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MECH 493 project: Optimization of weld quality using data-driven models

Background and research goal

Welding is widely used for joining metallic plates but also depositing material on their surface. The latter process, perhaps less known, is called cladding and is commonly used to improve locally quality of materials, or repair damaged components, which can yield significant cost savings and reduce machine down time. Both of these processes require fine-tuned welding parameters to achieve optimal weld quality. If this is not the case, a number of welding defects can arise. Recent advancements (e.g. cold metal transfer welding) allow better control of welding current and voltage to decrease the heat input to weldments, which is important to reduce distortion of plates after welding and reduce the extent of phase transformations in metals.

To find the optimal settings of welding parameters, this project leverages the strength of data-driven models and gradient based optimization techniques. That way the control of the parameters can be performed on the fly. Data will be provided to you, consisting of high-speed camera images, acoustic signals, voltage and current data. You will focus on developing the architecture of machine/deep learning models and using them to optimize the parameters with an appropriate optimization algorithm. This project is part of a research program that aims to provide design tools and advanced structural solutions for a new generation of ships for Canadian Coast Guard and Canadian mining industry.

Tasks to be performed by the student

1) Survey scientific literature to get familiar with (a) cold metal transfer welding, (b) machine learning and (c) optimization
2) Create machine and deep learning models using Matlab/Python
3) Run tests to find out an appropriate optimization algorithm for online control of welding parameters

You are expected to be a fast learner working on the interface between physical testing and computational techniques. Basic experience with Matlab/Python is strongly encouraged. Experience with any of the techniques in (1) is desirable, but not necessary.

Facilities and team:

You will periodically interact with Dr. Jelovica and his research group. You will need to create the models and run initial analyses using your own personal computer. Longer analyses will be run on a local cluster, with the help from the group.