A Study on Robust Estimators for Detecting Non-random Patterns in Multivariate Control Charts

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Abstract

In the past decade, different robust estimators have been proposed by several researchers to improve the ability for detecting non-random patterns such as trend, process mean shift, and outliers in multivariate Phase I control charts. Though the sample mean vector and the mean square successive difference matrix in the T^2 control chart (Holmes and Mergern, 1993; Sullivan and Woodall, 1996) is sensitive to the detection of process mean shifts or trends, it is less sensitive to the detection of outliers. Conversely, the minimum volume ellipsoid (MVE) estimators in the T^2 control chart (Vargas, 2003) are sensitive to the detection of outliers, but less sensitive to the detection of trends or shifts in the process mean. Hence, we propose new robust estimators that use the merits of both the mean square successive difference matrix and the MVE estimators in Hotelling's T^2 control chart. To compare the detection performance of various control charts, a simulation approach has been adopted to estimate control limits and signal probabilities. Our simulation results show that T^2 control chart using the new robust estimators (T^2_{WD} control chart) achieve a well-balanced sensitivity when detecting non-random patterns. In the first part of the talk, we demonstrate the usefulness and robustness of our new estimators using three numerical examples.

Since these estimators have not been studied before in a multivariate Phase II control chart, in the second part of the talk, an evaluation method for measuring and comparing the detection performances of various T^2 Phase II control charts are proposed. The expected value of the conditional average run length (ARL) and the median of the conditional standard deviation of run length (SDRL) are used to evaluate long-run detection performance. Our simulation results indicate that the T^2 control chart using weighted sample mean vector and the weighted mean square successive difference matrix, obtained from RMINVOL, can achieve well-balanced detection performance in Phase II. Finally, the effects of using these estimated process parameters on the detection performance for various multivariate Phase II control charts are demonstrated in three numerical examples.