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Bayesian Machine Learning–Based Adaptive EWMA Control Chart with Variable Sample Size

Communication Info

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- (1) statistical process control
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Abstract

This study proposes a Bayesian Support Vector Regression–based Adaptive Exponentially Weighted Moving Average (BSVR-AEWMA) control chart incorporating a Variable Sample Size (VSS) strategy for efficient monitoring of process mean. The proposed framework integrates Bayesian inference with machine learning through Support Vector Regression to dynamically adapt both the smoothing mechanism and the sampling size based on evolving process behavior. A sigmoid-based adjustment function is employed to regulate the sample size in response to the magnitude of detected deviations, allowing smaller samples during stable conditions and larger samples when early warning signals arise. This adaptive structure enhances sensitivity to small and moderate shifts while simultaneously optimizing inspection resources. Extensive simulation study demonstrates that the BSVR-AEWMA control chart consistently outperforms traditional fixed-sample FEWMA and FAEWMA schemes in terms of lower Average Run Lengths (ARLs), reduced run-length variability, and faster and more reliable detection performance. The results confirm that the proposed chart offers a robust, flexible, and cost-effective solution for industrial process monitoring, particularly in dynamic and nonlinear environments. The practical applicability of the method is well suited to modern manufacturing systems where adaptive sampling is essential for balancing detection accuracy and operational efficiency.

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