thus, the agents can

only update their states based on fading information exchanged with their neighbors and the false control input under attacks. The consensus tracking error variables are first designed via the fading signal received from neighbors. Then, an online estimation strategy is introduced to estimate the unknown attacks, based on which the adaptive sliding mode controller is designed to attenuate the effect of the time-varying attacks on MASs. Convergence analysis of the MASs under the designed control strategy is provided by using the Lyapunov stability theory and adaptive sliding mode control method. Finally, the effectiveness of the theoretical results is verified via numerical simulations.

Keywords: Multi-agent systems, consensus tracking, adaptive mechanism, sliding mode control, deception attacks, channel fading

Cite this article

Ding M, Chen B. Secure consensus control for multi-agent systems under communication constraints via adaptive sliding mode technique. *Complex Eng Syst* 2023;3:7.

7. Nonlinear hierarchical control for four-wheel-independent-drive electric vehicle

Xiang Chen, Yuan Qu, Taowen Cui, Jin Zhao

Read PDF DOI: 10.20517/ces.2022.50

Abstract:

As under-constrained systems, four-wheel-independent-drive (4WID) electric vehicles have more driving degrees of freedom. In this context, reasonable control and distribution of driving or braking torque to each wheel is extremely important from the vehicle safety perspective. However, it is difficult to provide the optimal wheel torque because of the time-varying characteristics and typical over-actuated nature of the system. In light of these challenges, a novel hierarchical control scheme comprising a top- and bottom-level controller is proposed herein. First, for the top-level controller, a time-varying model-predictive-control (TV-MPC) controller is designed based on an extended 3-degree-of-freedom (3-DOF) reference vehicle model. The total driving force and additional yaw moment can be obtained using the TV-MPC. Second, for the bottom-level controller, the torque expression of each wheel is determined using the equal-adhesion-rate-rule -based algorithm. The co-simulation results obtained herein indicate that the proposed control scheme can effectively improve vehicle safety.

Keywords: Safety, four-wheel-independent-drive electric vehicle, time-varying model-predictive-control, equal adhesion allocation

Cite this article

Chen X, Qu Y, Cui T, Zhao J. Nonlinear hierarchical control for four-wheel-independent-drive electric vehicle. *Complex Eng Syst* 2023;3:8.

8. Reinforcement learning with Takagi-Sugeno-Kang fuzzy systems

Eric Zander, Ben van Oostendorp, Barnabas Bede

Read PDF DOI: 10.20517/ces.2023.11

Abstract:
We propose reinforcement learning (RL) architectures for producing performant Takagi-Sugeno-Kang (TSK) fuzzy systems. The first employs an actor-critic algorithm to optimize existing TSK systems. An evaluation of this approach with respect to the Explainable Fuzzy Challenge (XFC) 2022 is given. A second proposed system applies Deep Q-Learning Network (DQN) principles to the Adaptive Network-based Fuzzy Inference System (ANFIS). This approach is evaluated in the CartPole environment and demonstrates comparability to the performance of traditional DQN. In both applications, TSK systems optimized via RL performed well in testing. Moreover, the given discussion and experimental results highlight the value of exploring the intersection of RL and fuzzy logic in producing explainable systems.
Keywords: Explainable AI, Fuzzy systems, Takagi-Sugeno-Kang fuzzy systems, Adaptive neuro-fuzzy inference systems, Reinforcement learning

Cite this article
Zander E, van Oostendorp B, Bede B. Reinforcement learning with Takagi-Sugeno-Kang fuzzy systems. *Complex Eng Syst* 2023;3:9.

