

Hitachi develops edge AI technologies that boost frontline application of Lumada 3.0

Energy-efficient edge AI analyzing diverse sensor data in real time will contribute to stable equipment operation and social value creation

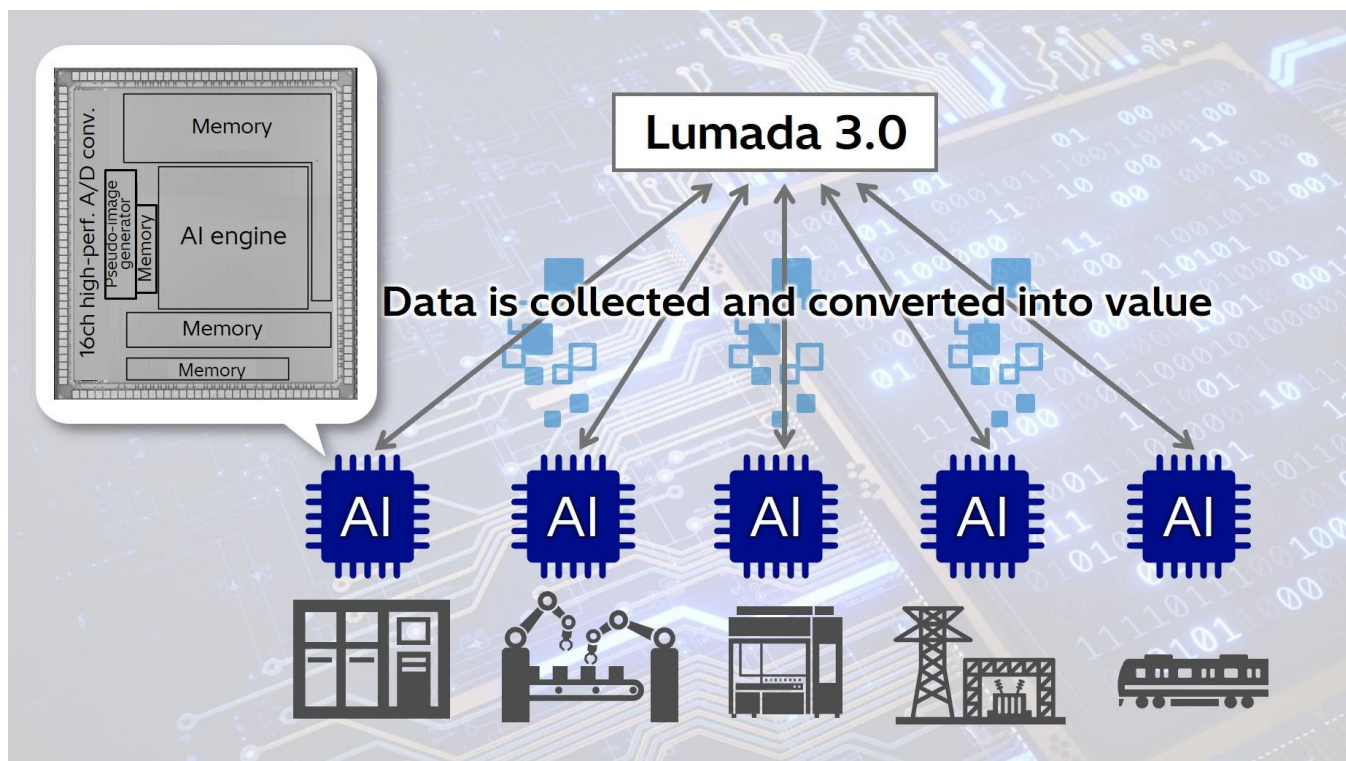


Figure 1. Anticipated applications of the developed technologies

Tokyo, October 14, 2025 Hitachi, Ltd. (TSE: 6501; “Hitachi”) has developed edge AI^{*1} technologies for boosting frontline application of Lumada 3.0, aiming to solve customer problems and create value on the way to continuous growth. The technologies enable high-density integration, on one semiconductor chip, of the circuitry for processing data from sensors for images, sound, vibrations, and more, achieving an energy-efficient and compact package. In addition, using the design and prototyping platform provided by the Research Association for Advanced Systems (RaaS),^{*2} Hitachi has designed circuitry that succeeds in reducing power consumption to approximately 1/10 that of an AI semiconductor with similar processing speed. As a result, real-time data analysis by edge AI will be possible even in locations with constraints on power supply or installation space, which will contribute to more stable equipment operation, improved productivity, and more advanced quality control. Through collaborations with partner companies in the semiconductor manufacturing field and other such efforts, Hitachi plans to deploy these technologies in its own inspection equipment and visual inspection^{*3} solutions, aiming to enhance the value of digitalized assets. In such ways, these technologies will help users convert data collected in the worksite into value, contributing to the advancement of industrial fields and social infrastructure, their continuous growth, and the creation of social value (Figure 1). Moreover, by combining these frontline-optimized technologies with AI semiconductors such as GPUs^{*4} used in large-scale systems, Hitachi aims to provide an AI processing platform, broadly applicable from the cloud to worksites, that can help address a wide range of challenges that society faces.

^{*1} Artificial intelligence deployed directly in network terminal equipment (edge devices).

- *2 An organization providing Research as a Service, making leading-edge semiconductor technology available for anyone to use.
- *3 A process of inspecting the exterior of a product or part visually or by machine to check for scratches, soiling, deformation, and other defects.
- *4 Graphics processing units: Processors capable of graphical processing or AI operation processing.

