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Self-Starting Control Charts for Few-Shot In Situ Monitoring in Customized Manufacturing

Additive manufacturing processes are increasingly characterized by high customization, small batch sizes, and limited availability of historical data, making traditional statistical process control approaches difficult to apply. This work proposes a self-starting monitoring framework for few-shot additive manufacturing environments, enabling effective process monitoring from the earliest production stages without requiring large calibration datasets.

The methodology focuses on the *in situ* monitoring of powder bed fusion processes through the layer-wise analysis of the maximum geometrical deviation between reconstructed and nominal geometries. Since the monitored statistic follows an extreme-value behaviour, the proposed control scheme is developed under a Gumbel-distributed setting, extending self-starting control chart approaches beyond the standard Gaussian assumption.

A further contribution of the work is the introduction of a strategy to estimate the process transient phase and identify the transition toward steady-state conditions, improving monitoring effectiveness during process start-up. Results from a real industrial case study in additive manufacturing demonstrate the effectiveness of the proposed framework for online detection of geometrical defects using layerwise images.

Special/ Invited session

Classification

Both methodology and application

Keywords

Self-starting control chart, Additive Manufacturing, In situ monitoring, Image data mining

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