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Quantification Model for Capability Evaluation of Optical-Based in-Situ Monitoring System for Laser Powder Bed Fusion (LPBF) Process

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Abstract : Due to the increasing demand for quality assurance and reliability for additive manufacturing, the development of an advanced in-situ monitoring system is required to monitor the process anomalies as input for further process control. Optical-based monitoring systems, such as CMOS cameras and NIR cameras, are proved as effective ways to monitor the geometrical distortion and exceptional thermal distribution. Therefore, many studies and applications are focusing on the availability of the optical-based monitoring system for detecting varied types of defects. However, the capability of the monitoring setup is not quantified. In this study, a quantification model to evaluate the capability of the monitoring setups for the LPBF machine based on acquired monitoring data of a designed test artifact is presented, while the design of the relevant test artifacts is discussed. The monitoring setup is evaluated based on its hardware properties, location of the integration, and light condition. Methodology of data processing to quantify the capacity for each aspect is discussed. The minimal capability of the detectable size of the monitoring set up in the application is estimated by quantifying its resolution and accuracy. The quantification model is validated using a CCD camera-based monitoring system for LPBF machines in the laboratory with different setups. The result shows the model to quantify the monitoring system's performance, which makes the evaluation of monitoring systems with the same concept but different setups possible for the LPBF process and provides the direction to improve the setups.

Keywords : data processing, in-situ monitoring, LPBF process, optical system, quantization model, test artifact
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