Data-Based Spatial and Temporal Modeling for Surface Variation Monitoring in Manufacturing

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Abstract

Spatiotemporal processes exist widely in manufacturing, such as tool surface degradation in ultrasonic metal welding and surface shape progression in high-precision machining. High-resolution characterization and monitoring of spatiotemporal processes are crucial for manufacturing process control. The rapid development of 3D sensing technologies has made it possible to generate large volumes of spatiotemporal data in manufacturing. However, critical challenges exist in effectively collecting and analyzing such data. The cost of acquiring high-resolution spatiotemporal data is still high, and there is a lack of systematic approaches for modeling multi-source data and monitoring spatiotemporal processes. This talk will focus on two important problems in the characterization and monitoring of spatiotemporal processes. First, a novel dynamic sampling method has been designed to efficiently measure spatiotemporal processes by using a new flexible design criterion. With same measurement costs, the developed algorithm yields smaller prediction variance than the existing methods, such as random sampling. Second, an innovative surface modeling approach has been developed to cost-effectively characterize surface variations by fusing engineering physics and multi-task learning. Compared with conventional surface models, e.g., kriging methods and data-driven machine learning techniques, the proposed method achieves superior surface prediction performance when only

BIOGRAPHY

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