

Nidec Machine Tool Equips LAMDA Series Metal 3D Printers with Newly Developed Autonomous Learning-Based Automatic Control System

System autonomously learns and responds to changes during the build process, achieving more stable fabrication than conventional methods

Nidec Machine Tool Corporation (Headquarters: Ritto, Shiga Prefecture, Japan; President: Kenji Hamanaka; hereinafter “Nidec Machine Tool”) has developed an Autonomous Learning-Based Automatic Control System for its LAMDA Series*1 metal 3D printers. The system autonomously learns from changes in the build process and automatically adjusts process parameters as the part is built.

Combining a proprietary, patent-pending algorithm with image processing technology, the system adaptively controls laser power and travel speed in response to changes in thermal conditions and geometry during the build process. This adaptive control*3 helps prevent build collapse, including in thin-walled structures and at toolpath intersections where heat accumulation can limit the effectiveness of conventional feedback methods such as PID control*2. The result is more stable builds and more efficient equipment operation.

Nidec Machine Tool will demonstrate the system using its LAMDA500 five-axis metal 3D printer at JIMTOF2026, which opens October 26, 2026, at Tokyo Big Sight.

Five-axis-controlled metal 3D printer
「LAMDA500」



■ Key Features and Benefits of the New System

The newly developed Autonomous Learning-Based Automatic Control System (patent pending) continuously learns in real time as the part is built, autonomously optimizing laser power and travel speed. Conventional open-loop control*4 and PID control can experience build collapse in geometries prone to heat accumulation or in areas subject to rapid thermal changes, even after control gains have been adjusted. In contrast, the new system learns changes in the build state during fabrication and autonomously adjusts control conditions accordingly.

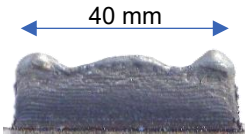
To enable accurate monitoring of build conditions, Nidec Machine Tool has also developed new image processing technology (patent pending). Using images captured by a coaxial camera, the technology accurately detects brightness, which correlates with the melt pool temperature, as well as the distance between the nozzle and the workpiece (work distance). The system uses this information to track changes in build conditions in real time and adjust laser power and travel speed accordingly.

By combining these two technologies, the system can autonomously adjust control conditions while learning the build state in real time, with the operator only needing to set baseline target values. This eliminates the need to collect and train the system on large volumes of data in advance, contributing to stable fabrication and improved equipment operating efficiency.

■ Comparison of the New Autonomous Learning-Based Automatic Control System with Conventional Methods (Material: Maraging steel)

Example 1: Vertical Wall Build

Workpiece dimensions: Width: 40 mm × Depth: 1 bead × Height: 50 mm

Open-loop control (constant laser power and travel speed)	PID control	New system
Heat accumulation significantly affects the geometry.	Adjusting the control gains alone is insufficient to track rapid changes in thermal conditions.	The system autonomously learns from changes in thermal conditions and geometry, determines the optimal output to prevent build collapse, and successfully completes the build.
<p>The build is stopped prematurely due to build collapse.</p> 	<p>The build is stopped prematurely due to build collapse.</p> 	

Example 2: Build at Toolpath Intersections

Workpiece dimensions: Width: 30 mm × Depth: 30 mm × Height: 50 mm

Open-loop control (constant laser power and travel speed)	PID control	New system
The combined thermal and geometric effects at toolpath intersections result in insufficient build height.		The system autonomously learns from changes in thermal conditions and geometry, determines the optimal output to prevent build collapse, and successfully completes the build.
		

Notes

*1 LAMDA Series: A series of metal 3D printers that use directed energy deposition (DED), an additive manufacturing process that melts material using concentrated thermal energy. Nidec Machine Tool's proprietary local shielding technology and monitoring feedback functions enable the fabrication of large, high-quality components without the need for an inert gas chamber.

*2 PID control: A feedback control method that adjusts equipment output smoothly and precisely based on the deviation between a target value and a current value, using proportional (P), integral (I), and derivative (D) control. In this context, it refers to feedback control that monitors the build process using a camera and automatically adjusts laser power and travel speed.

*3 Safety measures: To account for variations in system behavior and uncertainties inherent in machine-learning-based control, safeguards such as output limits are implemented to achieve stable control and help prevent build collapse.

*4 Open-loop control: A method in which fabrication continues under predetermined, constant conditions.