

## **AI-Driven Simulation of Overlay Welding for Active Exploration Of Weld Distortion Scenarios On Cloud-Based Digital Twins**

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The time-intensive simulation component of a digital twin falls short of meeting the demands of a smart system when tackling governing constitutive equations represented as partial differential equations (PDEs). With the significant growth in AI and GPU architecture, digital twins are now transforming into simulation surrogates. These surrogates emulate PDE solves by mapping results rather than performing exhaustive computations. However, developing an AI surrogate for welding simulations requires a platform that facilitates the automated execution of various design experiments guided by adaptive learning algorithms. Moreover, it should establish a correlation between adaptive learning and the refinement of AI surrogates, enabling the tracking and monitoring of surrogate maturity before deployment. This platform streamlines the creation of AI surrogates without delving into the complexities of software and AI. This presentation uses the platform showcasing an overlay deposition application on panel structures. Through 100 interactive and iterative labeling queries to Finite Element Analysis (FEA), this digital twin achieves commendable fidelity. Employing a physics-guided machine learning approach, the system becomes increasingly informed while reducing data dependency. This hybrid digital twin is delivered as a cloud-based tool, empowering engineers to analyze and compare various weld distortion patterns for assessing fabrication scenarios without computational delays.

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Mahyar is the Vice President of Innovation at Novarc Technologies, directing smart welding technologies using industry 4.0 platforms, machine learning, intelligent vision systems, digital twins, IIoT, and simulation tools for welding automation and autonomy. His industry-leading work has resulted in more than 110 published papers and significant awards from the International Institute of Welding, the Canadian Welding Bureau, The American Society of Mechanical Engineers, and Canada's Natural Sciences and Engineering Research Council. Mahyar has a Ph.D. in Computational Weld Mechanics and high-profile experience applying his knowledge to the automotive, aircraft, marine, medical devices, energy, oil & gas, and heavy machinery industries. He holds a Professional Engineering Licence, PMP certificate, IWE designation, ASME FFS, Digital Twins, and Machine Learning Certificates. He is also an adjunct professor in the Materials Department at the University of British Columbia, teaching a signature course on "Welding and Joining of Materials."