New Control Charts for Dispersion Monitoring of Multivariate Processes

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Abstract

For signalling alarms sooner when the dispersion of a multivariate process is "increased" (or "decreased"), new multivariate control charting schemes for Phase II process monitoring are proposed. The proposed charts are constructed based on the two one-sided likelihood ratio tests (LRT) for testing the hypothesis that the covariance matrix of the quality characteristic vector of the current process, $\boldsymbol{\Sigma}$, is "larger" (or "smaller") than that of the in-control process, $\boldsymbol{\Sigma}_0$. $\boldsymbol{\Sigma}$is "larger" ("smaller") than $\boldsymbol{\Sigma}_0$ here means $\boldsymbol{\Sigma}$-$\boldsymbol{\Sigma}_0$ ($\boldsymbol{\Sigma}_0$-$\boldsymbol{\Sigma}$) is positive semidefinite and $\boldsymbol{\Sigma}\neq\boldsymbol{\Sigma}_0$. Assuming $\boldsymbol{\Sigma}_0$ is known, the LRT statistics are derived and then used to construct the control charts. Furthermore, we also propose a combined charting scheme, which combines these two one-sided charts for detecting either dispersion increases or decreases. Simulation studies show that the proposed one-sided control charting schemes indeed outperform the existing two-sided-test-based control charts under comparison in terms of the average run length. The applicability and effectiveness of the proposed control chart are demonstrated through two real-life examples.