Artificial Intelligence-Based Self-Learning Control Methods

Derong Liu
Southern University of Science and Technology, China

Artificial Intelligence-Based Self-Learning Control Methods have emerged as a transformative approach for optimal control of nonlinear systems in dynamic and complex environments. Unlike traditional control techniques that rely on predefined models and manual tuning, self-learning control leverages AI-driven algorithms, such as reinforcement learning and neural networks to adapt and optimize control strategies in real time. These methods enable autonomous decision-making, improved robustness, and enhanced adaptability, making them particularly useful in robotics, autonomous vehicles, industrial automation, and smart energy systems. This lecture explores the fundamental principles of AI-driven self-learning control, discusses key methodologies including adaptive dynamic programming and parallel control approaches, and examines their practical applications across various domains. Furthermore, this lecture also explores the trade-offs between learning efficiency, real-time adaptability, and deployment feasibility, offering insights into overcoming these challenges for real-world implementations. Additionally, the concept of meta-control is considered as a higher-level mechanism to dynamically adjust self-learning strategies, improving the efficiency and robustness of AI-driven control systems. By integrating AI with control theory, self-learning control is poised to revolutionize intelligent automation, enabling more efficient and autonomous systems.