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Image-Based Feedback Control Using Tensor Analysis

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In manufacturing systems, many quality measurements are in the form of images, including overlay measurements in semiconductor manufacturing, and dimensional deformation profiles of fuselages in an aircraft assembly process. To reduce the process variability and ensure on-target quality, process control strategies should be deployed, where the high-dimensional image output is controlled by one or more input variables. To design an effective control strategy, one first needs to estimate the process model off-line by finding the relationship between the image output and inputs, and then to obtain the control law by minimizing the control objective function online. The main challenges in achieving such a control strategy include (i) the high-dimensionality of the output in building a regression model, (ii) the spatial structure of image outputs and the temporal structure of the images sequence, and (iii) non-iid noises. To address these challenges, we propose a novel tensor-based process control approach by incorporating the tensor time series and regression techniques. Based on the process model, we can then obtain the control law by minimizing a control objective function. Although our proposed approach is motivated by the 2D image case, it can be extended to the higher-order tensors such as point clouds. Simulation and case studies show that our proposed method is more effective than benchmarks in terms of relative mean square error.

Keywords

Tensor Decomposition, High-Dimensional Data, Sptatio-Temporal Process

Special/invited session

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Primary authors: Dr ZHANG, Zhen (Georgia Tech); Dr PAYNABAR, Kamran (Georgia Tech); Prof. SHI, Jianjun (Georgia Tech)

Presenter: Dr PAYNABAR, Kamran (Georgia Tech)

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