9. Fixed-time integral sliding mode tracking control of a wheeled mobile robot

Ling Ma, Chenghu Wang, Cheng Ge, Hui Liu, Bo Li

Read PDF DOI: 10.20517/ces.2023.14

Abstract:
This paper presents a fixed-time integral sliding mode control scheme for a nonholonomic wheeled mobile robot (WMR). To achieve the trajectory tracking mission, the dynamic model of a WMR is first transformed into a second-order attitude subsystem and a third-order position subsystem. Two novel continuous fixed-time disturbance observers are proposed to estimate the external disturbances of the two subsystems, respectively. Then, trajectory tracking controllers are designed for two subsystems by utilizing the reconstructed information obtained from the disturbance observers. Additionally, an auxiliary variable that incorporates the Gaussian error function is introduced to address the chattering problem of the control system. Finally, the proposed control scheme is validated by a wheeled mobile robotic experimental platform.
Keywords: Wheeled mobile robot, trajectory tracking, disturbance observer, fixed-time stability, integral sliding mode control

Cite this article
Ma L, Wang C, Ge C, Liu H, Li B. Fixed-time integral sliding mode tracking control of a wheeled mobile robot. *Complex Eng Syst* 2023;3:10.

10. Region stability of switched two-dimensional linear dissipative Hamiltonian systems with multiple equilibria

Tongsu Liu, Liying Zhu

Read PDF DOI: 10.20517/ces.2023.13

Abstract:
This paper studies the issues of region stability of switched two-dimensional linear dissipative Hamiltonian systems. Such switched systems are composed of two stable subsystems with two different equilibrium points. Since the equilibrium points of two subsystems are different, and the state matrices of subsystems may not commute, it is difficult to address such switched systems. This paper considers the case that the switching path corresponding to the switched systems is a switching line passing through the equilibrium points of two different subsystems. A suitable region containing all the equilibrium points of subsystems is first determined. Based on the concept of region stability of switched systems with multiple equilibrium points, this paper proposes some sufficient conditions of region stability and asymptotically region stability for such kind of switched linear dissipative Hamiltonian systems via the maximum energy function method. The above main results obtained can be applied to some classes of electronic circuits, such as switching DC/DC converters and AC/DC converters. As an application and illustration, a switching DC circuit and two numerical examples are carried out to show the effectiveness of the region stability results obtained in this paper.
Keywords: Switched linear systems, dissipative Hamiltonian systems, switched line, regional stability, asymptotic regional stability, multiple equilibrium points, maximum energy function method

Cite this article
Liu T, Zhu L. Region stability of switched two-dimensional linear dissipative Hamiltonian systems with multiple equilibria. *Complex Eng Syst* 2023;3:11.

11. Robust adaptive finite-time course tracking control of vessel under actuator attacks

Xiangfei Meng, Guichen Zhang, Bing Han

Read PDF DOI: 10.20517/ces.2023.18

Abstract:
This paper studies the course tracking control problem of unmanned surface vessels under the influence of uncertain dynamics, external unknown disturbances, constraints, and actuator attacks. In the design of the control scheme, adaptive technology is applied to approach the uncertain dynamics of the system, and a nonlinear finite-time disturbance observer is established to reconstruct the actuator attack signal and the unknown time-varying disturbances online. Combining disturbance compensation and adaptive technology, a finite-time course tracking control scheme is designed. The control scheme does not need to obtain the prior knowledge of the model in advance, and it has good robustness in the face of uncertain dynamics within the system, external disturbances, and actuator attacks. A rigorous stability analysis is provided for the control scheme based on the Lyapunov stability theory.

Finally, the simulation shows that the proposed control scheme can effectively resist the influence of actuator attacks and external uncertain disturbances.

Keywords: Actuator attacks, course tracking, unmanned surface vessel, finite-time disturbance observer

Cite this article

Meng X, Zhang G, Han B. Robust adaptive finite-time course tracking control of vessel under actuator attacks. *Complex Eng Syst* 2023;3:12.

