Scalable Journey to Intelligent Welding Automation and Human-Machine Collaboration with Metadata and Vision

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The industrial journey from manual welding to intelligent, automated welding depends on the seamless integration of metadata, vision data, and both image and signal processing. To be effective for AI-driven analysis and decision-making, these data streams must be properly collected, time-synchronized, and processed at scale.

Beyond AI-driven insights, the next level of welding automation involves enabling real-time human-machine collaboration. Many aspects of a welder's perception, cognition, and dexterity need to be integrated into an autonomous system. The knowledge and techniques derived from skilled welders are essential in bridging the gap between manual welding and full automation. This hybrid approach fosters adaptive control, autonomy, and ongoing process optimization, pushing welding performance beyond the limits of traditional automation—without relying on explicit robot programming, particularly in high-mix applications.

We introduce a robust data infrastructure designed to capture welding and motion parameters, alongside high-speed vision data, enabling data-driven innovation and providing valuable insights for continuous improvement. We also present the solution for human-machine interaction, including learning from human expertise to achieve full autonomy, all while ensuring minimal disruption to the production workflow and maintaining productivity.