Background and issues

Demand for real-time processing of the huge amounts of data generated at worksites has risen in recent years with the growing use of IoT devices and sensors. At the same time, worksites in industrial and other fields face increasingly serious issues such as labor shortages, equipment obsolescence, and the need for more advanced quality control, giving rise to urgent needs for equipment anomaly detection and preventive maintenance and better safety and productivity among frontline workers. Conscious of these issues, Hitachi has been promoting initiatives, through the AI-driven advancement of Lumada, for the real-time processing of various frontline data as a path to converting the data into value that will help customers solve problems and support their continuous growth. Conventional edge AI systems, however, have struggled to find practical applications in worksites due to problems ranging from the substantial requirements for power consumption and installation space to the difficulties of processing data from multiple types of sensors. For leveraging frontline data in real time and achieving a sustainable society and industrial transformation, there is a need for a more efficient AI processing platform.

Features of the developed technologies

To address these issues, Hitachi has developed edge AI technologies for boosting frontline Lumada 3.0 application, providing a foundation for solving diverse problems at industrial worksites and creating social value. Below are the main features of these technologies.

1. Circuit technology that reduces power usage in edge AI processing

Power supply and installation space limitations are problems that affect industrial worksites and IoT devices. Therefore, reducing power consumption and achieving more compact device sizes play important roles in AI introduction. By designing semiconductor circuitry optimized to industrial equipment anomaly detection and inspection applications and fabricating the chips using the RaaS FinFET^{*5} CMOS design and prototyping platform, Hitachi has succeeded in reducing power use to approximately 1/10 that of conventional AI semiconductors with equivalent processing speed. Through the developed technology, sensor signals are converted to images, and the AI engine is made to operate efficiently in circuitry optimized for image-recognition neural network operations. The intermediate results of the operations are stored in on-chip memory, eliminating the need to write them to external storage. This design saves energy for moving data around and thereby reduces power consumption. A compact footprint is achieved by integrating these functions in a high-density configuration, along with the A/D converters^{*6} serving as sensor interface, all on one chip. The technology will thus pave the way for AI processing in a wide range of worksites facing constraints on power supply or thermal dissipation space.

*5 Fin field-effect transistor: A type of field-effect transistor (FET) whose channel has a vertical fin-like structure instead of being completely planar. This CMOS transistor design improves the gate's control of the flow of current and achieves higher performance and lower power consumption than a planar FET.

*6 Analog/digital converter: A circuit converting analog to digital signals.

2. Sensor-fusion technology enabling integration and analysis of diverse frontline data on one chip

Separate processing of the data obtained from different kinds of sensors (image, sound, vibration, etc.) used at worksites has been common practice, but this approach has limitations in the early detection of anomalies or monitoring of complex phenomena. Attempts to solve this through integrated data analysis run up against the need for large equipment and electric power, hindering introduction at the worksite. The newly developed sensor-fusion technology employs an original low-voltage, small-footprint analog circuit design to aggregate numerous high-performance A/D converters on a single chip along with the AI engine, giving it the major advantage of enabling

real-time and power-efficient analysis. Besides image data, the technology makes it possible to capture, integrate, and analyze such phenomena as slight mechanical vibrations or abnormal noise in a simultaneous fashion. This makes it possible to detect subtle anomalies or compound changes that, up to now, may have been missed. These capabilities will contribute significantly to stable equipment operation and improved workplace safety and productivity.

Confirmed benefits

When an AI semiconductor fabricated applying the developed technologies was used for semiconductor wafer defect detection, for motor bearing^{*7} anomaly detection, and other applications, power consumption was confirmed to be approximately 1/10 that of a conventional AI semiconductor with equivalent processing speed. Moreover, the semiconductor applying these technologies proved capable of error-free detection of very slight abnormalities, such as defects in the fine patterns formed on a wafer surface, and tiny scratches in multiple places on a bearing.

^{*7} A part supporting the shaft of a motor so that it rotates smoothly. The public dataset of the Bearing Data Center, Case Western Reserve University was applied.

Looking ahead

Positioning these technologies as part of the core technologies underpinning Lumada 3.0, Hitachi will aim to enhance the added value of digitalized assets, including semiconductor inspection equipment and visual inspection solutions, and deploy the technologies toward advancing products and services in various industrial fields and social infrastructure. Moreover, by collaborating with partner corporations that manufacture semiconductors and building eco systems with them, Hitachi will accelerate the use of real-time data at worksites and the advancement of AI processing. The aim of these initiatives will be to transform industrial fields and social infrastructure while achieving continuous growth.

The outcomes of this development project are to be presented in part at the 51st Annual Conference of the IEEE Industrial Electronics Society (IECON 2025) from October 14 to 17 in Madrid, Spain.

About Hitachi, Ltd.

Through its Social Innovation Business (SIB) that brings together IT, OT(Operational Technology) and products, Hitachi contributes to a harmonized society where the environment, wellbeing, and economic growth are in balance. Hitachi operates globally in four sectors – Digital Systems & Services, Energy, Mobility, and Connective Industries – and the Strategic SIB Business Unit for new growth businesses. With Lumada at its core, Hitachi generates value from integrating data, technology and domain knowledge to solve customer and social challenges. Revenues for FY2024 (ended March 31, 2025) totaled 9,783.3 billion yen, with 618 consolidated subsidiaries and approximately 280,000 employees worldwide. Visit us at www.hitachi.com.

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