12. Rolling bearing fault diagnosis method based on 2D grayscale images and Wasserstein Generative Adversarial Nets under unbalanced sample condition

Jiaxing He, Zhaomin Lv, Xingjie Chen

Read PDF DOI: 10.20517/ces.2023.20

Abstract:

Accurate diagnosis of rolling bearing faults plays a crucial role in ensuring the stable operation of rotating machinery systems. However, in actual engineering applications, a significant disparity between the volume of normal data and the quantity of fault data collected impairs diagnostic performance. Bearing fault diagnosis under sample imbalance conditions is an engineering challenge encountered in the field of fault diagnosis. To improve the fault diagnosis accuracy under unbalanced sample conditions, a rolling bearing fault diagnosis method based on 2D grayscale images and Wasserstein Generative Adversarial Networks (WGAN) is proposed. The method consists of three main steps. First, the acquired bearing vibration signals are transformed into 2D grayscale images. Second, the WGAN generation model is used to generate more fault samples. Finally, both the original samples and the generated samples are used to train the Convolutional Neural Networks classification model. The validity and effectiveness of the proposed method are evaluated and compared to other bearing fault diagnosis approaches using the Case Western Reserve University Bearing Data Center dataset. The experimental results demonstrate the superior quality of the generated samples and the improved fault identification accuracy achieved by the proposed method.

Cite this article

He J, Lv Z, Chen X. Rolling bearing fault diagnosis method based on 2D grayscale images and Wasserstein Generative Adversarial Nets under unbalanced sample condition. *Complex Eng Syst* 2023;3:13. http://dx.doi.org/10.20517/ces.2023.20

13. Event-triggered state estimation for complex networks under deception attacks: a partial-nodes-based approach

Lu Zhou, Bing Li

Read PDF DOI: 10.20517/ces.2023.16

Abstract:
This paper addresses the issue of state estimation for a kind of complex network (CN) with distributed delays and random interference through output measurements. In the data transmission, the deception attacks are taken into account by resorting to a sequence of Bernoulli random variables with a given probability. Considering the complexity of the network, the fact that only partial output measurements are available in practical environments presents a new challenge. Therefore, the partial-nodes-based (PNB) state estimation problem is proposed. For the sake of data collision avoidance and energy saving, a general event-triggered scheme is adopted in the design of the estimator. A novel estimator is constructed to consider both cyber attacks and resource limitations, filling the gap in previous results on PNB state estimation. By using the Lyapunov method and several stochastic analysis techniques, a few sufficient conditions are derived to guarantee the desired security and convergency performance for the overall estimation error. The estimator gains are obtained by solving a set of matrix inequalities with nonlinear constraints. At last, two examples and simulations are presented to further show the efficiency of the proposed method.

Cite this article
Zhou L, Li B. Event-triggered state estimation for complex networks under deception attacks: a partial-nodes-based approach. *Complex Eng Syst* 2023;3:14. http://dx.doi.org/10.20517/ces.2023.16

14. Model predictive control of multi-objective adaptive cruise system based on extension theory

Zhutao Li, Xinxin Zhao, Jue Yang, Menglei Liu

Read PDF DOI: 10.20517/ces.2023.15

Abstract:
Under certain working conditions, the car-following performance and longitudinal ride comfort of adaptive cruise control (ACC) vehicles are contradictory. Therefore, the extension coordinated control is introduced into the weighted design of each performance index under the model predictive control (MPC) framework to optimize the overall vehicle driving performance. In this article, the dynamic model of the ACC vehicle and the variable time headway model are established, and then the predictive model and its corresponding cost function under the MPC framework are designed. By using the co-simulation platform of CarSim and Matlab/Simulink, three different simulation conditions are established and compared with the traditional ACC operating results. It was determined that the tracking speed error in the acceleration stage can be reduced by approximately 40% and the acceleration amplitude can be reduced by between 8%–17%. Therefore, there is an optimization effect under this control method. This study provides a foundation for curving ACC under an extension coordinated control theory.

Cite this article

Li Z, Zhao X, Yang J, Liu M. Model predictive control of multi-objective adaptive cruise system based on extension theory. *Complex Eng Syst* 2023;3:15. http://dx.doi.org/10.20517/ces.2023.15