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Editorial

Special Issue on Modeling, Simulation, Operation and Control of Discrete Event Systems

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Information and computer technologies provide the spur to burgeoning man-made, highly automated systems. Nowadays, discrete event systems (DES), as a natural abstraction of various contemporary technological applications, include intelligent urban traffic systems, automated flexible manufacturing systems, computer networks, communication protocols, logistic systems, monitoring and control of large buildings, scientific and business workflows, distributed databases, and concurrent software systems. Their modeling, simulation, operation, scheduling and control are the primary issues to be investigated. It is of paramount significance to develop novel formal frameworks, analysis techniques, design tools, testing methods, and systematic control and optimization procedures for these kinds of man-made, highly complex systems. This is critical for their development and survivability [1–6].

Focusing on supervisory control, deadlock analysis, scheduling, resource management, performance evaluation, system identification, fault diagnosis, and performance evaluation, as well as pertinent problems of DES, this special issue aims to make a timely collection of recent advances in the area. There were 77 manuscripts submitted to this special issue, and 19 papers were finally accepted for publication. The acceptance rate was 24.6%.

The first paper [7], authored by Yao and Li, investigates the input–output finite time stabilization of time-varying impulsive positive hybrid systems based on finite state machines through the mode-dependent average dwell time technique. An output feedback controller is proposed that can stabilize non-autonomous hybrid systems by formulating the considered problem as a linear program. The second paper [8], authored by Yang, Peng, Ju, Xu, Yin, and Huang, is concerned with the efficiency improvement of multi-agent simulation. To address the problem of resynchronization interval selection and cyclic dependency, this paper presents a lookahead behavior model where a minimal safe time window is used to predict the interactions among implicit models. Consequently, the resynchronization interval can be efficiently determined.

The third paper [9], authored by Kucharska, proposes a heuristic decision-making approach for an NP-hard scheduling problem based on an algebraic-logical meta-model. By constructing an acceptable solution only, it significantly reduces the calculation cost. A general algorithm is developed and applied to the scheduling problems of unrelated parallel machines with a deadline and machine setup time dependent on the process state. The fourth paper [10], authored by Choi, Seo, and Kim, deals with discrete event system simulation, aiming to improve simulation efficiency by using a multi-fidelity modeling framework, while keeping simulation accuracy loss minimized. A number of novel concepts, such as an interest region, a fidelity change condition, and a selection model, are defined and integrated into the framework.

Motivated by the effectiveness of heuristic rules, the fifth paper [11], authored by Ma, Qiao, Zhao, and Sutherland, reports a dynamic scheduling strategy for semiconductor manufacturing lines by considering various factors and constraints such as make-span and equipment efficiency that are stringently tied to system performance. The proposed method dynamically computes a composite dispatching rule that can be used to optimize production performance. Proposed in the sixth paper [12], by Choi, Jin and Kim, is an optimization method for single artillery unit fire scheduling problems. Taking the threat level of an enemy target to be an uncertain parameter, a robust optimization model is developed, minimizing the total enemy threat to friendly forces. Numerical experiments are conducted to validate the performance of the presented solution method.

The seventh paper [13], authored by Arriagada-Benítez, Sepúlveda, Munoz-Gama, and Buijs, deals with the model identification problem by developing automated strategies to derive a process model from event data in discrete event systems. Three strategies, based on exhaustive search, genetic algorithms and a greedy heuristic, respectively, are formulated, which have been implemented and tested. The eighth paper [14], contributed by Tamás, dwells upon decision support simulation for intermittent production systems that represent an important class of industrial processes. As claimed by the author, the proposed simulation method takes less time than the earlier methods (the modeling steps are clear and simple to implement) and it can also examine every complex intermittent production system by using the elaborated investigational method.

The ninth paper [15], authored by Hong, Feng, Li, Tian, and Tan, focuses on reliability-based and cost-oriented product optimization. A pertinent product optimization method integrating a fuzzy reasoning Petri net, interval expert evaluation and cultural-based dynamic multi-objective particle swarm optimization is developed. A mathematical model of product optimization is established. The efficiency and effectiveness of the proposed method are demonstrated via the numerical example of the optimization design for a machine tool. The 10th paper [16], authored by Wang, Hsu, and Tran, deals with an automated material handling problem in the semiconductor industry for 450 mm wafer fabrication, where traffic-jam problems and lot-prioritization are of particular interest. An improved dispatching method is reported, as well as some effective rules. Experimental results show the better performance of the proposed methods and rules.

