Autonomous Control of Weldment Variations in Robotic Welding

Ahmad Ashoori, Ringo Gonzalez, Soroush Karimzadeh, Mahyar Asadi

Open root pass welding in Gas Metal Arc Welding (GMAW) poses persistent challenges, primarily due to the unpredictable variations in weldment gap geometries and location of manual tacks. Moreover, the welding industry currently lacks seasoned welders whose expertise is crucial for manually welding these weldments. Even when such welders are assigned, repeatability is also a challenge as they have to adeptly tune many weld variables in real time.

The welding industry is advancing towards autonomous processes utilizing laser or vision systems to address tracking challenges. Yet, adjusting welding (such as wire feed speed) and motion parameters (such as weave and travel speed) for high-quality and consistent welds remains crucial. This presentation introduces an adaptive control method for pipe welding. A vision-based system mimics welders' perception, dynamically adjusting parameters in real-time based on the pipe gap. This enables seamless fusion of root passes which is critical for autonomous robotic welding.

The controller continuously monitors the state condition and communicates necessary process and motion updates to the robot based on real-time discrepancies and the condition of the weldment’s geometries. We tested ten pipes ranging from 6 to 10 inches in diameter, including tacks and natural gap variation. To evaluate the accuracy of our trained network, we employed the intersection over union measure, yielding a commendable accuracy rate of 93.7%. Regarding tack detection, our vision system successfully identified tacks, achieving a detection rate of 96.6%. This closed-loop system has significantly enhanced the quality and consistency of welds throughout the pipe welding process.