Welding Methodologies for Autonomous Robotic Arc Welding using Computer Vision and Machine Learning

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The integration of artificial intelligence in welding is rapidly increasing, with smart vision systems being a popular front line for data collection in arc welding processes. These systems are designed to learn and improve over time, and continuously enhance the welding process from its current state. Autonomy is a requirement in the current welding industry for eliminating human risk factors and controlling the fabrication process to adapt the relative welding parameters to the weldment's condition. In response to this demand, this work focuses on the development and implementation of vision-based AI models for real-time understanding of weldment conditions under the welding pool. The system is integrated into a pipe welding robot with gas metal arc welding (GMAW) and enables the robot to adaptively react to the pipe's variation. Our main implementation of the system is demonstrated on groove and fillet welding of pipe at 1G position, but the method can adapt to other weld configurations through optimizations and machine learning techniques such as transfer learning. In this paper, we provide examples of successful transfer learning to articulated robots for other weld configurations, demonstrating the versatility and potential of the approach. We also present a platform that collects welding experience globally and provides actionable insights through the analysis of vast amounts of data. Our solution demonstrates the potential of incorporating the perception and cognition of welders into the machine for improving the consistency, throughput, and quality of arc welding processes.

Keywords

Robotic Arc Welding, AI in Welding, Vision system, Adaptive Control, GMAW, Transfer Learning