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Image Processing as a Tool for Data Reduction in the Context of High-Speed Imaging of Laser Materials Processing

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Laser materials processing applications have reached a variety of industry sectors. Lasers are used for cutting, welding, brazing and many other applications [1]. However, process defects still lead to a limitation of industrial applications of the laser. In order to avoid process defects, their causes and mechanisms have to be understood. The highly dynamic process behaviors require a high temporal resolution of the measurement.
A tool to gain insights into the process behavior is high-speed (HS) imaging. It allows the acquisition of data with high temporal and spatial resolution. This certainly results in a large amount of measurement data. However, the measurements cannot directly be linked to physical values, which characterize the IZ and the process behavior. Hence, an approach has to be used reducing the data to values quantifying the process characteristics [2,3].

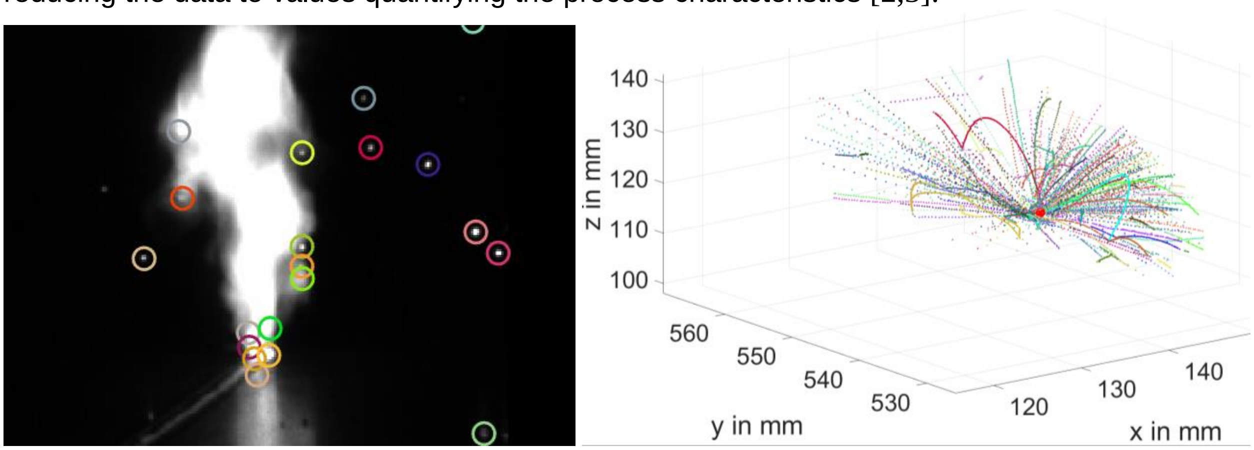

Fig. 1. Exemplary application of image processing – the raw data is acquired by two cameras (exemplary image left) during laser welding, in which spatter positions are detected, and afterwards processed to three-dimensional spatter trajectories (right)

In a first step, dominating characteristics of the IZ are identified. This are for example geometrical features like the width and size of the IZ. Furthermore, the temporal resolution enables the quantification of the process dynamics. The target features are considered for the definition of the camera setup and potential illumination. In order to derive general process knowledge a sufficiently wide spread parameter set has to be investigated in the experiments.
Secondly, a data processing pipeline has to be developed. It takes the raw data as an input and processes it to the target data. For this, prototypes of applicable image processing algorithms are implemented and benchmarked. In case of complex algorithms applied to a data set of a

number of experiments, the transfer of the image processing pipeline onto compute efficient hardware, like graphics processing units (GPUs), might be required. In order to enable a high reusability of the code optimized towards compute efficiency, the new processing steps are integrated into a structured framework.
The measurements are then systematically analyzed to investigate the correlation between the input parameters and the process output. This leads to increased process knowledge that helps to derive countermeasures. This way, new processes can be stabilized and brought to the industrial application.

References

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