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Editorial

Using Communication Networks in Control Systems: The Theoretical and Practical Challenges

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From the perspective of information exchange, three stages can be identified for the evolvement of control systems. Conventional control systems with simple system structure can be implemented in a way that all system components, including the controller, the plant, the sensors, and the actuators, are connected point-to-point via communication cables, meaning that the information exchange within such systems is almost perfect, without any information loss or delay. Later, with the development of complex applications of control systems in industry, the system scale becomes larger and larger, which makes the point-to-point connections too expensive and impractical. In order to facilitate the communication among system components, the bus structure is then proposed, where many control components can share the same bus communication channel. In recent years, communication networks have been more and more popular, and naturally, the information exchange in control systems has taken advantage of these existing communication networks to develop the concept of networked control systems, as well as a few new branches in control field such as cyberphysical systems, Internet of Things, and almost all large intelligent systems including smart home, intelligent transportation, and smart city [1–3].

Using communication networks in control systems is the foundation of many modern intelligent systems. However, such a technical integration has resulted in many challenges in both theories and applications. For instance, the information exchange in modern industrial systems is also carried out via the shared communication channel whose communication characteristics are usually unknown and unpredictable. This then breaks the real-time requirement of information exchange by control systems (the same as in control systems with bus communication channel) and also introduces unpredictable, stochastic nature of information exchange (a brand-new feature for these systems). New methodologies and approaches are therefore needed for making such systems reliably useful in future [4].

This special issue has collected a number of research articles which may shed light on the-state-of-the-art of control systems using communication networks. We briefly outline the key points of these research articles in what follows, and for the detailed works please refer to the articles in this special issue.

The article entitled "Dynamic Output Feedback Control of Discrete Markov Jump Systems based on Event-Triggered Mechanism" by Z. Zhao et. al. investigates the random time delay caused by the communication network and models it as a Markov process. Then, the authors propose an event-triggered mechanism for information transmission and a codesign strategy involving both the event-triggered scheme and a dynamic output feedback controller. The stability of the closed-loop system is finally addressed using the Lyapunov-Krasovskii functional and linear matrix inequality (LMI).

The article entitled "Event-Based Nonfragile H_∞ Filter Design for Networked Control Systems with Interval Time-Varying Delay" by Z. Lu et. al. considers interval time-varying delay in nonlinear control systems. Similarly, the authors propose an event-triggered scheme to schedule the sampled data transmission through the communication network, and then model the filtering error system as a system with interval time-varying delay. The authors then take advantage of a new Lyapunov-Krasovskii functional and the Wirtinger inequality to derive the sufficient stability conditions, and also propose the LMI based design of the nonfragile filter parameters.

The article entitled "Event-Triggered H_∞ Filtering for Multiagent Systems with Markovian Switching Topologies" by J. Li et. al. considers network-induced delay in the context of multiagent systems with Markovian switching topologies. Again, an event-triggered mechanism is proposed for information transmission, but it is for the directed network topology representing the communication links.

The article entitled "Networked Closed-Loop Model for Smart On-Site Maintenance of Substation Equipment Using Mobile Networks" by Z. Feng et. al. is concerned with mobile networks in the context of smart on-site maintenance of substation equipment. The authors propose a model for such systems, which allows bidirectional communication among the people and the equipment. This article can be regarded as a successful practical application of control systems using communication networks.

The article entitled "Neural Network Predictive Control for Autonomous Underwater Vehicle with Input Delay" by J. Zhao considers input delay for an autonomous underwater vehicle (AUV). The authors propose a predictive control algorithm to compensate for the negative effects of time delay in path tracking, with the use of neural networks to estimate the nonlinear uncertainties of AUV. The authors finally give the stability conditions using the Lyapunov theorem.

