# Intelligent Edge-Embedded Technologies for Digitising Industry

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## Dedication

"Wise thinkers prevail everywhere."

- Sophocles

"Intelligence is what you use when you don't know what to do."

- Jean Piaget

"The intelligence is proved not by ease of learning, but by understanding what we learn."

- Joseph Whitney

"A computer would deserve to be called intelligent if it could deceive a human into believing that it was human."

- Alan Turing

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Ovidiu Vermesan
Mario Diaz Nava

# Contents

# Preface

### Intelligent Edge-Embedded Technologies for Digitising Industry

Industrial intelligent edge systems are designed with more computing power and sensors to enable analytics, AI inferencing, and natural user interfaces. These new capabilities enhance their behaviour and provide new functionalities based on sensing, actuating, programming, and connectivity to dynamically interact and autonomously function.

Intelligent edge architectures are complementary to embedded systems, bringing scalable computing nearer to resource-constrained embedded systems and enabling these systems to leverage more complex, computing-intensive processes (including machine and deep learning) and local processing of historical data.

Intelligent edge devices are often resource-constrained by design. Such fixed-function systems are highly optimised for performance (speed, reliability, safety) and cost.

By making additional computing resources available to these systems, intelligent edge deployments enable diverse decision-making processes in the local industrial environment. These include system-level optimisations across devices, changes to the programming of specific devices, and other forms of control.

AI algorithms are processed locally, directly on the device, on the gateway, or on-premises servers near the edge devices. The algorithms utilise the data generated by the devices themselves. Industrial edge IIoT devices can make independent decisions in a matter of milliseconds without having to connect to the cloud.

As the computing and microcontroller architectures evolve, they support edge AI on embedded industrial systems and make the most of the limited computing resources there. The ARM Cortex cores, and AI accelerator's developments are pushing forward AI in resource-constrained environments. Several chip manufacturers are directly enabling machine learning-based AI on their microcontrollers. The increased hardware support for AI, including tools for edge AI, opens new opportunities for industrial edge AI implementations and deployments with new AI configurations that can operate in real-time and be integrated into the industrial manufacturing process.

This book provides a valuable resource for researchers working with intelligent edge-embedded technologies for digitising industry and industry professionals, machine and deep learning engineers, front-end developers, IIoT developers, and back-end developers looking to deploy intelligent solutions at the industrial edge.

# List of Figures

# List of Tables

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# List of Abbreviations

| | |
|---|---|
| AP | Access point |
| ARQ | Automatic repeat request |
| ASIC | Application specific integrated circuit |
| CPU | Central processing unit |
| CU | Central unit |
| DL | Deep learning |
| DSO | Distribution system operator |
| DU | Distributed unit |
| DT | Digital twin |
| e2e | End to end |
| FEC | Forward error correction |
| FH | Fronthaul |
| FL | Federated learning |
| FPGA | Field-programmable gate array |
| GPU | Graphic processing units |
| HW | Hardware |
| IBM | Information bottleneck method |
| IIoT | Industrial internet of things |
| IoT | Internet of things |
| LUT | Look-up-table |
| MedTech | Medical technology |
| MIMO | Multi-input multiple-output |
| ML | Machine learning |
| NN | Neural network |
| QA | Quality assurance |
| RAN | Radio access network |
| RU | Radio unit |
| SDK | Software development kit |
| SotA | State of the art |
| SW | Software |
| TSO | Transmission system operator |