THE UNIVERSITY OF BRITISH COLUMBIA

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MECH 439 Project: Layer-to-layer Process Control of a Metal Additive Manufacturing Process

Background

Additive manufacturing (AM) is a family of production technologies that build up three-dimensional (3D) objects layer-by-layer. AM is particularly popular in the aerospace and biomedical industries due to its flexibility and ability to produce intricate product geometries using a variety of materials. Among different AM technologies, direct energy deposition (DED) is one of the most widely-used processes for metals due to its feasibility for manufacturing of parts with complex geometry, part repair, and remanufacturing.

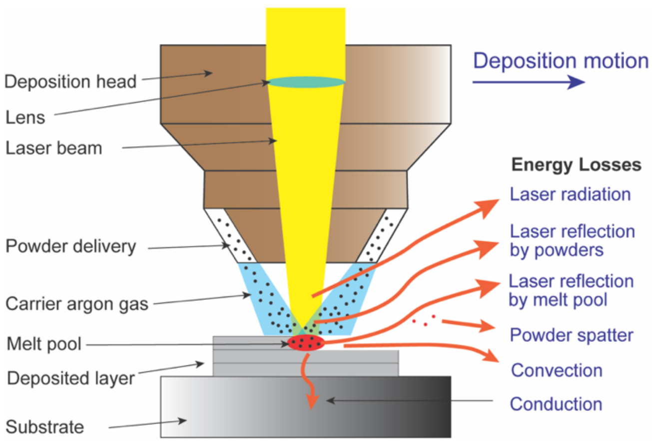

Figure 1: In a laser DED process, a moving laser is used to melt the metal powder which is transported through argon gas to form a desired cross section. It is desirable to control the temperature and dimensions of the meltpool to ensure good bonding between layers and consistent mechanical properties of the resulting part.

One of the key challenges in metal AM processes, is ensuring reliability and repeatability under changing process conditions and for different part geometries. Process control is a promising approach for compensating for changing process conditions. Layer-to-layer (L2L) control updates the input signal for the next layer based on the in-situ information gathered during the printing of previous layers. This allows for longer controller update intervals which enables the optimization of more complex control problems and avoids the need for ultra-fast sensors and actuators.

The project

The goal of the project is to develop a L2L controller that controls the laser power input to stabilize the dimensions of the meltpool and minimizes residual thermal stress and distortion. The student will:

1. Build data-driven models of the layer-to layer dynamics of the AM process using system identification and/or machine learning techniques using data obtained from experiments or high-fidelity simulations.
2. Design a controller to stabilize the meltpool temperature to a desired reference
3. Integrate a thermal stress model to determine optimal meltpool characteristics for minimizing residual stress and distortion.
4. Present their work to the group and prepare a final report.

Facilities and supervision

This project is hosted between the Advanced Manufacturing Processes Lab (Dr. Xiaoliang Jin) and Optimization Algorithms and Control Lab (Dr. Dominic Liao-McPherson). The student will meet regularly with Dr. Liao-McPherson and have the opportunity to interact with graduate students in both labs as appropriate.

Contact Information

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