In summary, we believe that this special issue has contained sufficiently useful materials on control systems using communication networks and hope that this special issue will provide the reader with a useful reference for their future research.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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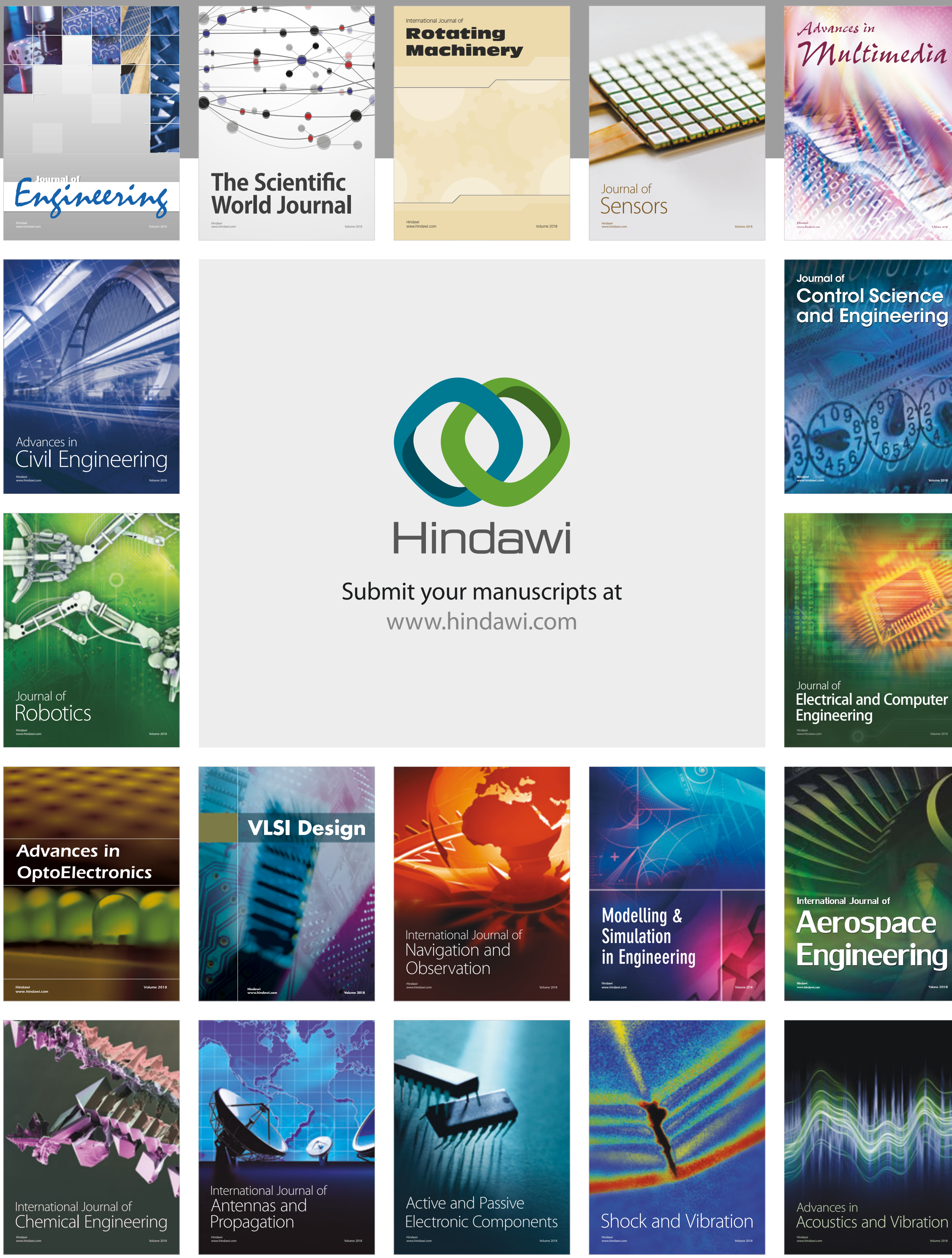
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