The 11th paper [17], by Alfian, Rhee, Ijaz, Syafrudin, and Fitriyani, discusses the performance of a discrete event simulation model for a new transport mode—a carsharing service. The work details forecasting relocation to solve car distribution imbalances for one-way carsharing services. A real case dataset is employed to help find the best simulation results, which provides a clear insight into the impact of forecasting relocation on high system utilization and the reservation acceptance ratio. The 12th paper [18], by An, Wu, Hon, and Li, deals with the short-term scheduling problem of crude oil operations without sufficient charging tanks in a refinery. A hybrid Petri net model is developed to describe the behavior of the system. A method is proposed to find a schedule such that the simultaneously-charging-and-feeding mode is minimally used, which is computationally efficient.

The 13th paper [19], by Markiewicz and Gniewek, investigates the control problem of discrete event systems by using fuzzy interpreted Petri nets to overcome the limitation of regular Petri net models. This work makes the use of a program model and proposes a method for generation of this model via a graphical representation. A computer tool is developed to implement the method that transforms the graphical form of fuzzy interpreted Petri nets into Structured Text language supported by the IEC 61131-3 standard.

The 14th paper [20], by Kammoun, Ezzeddine, Rezg, and Achour, considers the scheduling problem of flexible manufacturing systems by using timed Petri nets, which can provide an optimal solution for large-scale systems under availability constraints. A mathematical model is built to determine the optimal firing transition sequence to minimize the total manufacturing time. The 15th paper [21], by Guo, Zhang, Zhao, and Song, studies the collaboration problem between production and logistics in a flexible production system by using timed colored Petri nets. This paper proposes a self-adaptive collaboration method by combining the schedule of token sequences. An integrated

framework based on a cloud service platform is introduced to provide the basis for self-adaptive collaboration of production-logistics systems.

The 16th paper [22], by Hsu, Wang, Chou, Lee, and Wen, deals with a number of seaside operational problems in transportation systems, which have, in general, been solved individually or partially in previous studies, leading to poor overall system performance. This work integrates them as a novel Petri net model. By using the Prolog programming language, the proposed model is implemented as a simulation tool to find the best solution.

The 17th paper [23], by Mailloux, Grimaila, Hodson, Engle, McLaughlin, and Baumgartner, focuses on the modeling, simulation, and performance analysis of a class of quantum key distribution (QKD) systems. A detailed performance analysis of decoy state enabled QKD systems is conducted, showing that the decoy state protocol can ensure that Photon Number Splitting attacks are detected with high confidence.

The 18th paper [24], by Drakaki and Tzionas, addresses the scheduling problem of manufacturing systems based on timed colored Petri nets and reinforcement learning. A warehouse order-picking scheduling is presented as a case study to illustrate the method. The proposed scheduling method is compared with some existing methods and its performance advantages are demonstrated.

The last paper [25], by Lv, Zhang, and Qin, deals with dynamic hybrid flow shop scheduling with uncertain processing time by proposing a genetic regulatory network-based rescheduling algorithm. The decision variables are represented by genes in the network and the constraints and certain rescheduling rules are described by regulation equations among genes. The objective of minimizing makespan is realized by optimizing regulatory parameters in regulation equations.

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References

1. Lu, X.; Zhou, M.; Ammari, A.C.; Ji, J. Hybrid Petri Nets for Modeling and Analysis of Microgrid Systems. *IEEE/CAA J. Autom. Sin.* **2016**, *3*, 347–354.
2. Ran, N.; Su, H.; Wang, S. An Improved Approach to Test Diagnosability of Bounded Petri Nets. *IEEE/CAA J. Autom. Sin.* **2017**, *4*, 297–303. [CrossRef]
3. Wu, N.; Zhou, M.; Bai, L.; Li, Z. Short-term Scheduling of Crude Oil Operations in Refinery with High-fusion-point Oil and Two Transportation Pipelines. *Enterp. Inf. Syst.* **2016**, *10*, 581–610. [CrossRef]
4. Wu, N.; Zhou, M.; Li, Z. Short-term Scheduling of Crude-oil Operations: Petri net-based Control-theoretic Approach. *IEEE Robot. Autom. Mag.* **2015**, *22*, 64–76. [CrossRef]
5. Chen, Y.; Li, Z.; Barkaoui, K.; Giua, A. On the Enforcement of a Class of Nonlinear Constraints on Petri Nets. *Automatica* **2015**, *55*, 116–124. [CrossRef]
6. Wang, X.; Khemaissia, I.; Khalgui, M.; Li, Z.; Mosbahi, O.; Zhou, M. Dynamic Low-power Reconfiguration of Real-time Systems with Periodic and Probabilistic Tasks. *IEEE Trans. Autom. Sci. Eng.* **2015**, *12*, 258–271. [CrossRef]
7. Yao, L.; Li, J. Input–Output Finite Time Stabilization of Time-Varying Impulsive Positive Hybrid Systems under MDADT. *Appl. Sci.* **2017**, *7*, 1187. [CrossRef]
8. Yang, M.; Peng, Y.; Ju, R.; Xu, X.; Yin, Q.; Huang, K. A Lookahead Behavior Model for Multi-Agent Hybrid Simulation. *Appl. Sci.* **2017**, *7*, 1095. [CrossRef]
9. Kucharska, E. Heuristic Method for Decision-Making in Common Scheduling Problems. *Appl. Sci.* **2017**, *7*, 1073. [CrossRef]
10. Choi, S.; Seo, K.; Kim, T. Accelerated Simulation of Discrete Event Dynamic Systems via a Multi-Fidelity Modeling Framework. *Appl. Sci.* **2017**, *7*, 1056. [CrossRef]

