Intelligent Co-robots for Complex Welding Manufacturing through Learning and Generalization of Welders Capabilities

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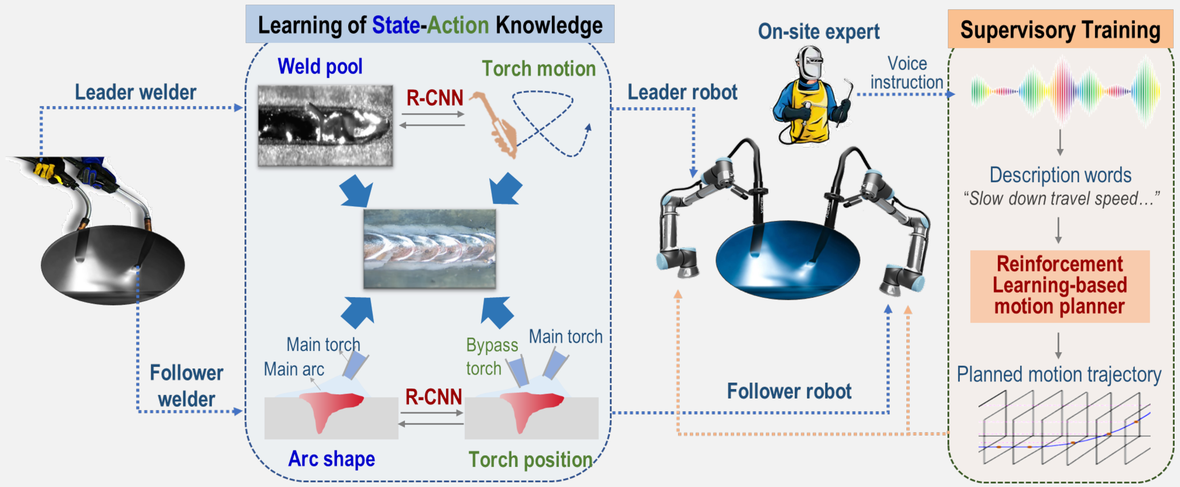
Objective

- Formulate a systematic solution for advancing robotic capabilities on **acquiring domain-specific knowledge**, **interactive learning**, and **adaptive decision making**, for robotic automation of complex welding processes that can only be handled by human in the past.



Intellectual Merit

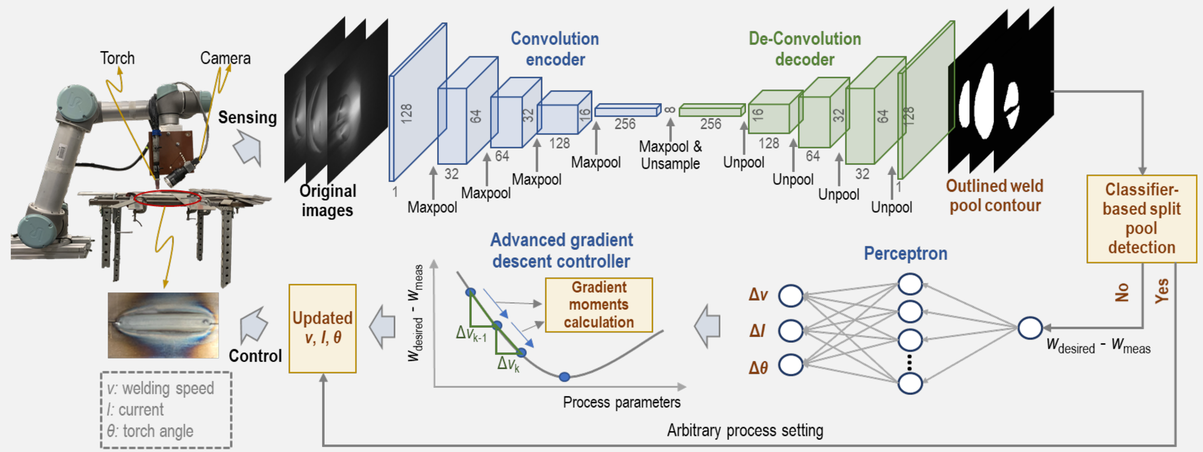
- Dynamic characterization and modeling of weld scene under continuous operation;
- Modeling and generalization of human welders' operations w.r.t weld scene evolution, through explainable deep learning-enabled in-situ sensing data analysis and causal analysis;
- Develop an interactive learning module, to welding robots to be supervised by human welders through the reinforcement learning-based perception of language instructions.

Broader Impacts

- The project contributes to enhancing the science base for robotic control, and facilitate the transition of industrial manufacturing to fully automatic, robotic, and intelligent manufacturing;
- The developed virtual reality test platform for co-robotic welding will be available to the research community, welding companies, and students;
- The multi-discipline research broadens the participation of students from diverse backgrounds in research, advance curricula development in robotic and intelligent manufacturing.

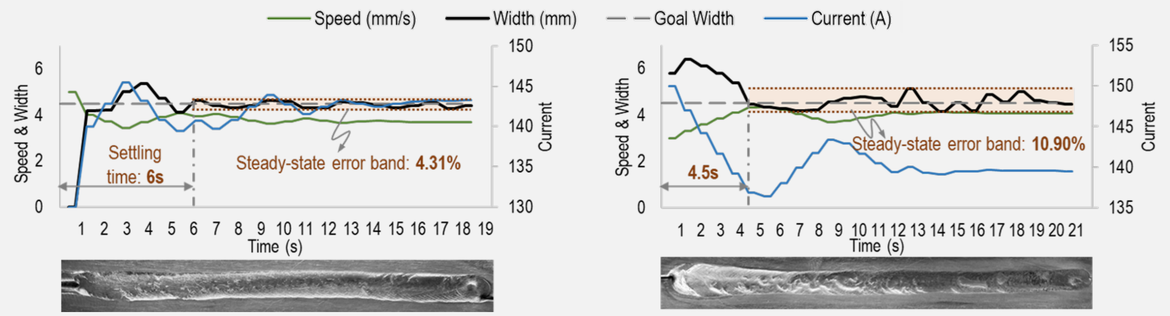
Adaptive Robotic Welding

- Have welding robot automatically and adaptively adjust welding parameters to optimize welding quality, through **in-situ sensing**, **deep learning-based quality prediction**, and **computationally efficient optimization** algorithms, in robotic GTAW.



Automatic Welding Parameter Adjustment

- Upon in-situ weld pool sensing, computationally efficient process optimization has been developed for real-time welding speed, current, and torch angle adjustment to quickly (within 7 adjustment cycles) adjust process to desired status with low error band;
- As a next step, the system will be expanded to more complex welding scenarios.



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