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Editorial

Theory, Applications, and Challenges of Cyber-Physical Systems 2021

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Cyber-physical systems (CPS) is a field that encompasses various computational and engineering disciplines, such as complex networks and communications, control, information fusion, signal processing, optimization, and computer science, as well as their applications [1–3]. The increasing number of complex system applications, together with more requirements and demands for system intelligence, flexibility, adaptability, robustness, and resilience, is revealing new theoretical and technological challenges for advanced cyber-physical systems [4–6].

A major challenge is the need for innovative frameworks and algorithms to deal with complex cyber-physical systems [7, 8]. Increasing complexities can be due to complex components, for example, some applications of advanced robot manipulators, sensor networks, multiagent systems, human-in-the-loop systems, and also complex environments. In particular, as unstructured environments in manufacturing with multi-spatial and temporal scales, uncertain human-robot interaction in the complex healthcare system, or intelligent control and multimodal information fusion in large-scale complex distributed systems, is the urgent problem to be solved [9–11]. These theoretical, methodological, or practical focus complexities make high-precision and reliable real-time performance difficult to achieve and therefore require the design and development of novel methods for cyber-physical systems [12]. Advancements in cyber-physical systems will provide engineering systems with new capabilities that far exceed today's levels of intelligence, autonomy, functionality, adaptability, robustness, and cybersecurity.

This Special Issue aims to provide a platform for researchers and engineers to report their recent results, exchange research ideas, and overlook emerging research and application directions in "Theory, Applications, and Challenges of Cyber-Physical Systems." After a strict peer-review process, seven papers were selected out of the submissions. The selected papers can be categorized into the following: adaptive and robust control for complex cyber-physical systems, computational methods for internet-of-things-based cyber-physical systems, agent-based modeling and activity recognition in complex human-robot interaction, analytical methods of design, modeling and evaluation of complex cyber-physical systems, artificial intelligence-based analysis, modeling, optimization, and evaluation for complex cyber-physical systems, smart interactions in complex cyber-physical systems, applications of data science for complex cyber-physical systems, intelligent hardware devices and software algorithms in complex cyber-physical systems, multimodal and multichannel signal processing, and information fusion in complex cyber-physical systems.

The paper by Qiang Liu et al. entitled "Optimization of Noise Transfer Path Based on the Composite Panel Acoustic and Modal Contribution Analysis" [13] aims to propose a novel method based on composite panel acoustic and modal contribution analysis and noise transfer path optimization in a vibroacoustic model. Indeed, most studies only consider the panel acoustic contribution of a single frequency, without considering the contribution of major frequencies synthesis to confirm the optimized panels. The effectiveness

of the proposed method is applied and verified in an excavator cab. The sound pressure level (SPL) of the driver's right ear (DRE) decreased obviously. The acoustic analysis of the composite panel acoustic contribution and modal acoustic contribution can more accurately recognize an optimized area than the traditional PACA. This method can be applied in the optimization of the structure-borne transmission path for construction machinery cab and vehicle body.

The paper by Asim Shahzad et al. entitled "An Improved Framework for Content- and Link-Based Web-Spam Detection: A Combined Approach" [14] aims to propose an improved framework for content- and link-based web-spam identification. The framework uses stopwords, keywords' frequency, part of speech (POS) ratio, spam keywords database, and copied-content algorithms for content-based web-spam detection. This paper focused on the issue of web spamming, which is one of the most significant issues encountered by SEs because it dramatically affects the quality of SE results. To address these challenges, they initially exposed the relationship network behind the link-based web spamming and then used the paid-link database, neighbour pages, spam signals, and link-farm algorithms. Finally, they combined all the content- and link-based spam identification algorithms to identify both types of spam for link-based web-spam detection. WEBSPAM-UK2006 and WEBSPAM-UK2007 datasets were used to conduct experiments and to obtain threshold values. A promising F-measure of 79.6% with 81.2% precision shows the applicability and effectiveness of the proposed approach.

The paper by Lisha Xu et al. entitled "Approximate Inertial Manifold-Based Model Reduction and Vibration Suppression for Rigid-Flexible Mechanical Arms" [15] aims to accurately position and control the rigid-flexible mechanical arms with a complex rigid-flexible structure. It proposed a model reduction method of rigid-flexible mechanical arms based on the approximate inertial manifold. To repress the residual vibration of the end of the mechanical arm, a feedforward control strategy is designed. The simulation results depict the superiority of the proposed method, which greatly suppresses the end residual vibration of the mechanical arm and realizes the accurate positioning of the end of the mechanical arm. In addition, the hardware experimental device of the rigid-flexible mechanical arms is constructed, and the experimental verification of the above method is put into effect. The simulation results of angular displacement and end vibration of the reduced model are accordant which is shown by the experimental results of the hardware platform.

The paper by Jiange Kou et al. entitled "Complex Electrical Stimulation Systems in Motor Function Rehabilitation after Spinal Cord Injury" [16] aims to using spinal cord electrical stimulation to alleviate spinal cord injury in an effective way. Hence it summarizes several different spinal cord electrical stimulation methods, analyzes the stimulation effect, and briefly describes the current understanding of their origin and mechanism of action. Finally, the possible development direction and corresponding challenges of spinal cord electrical stimulation in the future are proposed.

The paper by Yashar Salami and Vahid Khajehvand entitled "LSKE: Lightweight Secure Key Exchange Scheme in Fog Federation" [17] focuses on the fog computing architecture which allows data exchange with the vehicle network, sensor networks, etc. They have proposed a lightweight, secure key exchange scheme for the fog federation to reduce computational overhead instead of with a high computational overhead. To prove the lightweight, they have compared the proposed scheme with the Yashar design in terms of computing, and communication cost AVISPA Tool was used for the formal analysis of the proposed scheme. Then, it simulated the proposed scheme with the NS3 tool and compared it with throughput, packet loss, packet delivery, and end-to-end delay with Yashar et al.'s scheme. The results show that the proposed design reduced 3.2457 ms of computational overhead and 1,024 transmitted data bits.

The paper by Shulin Feng et al. entitled "Pursuer Navigation Based on Proportional Navigation and Optimal Information Fusion" [18] focuses on the pursuer navigation based on the three-dimensional proportional navigation law. This method presents a family of navigation laws resulting in a rich behavior for different parameters. Based on point-to-point navigation, obstacle avoidance is implemented by adjusting the control parameters, and the combination can enrich the application range of obstacle avoidance and guidance laws. Finally, simulation results verify the availability of the proposed navigation law.

The paper by Jingen Xia et al. entitled "Flow Field Analysis of Adult High-Flow Nasal Cannula Oxygen Therapy" [19] focuses on the mechanical ventilation of human body, which is treated as a complex human-computer interaction process. The purpose of this paper is to analyze the pressure, flow, and strain rate of the upper respiratory tract with different flow and oxygen concentrations by using finite element simulation, to guide professionals to adjust the appropriate flow and oxygen concentration parameters of the HFNC machine. This paper studies the complex human-computer interaction environment of the human respiratory tract and ventilation airflow. The 3D model of the respiratory tract established by the conversion of image scanning data was taken as the research object. The flow state of the gases in the respiratory tract was judged by Reynolds equation. After that, RNG K-ε model was applied to the research object, and the simulation diagram of airway pressure, flow rate, and strain rate and trace diagram of flowing particles were obtained under the finite element method. The results explain some clinical phenomena in HFNC and guide people to make better use of mathematical tools to study the human-computer complex environment.

Conflicts of Interest

The Guest Editors declare that they have no conflicts of interest regarding the publication of this Special Issue.

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