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Intelligent Edge-Embedded Technologies for Digitising Industry

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Description:

This book explores new developments, ideas, and concepts in intelligent edge-embedded technologies for the digitising industry. The work is based on recent research results and activities in edge industrial computing, artificial intelligence (AI), the Industrial Internet of Things (IIoT) and digital twin technologies. Each chapter builds on the research, developments and innovative ideas generated by AI4DI, ANDANTE and TEMPO ECSEL JU, as well as other European research projects.

The evolution towards an environmentally friendly Industry 5.0 brings more industrial edge devices that include embedded intelligence, with enough computing power and sufficiently advanced programming to make operational decisions based on local data and independent of external advice.

These new intelligent edge-embedded devices act on the data they capture or generate about evolving conditions in the industrial process and change the machine's behaviour to optimise the operation and its functionalities. Connected, these intelligent edge IIoT devices can act on information generated across multiple intelligent edge devices and even across various types of intelligent edge devices to create more intelligent behaviours for industrial manufacturing processes.

The embedded intelligence technologies implement artificial intelligence (AI) capabilities into the edge device itself, so the device can learn, analyse, and act autonomously.

Intelligent edge systems implemented on-premises improve industrial manufacturing facilities' outcomes by making instantaneous, autonomous, or semi-autonomous decisions independent of external cloud computing capabilities.

The specific interest here lies in the advancement of the convergence of edge computing and AI technologies in edge industrial application areas. This is examined by introducing the concepts of sustainable industrial-edge AI technologies and industrial-edge AI for sustainability.

Insights from recent research on key AI technologies that support the development of industrial-edge AI applications for the digitising industry are presented. The concept of AI at the edge is introduced, and the edge continuum components and their distribution across the micro-, deep- and meta-edge continuum are explained.

Moreover, the book discusses how to build AI models (e.g., model training and inference) on edge and provides insights into this new interdisciplinary field of intelligent industrial edge from a broader perspective.

The authors examine the technologies and hardware for neuromorphic computing, highlighting emerging in-memory computing techniques, the implementation of resistive synapses for neural networks, neuromorphic reference architectures, and the tools and methodologies for training and mapping neural networks on hardware targets.

Furthermore, the book reviews the core concepts for edge AI advancements in the digitising industry and the impact of AI and digital twins on IIoT. Finally, the book addresses ethical considerations and the trustworthiness of industrial AI systems' core concepts, as well as the current challenges of AI standardisation in the digitising industry.

This book's target audience includes academics, research scholars, industrial experts, scientists, and postgraduate students working in industrial edge-embedded intelligence hardware, software, and algorithms to add machine learning and deep learning to enhance the industrial edge processing capabilities.

Keywords: Intelligent edge-embedded technologies, edge industrial computing, neuromorphic computing, artificial intelligence, deep learning, machine learning, industrial internet of things, digital twins, sustainable industrial-edge AI technologies, trustworthiness of industrial AI systems, AI standardisation.