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A New Multivariate Dispersion Control Chart

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Extended Abstract

Statistical process control methods are useful for improving or maintaining a manufacturing or service process in a stable and satisfactory state. Nowadays, the problem of monitoring multivariate process control for several related quality variables is of current interest. So far in the literature, a few papers have discussed monitoring process dispersion for cases in which the process has a multivariate normal or non-normal distribution. In this article, we develop a new Phase II dispersion control chart which is independent of the out-of-control process mean, and allows individual observations or multiple observations. It overcomes the problem in many existing covariance matrix control charts of assuming that there are no shifts in the process mean vector which, depending on the existence of shifts in mean, can lead to an increased false alarm rate. The proposed dispersion sample charting statistics are independent among samples. Moreover, the new Phase II dispersion control chart is constructed under the assumption of a multivariate normal distribution.

For a single quality variable, Yang and Arnold [1][2] developed a process dispersion control chart, which is independent of the mean shifts. In this article, we extend the method to the multivariate case. A Shewhart-type and one-sided exponentially weighted moving average (EWMA) dispersion control charts to monitor the upward multivariate process dispersion are developed assuming that there is only an upward out-of-control process dispersion. To investigate how the out-of-control detection performance of the proposed EWMA dispersion control chart, we adopt four scenarios for the variance-covariance matrix. They are increasing in variances, increasing in covariances or both. The results of numerical analysis reveal that the proposed dispersion control chart is powerful in detecting the out-of-control process dispersion with increase in variances whether covariances increase or not, but it will not be easy to detect out the out-of-control process dispersion with only increase in covariances. We compare the out-of-control detection performance among the proposed dispersion chart and the dispersion charts in literature. We find that the proposed dispersion chart always performs better. Furthermore, we give a real example using the semiconductor manufacturing data (SECOM) obtained from University of California, Irvine (McCann and Johnston [3]) to demonstrate the application of the proposed one-sided ZEWMAC chart. The ZEWMAC chart for λ=0.1 shows the first signal at sample 28, and 25 out of 29 out-of-control samples are detected to be out of control. Therefore, in this numerical example the one-sided ZEWMAC chart performs well.

References

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