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Editorial

Special Issue on Application of Artificial Intelligence in Mechatronics

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1. Introduction

In recent years, artificial intelligence has promoted the rapid development of intelligence in various fields, with mechatronics being one of its hot research topics. The aim is to organically combine mechanical skills, microelectronics skills, and information skills to realize the optimization of whole systems. It is a common trend to combine the development of mechatronic systems with artificial intelligence, which is mainly designed and realized through control technology; that is, it is realized using the control system in mechatronic systems. Intelligent systems can imitate human behavior, learn and imitate all kinds of known information and content in its environment, and use what it has learned for conducting analyses, decision making and control, optimizing the entire intelligent system and achieving the best effect. Therefore, the application of artificial intelligence in mechatronics should be given more attention in research.

2. Advances in Artificial Intelligence in Mechatronics

In light of the above, this Special Issue was introduced to collect the latest research on relevant topics and, more importantly, to address present challenging issues through the combination of mechatronic systems with artificial intelligence. There were seven papers submitted to this Special Issue, out of which six were accepted. When looking back to the Special Issue, various topics were addressed, mainly concerning electrohydraulic control systems, robotics, and vehicles.

There were three papers that focused on electrohydraulic control systems. The first paper, authored by C. Sun, X. Dong, M. Wang, and J. Li, presents an adaptive chatter-free sliding mode control [1] divided into two stages, namely, the initial state to the critical value and the system state variable reaching the equilibrium point of the sliding mode surface. The proposed approach was applied to an electrohydraulic position servo system. Simulation results showed that the proposed approach could significantly reduce the time to reach the sliding surface and improve the robustness of the system. The second paper, authored by M. Li and Q. Zhang, concentrates on both the velocity and force control of a single-rod electrohydraulic actuator in the presence of parameter uncertainties and uncertain nonlinearities [2], which is a very meaningful topic in engineering applications. Impedance control and adaptive robust control were synthesized to deal with this problem, i.e., the primary goal was velocity control, while the contact force was kept in an acceptable range. Fuzzy logic was used to adjust the parameters of the impedance rules to improve control performance, and parameter uncertainties and uncertain nonlinearities were compensated for through adaptive robust velocity control. The last paper about an electrohydraulic control system was authored by G. Zhao, S. Chen, Y. Liu, and K. Guo, who analyzed the pressure control problem in a dual-actuator-driven electrohydraulic actuator [3]. The study improved the pressure control performance in the case of external disturbances, and guaranteed that the magnitude and velocity constants of both actuators were not violated.

As an emerging revolutionary technology, intensive research has been conducted on topics concerning robotics, with two papers focusing on this technology in this Special Issue.

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The first one, authored by Z. Chen, X. Li, L. Wang, Y. Shi, Z. Sun, and W. Sun, proposed an object detection and localization method for a teleoperated robot [4]. The classic YOLOv5 network model was improved to produce superior object detection performance and coordinate the attention module, included to help the model pay more attention to features of interest. Experimental results showed that the proposed approach could achieve an accurate and fast detection speed. In the other paper, authored by B. Yang, K. Guo, and J. Sun, the authors focused on chatter detection in robotic milling, which is a difficult issue due to the complex dynamic behavior of robots [5]. An improved empirical mode decomposition approach was proposed to decompose the milling vibration signals into a series of intrinsic mode functions, and the weighted and refined composite multiscale dispersion entropy was extracted from the reconstructed signals in order to characterize the chatter states. Experimental results proved that the proposed method was feasible for chatter detection in the robotic milling process under different robot configurations and machining parameters.

Lastly, the paper 'Target State Optimization: Drivability Improvement for Vehicles with Dual Clutch Transmissions' introduced a target state optimization approach for vehicles with dual clutch transmissions [6]. The paper was authored by M. Schmiedt, P. He, and S. Rinderknecht, and offered an overview of existing approaches for optimizing driving behavior with metaheuristics given. Since existing approaches have different drawbacks, a new approach based on reinforcement learning and supervised learning was proposed, which outperforms existing ones.

3. Future Intelligent Mechatronics

Although the Special Issue has now been closed, more in-depth studies in intelligent mechatronic technologies are expected. In the future, more intelligent approaches that can better learn known information from the environment, imitate human behaviors, and those capable of controlling and optimizing mechatronic systems are expected. Moreover, more software packages should be developed to promote the application of these approaches.

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