11. Ma, Y.; Qiao, F.; Zhao, F.; Sutherland, J. Dynamic Scheduling of a Semiconductor Production Line Based on a Composite Rule Set. *Appl. Sci.* **2017**, *7*, 1052. [CrossRef]
12. Choi, Y.; Jin, S.; Kim, K. Deterministic and Robust Optimization Approach for Single Artillery Unit Fire Scheduling Problem. *Appl. Sci.* **2017**, *7*, 1038. [CrossRef]
13. Arriagada-Benítez, M.; Sepúlveda, M.; Munoz-Gama, J.; Buijs, J. Strategies to Automatically Derive a Process Model from a Configurable Process Model Based on Event Data. *Appl. Sci.* **2017**, *7*, 1023. [CrossRef]
14. Tamás, P. Decision Support Simulation Method for Process Improvement of Intermittent Production Systems. *Appl. Sci.* **2017**, *7*, 950. [CrossRef]
15. Hong, Z.; Feng, Y.; Li, Z.; Tian, G.; Tan, J. Reliability-Based and Cost-Oriented Product Optimization Integrating Fuzzy Reasoning Petri Nets, Interval Expert Evaluation and Cultural-Based DMOPSO Using Crowding Distance Sorting. *Appl. Sci.* **2017**, *7*, 791. [CrossRef]
16. Wang, C.; Hsu, H.; Tran, V. An Improved Dispatching Method (a-HPDB) for Automated Material Handling System with Active Rolling Belt for 450 mm Wafer Fabrication. *Appl. Sci.* **2017**, *7*, 780. [CrossRef]
17. Alfian, G.; Rhee, J.; Ijaz, M.; Syafrudin, M.; Fitriyani, N. Performance Analysis of a Forecasting Relocation Model for One-Way Carsharing. *Appl. Sci.* **2017**, *7*, 598. [CrossRef]
18. An, Y.; Wu, N.; Hon, C.; Li, Z. Scheduling of Crude Oil Operations in Refinery without Sufficient Charging Tanks Using Petri Nets. *Appl. Sci.* **2017**, *7*, 564. [CrossRef]
19. Markiewicz, M.; Gniewek, L. A Program Model of Fuzzy Interpreted Petri Net to Control Discrete Event Systems. *Appl. Sci.* **2017**, *7*, 422. [CrossRef]
20. Kammoun, M.; Ezzeddine, W.; Rezg, N.; Achour, Z. FMS Scheduling under Availability Constraint with Supervisor Based on Timed Petri Nets. *Appl. Sci.* **2017**, *7*, 399. [CrossRef]
21. Guo, Z.; Zhang, Y.; Zhao, X.; Song, Y. A Timed Colored Petri Net Simulation-Based Self-Adaptive Collaboration Method for Production-Logistics Systems. *Appl. Sci.* **2017**, *7*, 235. [CrossRef]
22. Hsu, H.; Wang, C.; Chou, C.; Lee, Y.; Wen, Y. Modeling and Solving the Three Seaside Operational Problems Using an Object-Oriented and Timed Predicate/Transition Net. *Appl. Sci.* **2017**, *7*, 218. [CrossRef]
23. Mailloux, L.; Grimaila, M.; Hodson, D.; Engle, R.; McLaughlin, C.; Baumgartner, G. Modeling, Simulation, and Performance Analysis of Decoy State Enabled Quantum Key Distribution Systems. *Appl. Sci.* **2017**, *7*, 212. [CrossRef]
24. Drakaki, M.; Tzionas, P. Manufacturing Scheduling Using Colored Petri Nets and Reinforcement Learning. *Appl. Sci.* **2017**, *7*, 136. [CrossRef]
25. Lv, Y.; Zhang, J.; Qin, W. A Genetic Regulatory Network-Based Method for Dynamic Hybrid Flow Shop Scheduling with Uncertain Processing Times. *Appl. Sci.* **2017**, *7*, 23. [CrossRef]