Dissertation Defense

DECOMPOSITION-DRIVEN FAST NETWORK MODELING FOR IMAGE-BASED PRODUCTION PROCESS MONITORING

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Abstract

To meet the great demand of the ever-growing global market through process monitoring in real time, a high processing speed is required without loss of performance in industrial processes. In consequence, this work is geared towards developing and utilizing a fast, modified dynamic network modeling (MDNM) for image-based production process monitoring.

To this end, the proposed model which incorporates decomposition technique in dynamic network modeling (DNM) operates in four stages. The first stage involves decomposition of the original image data through the application of decomposition techniques, namely discrete wavelet decomposition (DWD), bi-dimensional empirical mode decomposition (BEMD) and non-negative matrix factorization (NMF).

The second stage utilizes radial basis function and spatial Euclidean distance to cast the decomposed image as a complete network. The third stage detects the community patterns and characterizes organizational behaviors in the image network by minimization of the network energy given by the Potts model Hamiltonian function.

The last stage involves a development and application of a novel modified network-generalized likelihood ratio (MNGLR) statistic for classification of the original image as in-control or out-of-control. Specifically, decomposition is introduced in the first stage for feature extraction associated with image pixels and, principally, for image dimensionality reduction to reduce the number of communities involved in the entire process monitoring, and, consequently, to reduce processing cost with improved performance.

The last stage involves modification of an established network-generalized likelihood ratio (NGLR) statistic through the introduction of a dissimilarity matrix comprising Euclidean distances of the communities taken pairwise. Finally, the proposed method is implemented and evaluated using, first, real-world bio-mimic wings fabricated through additive manufacturing using fused filament fabrication (FFF), second, 2-D surface heatmaps of generated surfaces with different degrees of roughness for each application, the efficiency of NGLR and MNGLR values as classification statistics are compared.

The experimental results show that the modified approach explored in this work has a huge potential for online process monitoring due to its overall improved classification accuracy and processing.