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ADAPTIVE CHART BASED ON INDEPENDENT COMPONENT ANALYSIS FOR MULTIVARIATE STATISTICAL PROCESS MONITORING

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Abstract. *Early detection of process faults is an important issue for ensuring plant safety and retaining high yield of final product in many industries, especially for process industries. The Independent Component Analysis (ICA) has been successfully applied in non-Gaussian multivariate statistical process monitoring (MSPM) recently. However, the conventional ICA-based monitoring method is not suitable for detecting small shifts of process since the monitoring statistic of ICA considers only the magnitudes of the most up-to-date samples but ignores the direction of process mean shifts. To overcome the drawback, this study aims to develop an adaptive chart based on ICA to enhance the fault detectability. The proposed method utilizes the Exponential Weighted Moving Average (EWMA) to predict the patterns of process mean shift and then constructs the adaptive monitoring statistic by combining the process mean shift and the ICA-extracted components. The proposed method is implemented by using two simulation studies to demonstrate the faults detection of process mean shifts and the small changes of system parameters. Furthermore, a real system, the Tennessee Eastman process, is conducted to evaluate the efficiency of the proposed method. The results show that the proposed method possesses superior performance when compared with various monitoring schemes.*
Keywords: MSPM, PCA, ICA, EWMA, Adaptive chart

1. **Introduction.** Fault detection and isolation is a critical issue in several application areas, such as aircraft systems [1-3], DNS traffic anomaly detection [4], and so forth. Moreover, in order to ensure plant safety and process stability as well as high quality of final products, quickly detecting fault conditions of a process becomes an important task, especially for pharmaceutical, food, chemical, and semiconductor industries.

Due to the rapid development of computer technique, hundreds or thousands of process variables can be on-line recorded. Thus, the Multivariate Statistical Process Monitoring (MSPM) plays an important role for on-line monitoring of process status. The Principal Component Analysis (PCA) method can project high dimensional data onto a lower space that contains the most variance of the original data and hence becomes a popular pre-processing tool for MSPM. Jackson [5] initially applied the PCA method and proposed a T^2 control chart for principal components. Further, Jackson and Mudholkar [6] introduced the residual analysis for the PCA method. After the initial work, the alternative PCA-based approaches have thereafter been developed in literature. Ku *et al.* [7] presented a dynamic PCA method to monitor time-dependent measurements. Dong and McAvoy [8] used principal curves and neural networks to develop a nonlinear PCA method. Hubert *et al.* [9,10] proposed a robust PCA algorithm to filter out outliers before building the reference model. Recently, Wang and Tsung [11] proposed an adaptive T^2 chart to monitor