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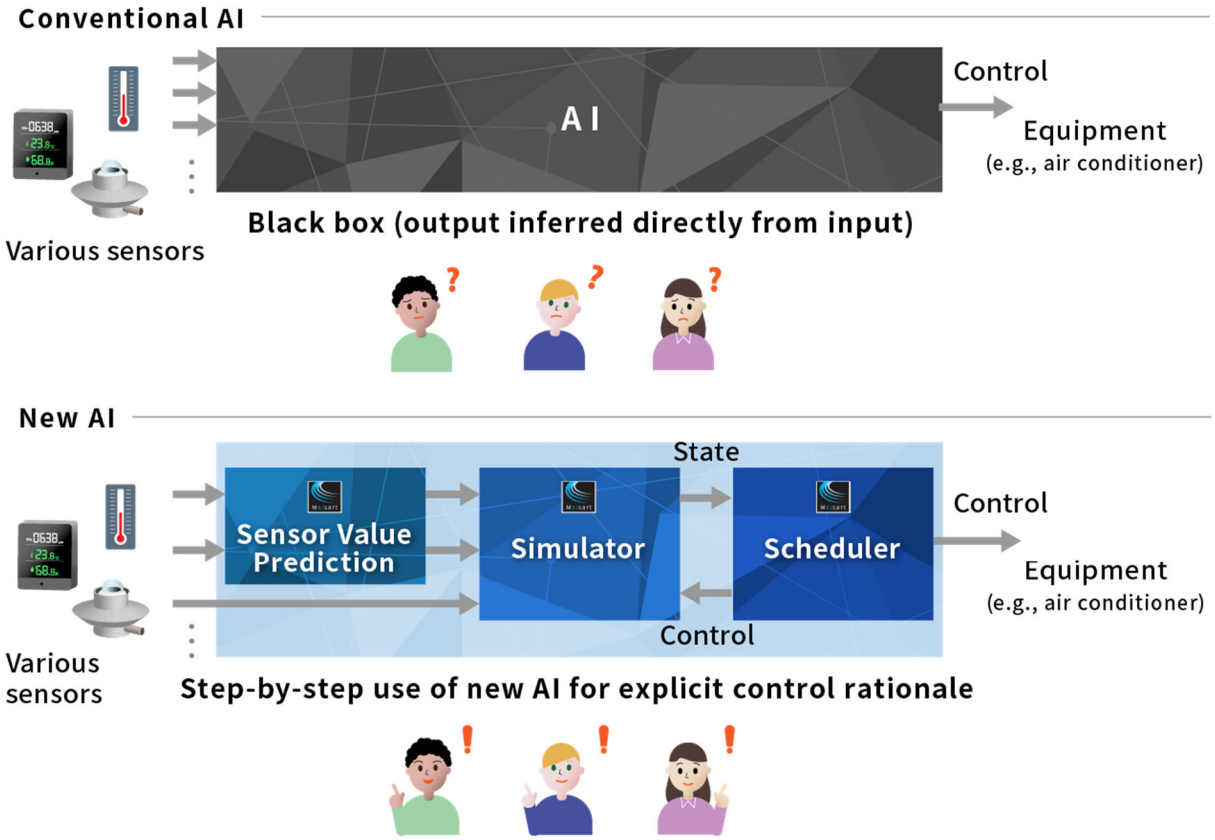
Mitsubishi Electric's New Technology Clarifies AI Control Rationale

Eliminates AI black boxes and realizes more understandable AI

TOKYO, December 14, 2021 – Mitsubishi Electric Corporation (TOKYO: 6503) announced today that together with RIKEN (The Institute of Physical and Chemical Research) it has developed an AI technology that clarifies the rationale underpinning each AI-based control system to enable such systems to be deployed in infrastructure and various equipment with confidence. Mitsubishi Electric will provide the new technology in its Maisart®* lineup.

* Mitsubishi Electric's AI creates the State-of-the- ART in technology Maisart



New AI technology compared with conventional AI technology

Features of Development

1) Step-by-step use of new AI realizes explicit control rationale

- By estimating the characteristics of the equipment's operating environment, the new AI quickly identifies and quantifies physical parameters using simulation rather than taking measurements with numerous sensors. Past working data can be used to learn equipment sensor values and physical quantities in order to predict future changes in the operating environment.
- Using predicted values and specified parameters, the simulation accurately predicts changes in the operating environment and then creates an optimal control plan in the scheduler.
- By visualizing predicted values, work environment changes and a control plan, the new AI clarifies the control rationale to eliminate black boxes. By increasing the confidence level for equipment control and operational confirmation, the new AI technology will to enable AI-equipped infrastructure, air-conditioning equipment, etc., to be used confidently and allow managers to clarify the basis of their AI control , such as when responding to complaints.

2) New AI clarify causes of equipment malfunction

- The new AI technology determines physical parameters and compares actual past values with predicted or planned values to visualize deviations. If a malfunction occurs, it identifies any deviation from predicted values and then uses physical parameters to identify the cause of malfunction due to controls not being implemented as planned.
- In addition, if the control system operates as planned but produces unexpected results, equipment abnormalities or changes in the operating environment can be quickly recognized, thereby allowing maintenance and recovery operations to be performed before an actual failure occurs.

Development System

	Responsibilities
Mitsubishi Electric Corporation	Construction and verification testing of overall control systems
RIKEN (The Institute of Physical and Chemical Research)	Development of AI technologies and theoretical verification

Future Developments

Mitsubishi Electric expects to develop practical applications for systems that require clear control rationales, such as infrastructure facilities and air-conditioning systems, aiming to commercialize these applications as soon as possible.

