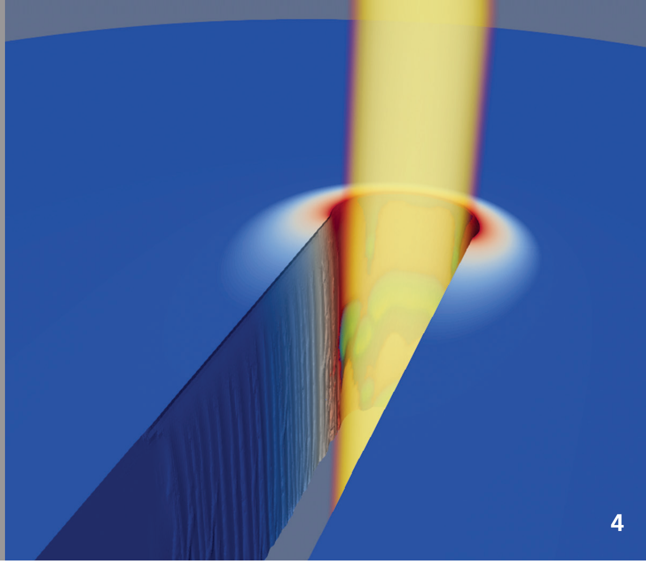

CONVOLUTIONAL NEURAL NETWORKS FOR THE PREDICTION OF CUT SURFACE PROFILES

Task

The mean profile height is one essential quality feature in sheet metal cutting with lasers. Moreover, by predicting surface profiles from in-situ process signals, research can better understand the cutting process and develop approaches for fast closed-loop control of the laser radiation. For this purpose, a relationship must be established between a very fast front signal, which is caused by fast moving waves on the melt front, and the one to two orders of magnitude slower generation of the cut surface profile.

Method

A profile signal is extracted from a dynamic process simulation and from in-situ high-speed videographies of trim cuts on a horizontal line in the upper third of the cut surface. Each discrete profile value is assigned to a preceding section of the front signal as input for a neural network. Because of their short training time and their ability to extract patterns, convolutional neural networks (CNN) are used to analyze the interconnection between the two signals.

Results

Spatially averaging the signal from the melt front improves the quality of the prediction of the surface profile, compared to local signals (train). Amplitude and frequency are already described by the neural model within the correct range (test and infer). By analyzing the relationship between the input variables and the quality of the network as well as the extracted features, Fraunhofer ILT and the Chair for Nonlinear Dynamics of Laser Processing NLD at RWTH Aachen University were able to verify and extend the process understanding.

Applications

Machine learning can make a significant contribution to the data-driven investigation of the interrelationships between dynamic process variables. Using the example of laser fusion cutting, the institutes analyzed whether a model-based control of the laser parameters with neural networks reduces the mean profile height. This methodology can be transferred to processes in which suitable in-situ signals are available for closed-loop control.

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3 Input signal and neural network prediction.

4 Simulation of melt waves.