

The Future of Power Electronics in the Age of Artificial Intelligence

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Abstract

A key enabling technology for contemporary electrification, power electronics supports applications like data centers, smart grids, electric vehicles, renewable energy systems, aircraft, and industrial automation. The practical boundaries of traditional design and control techniques are being reached as these systems get more sophisticated. Simultaneously, artificial intelligence (AI) is beginning to emerge as a revolutionary technology that has the potential to completely change power electronic systems in the future.

The integration of AI with power electronics is examined in this speech, which also shows how smart algorithms are converting traditional energy converters into autonomous, predictive, and adaptable systems. Key AI technologies are introduced in the presentation, along with their applications in converter control, optimization, fault diagnosis, predictive maintenance, thermal management, and intelligent system design. These technologies include machine learning, deep learning, reinforcement learning, digital twins, and generative AI. AI may enhance efficiency, dependability, power quality, and operational performance under various operating scenarios, as demonstrated by real-world examples involving DC–DC converters, DC–AC inverters, and wireless EV charging systems.

A vision for the upcoming generation of intelligent power converters that can self-learn, self-tune, self-diagnose, self-heal, and self-optimize is also presented in the keynote. It also discusses new research paths including Edge AI, Physics-Informed AI, and Explainable AI while highlighting important issues related to AI adoption, such as data quality, explainability, cybersecurity, and processing requirements. The presentation's conclusion emphasizes that the development of intelligent, resilient, and autonomous energy conversion systems—which will be crucial to the next wave of sustainable electrification—will define the future of power electronics rather than just increased efficiency.