Development Background

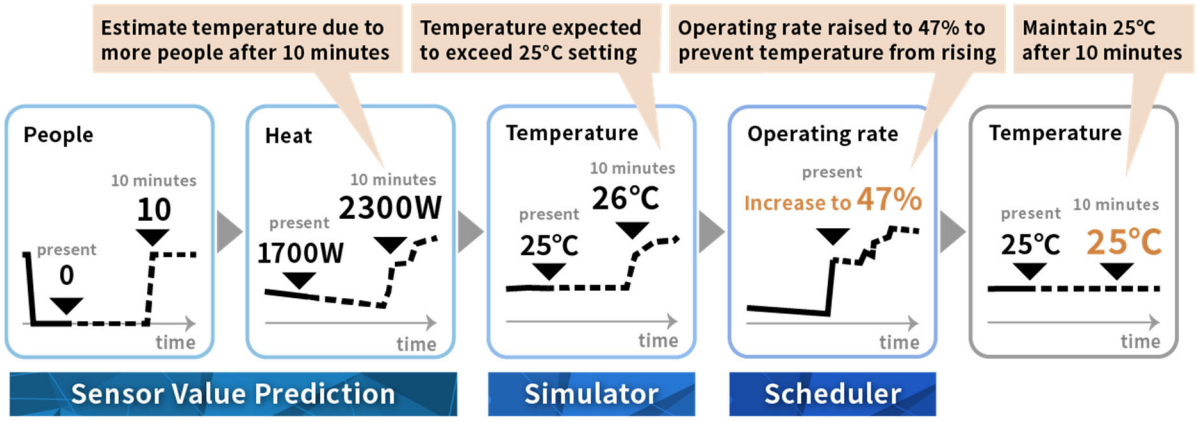
In many AI technologies, including deep learning, the reasoning processes are black boxes, which makes it difficult to specify the basis for control. Efforts are under way to eliminate AI black boxes, including moves to adopt related legal regulations in Europe and the establishment of AI guidelines in Japan. Mitsubishi Electric's new technology, by clearly indicating its basis for the control and the future state of systems when AI is used, is expected to help users better understand the rationale for AI control and use such systems with greater peace of mind.

Feature Details

1) ***Step-by-step use of AI allows for explicit rationale for control***

Conventional AI controls devices using past learning results and current sensor values without specifying the rationale, leading to cases where the control rationale is not clear and thus the AI possibly is not deployed even though expected performance may be good. When deploying AI in plants and factories, air conditioning, etc., equipment, clearly stating the rationale basis for control enables both the control basis and accuracy to be visualized, confidence to be raised, and equipment operation to be confirmed, thereby lowering the hurdles to AI deployment. This also allows facility managers to clarify the basis of control when responding to complaints, such as in regard to building air conditioning. In Mitsubishi Electric's new technology, AI first estimates the operating-environment characteristics and then identifies and quantifies the physical parameters using simulation rather than requiring measurements obtained with numerous sensors. In addition, the AI learns from past data, such as equipment sensor values, and then predicts future sensor values and physical levels. This leads to accurate simulations of future changes in operating environments and helps schedulers to optimize control plans. Moreover, it clarifies the control rationale by allowing users to visualize the control plan and expected future states, thereby eliminating the AI black box.

In the case of air conditioning equipment, for example, AI quantifies room size and insulation, which are characteristics of the operating environment not measured by sensors. Next, it learns past working data, such as the total number of people who might be in a given room, and then predicts the number of people who will enter and leave the room at given times in the future, as well as the room's future ambient heat level not measured by sensors. As a result, it is possible to simulate how the room temperature will change when the air conditioning equipment operates, and the scheduler can use simulation results to derive an optimal control plan (equipment operating rate, etc.). In addition, users can understand the control rationale and the validity of the control plan by looking at the simulation results and the control plan, such as the number of people entering and exiting in the future.



New AI's control rationale and control plan deployed in air conditioning equipment

2) New AI clarifies reasons for device malfunctions

Conventional AI predicts physical parameters and future physical quantities not measurable with sensors, making it possible to compare predicted sensor values, physical quantities, operating environment conditions and control plans with actual values measured with sensors, inferred physical quantities, operating environment conditions and control quantities. Now, however, if a device fails to operate properly, Mitsubishi Electric's new AI compares predicted and actual sensor values for discrepancies and then identifies and the specific sensor and physical quantity that are the basis of the malfunction. In addition, if the system is controlled as planned but does not perform as planned, this may indicate abnormalities in the equipment or changes in the operating environment, which the user can recognize and then perform remedial maintenance before a failure occurs.

About Maisart

Maisart encompasses Mitsubishi Electric's proprietary artificial intelligence (AI) technology, including its compact AI, automated-design deep-learning algorithm and extra-efficient smart-learning AI. Maisart is an abbreviation for "Mitsubishi Electric's AI creates the State-of-the-ART in technology." Under the corporate axiom "Original AI technology makes everything smart," the company is leveraging original AI technology and edge computing to make devices smarter and life more secure, intuitive and convenient.

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About Mitsubishi Electric Corporation

With 100 years of experience in providing reliable, high-quality products, Mitsubishi Electric Corporation (TOKYO: 6503) is a recognized world leader in the manufacture, marketing and sales of electrical and electronic equipment used in information processing and communications, space development and satellite communications, consumer electronics, industrial technology, energy, transportation and building equipment. Mitsubishi Electric enriches society with technology in the spirit of its "Changes for the Better." The company recorded a revenue of 4,191.4 billion yen (U.S.$ 37.8 billion*) in the fiscal year ended March 31, 2021. For more information, please visit www.MitsubishiElectric.com

*U.S. dollar amounts are translated from yen at the rate of ¥111=U.S.$1, the approximate rate on the Tokyo Foreign Exchange Market on March 31, 2021