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DETERMINING THE CONTRIBUTORS FOR A MULTIVARIATE SPC CHART SIGNAL USING ARTIFICIAL NEURAL NETWORKS AND SUPPORT VECTOR MACHINE

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Abstract. *Due to the rapid change of technology along with advanced data-collection systems, the simultaneous monitoring of two or more quality characteristics (or variables) is necessary. Multivariate Statistical Process Control (SPC) charts are able to effectively detect process disturbances. However, when a disturbance in a multivariate process is triggered by a multivariate SPC chart, process personnel are usually only aware that there are assignable causes causing the multivariate process to be out-of-control. It is very difficult to determine which of the monitored quality characteristics is responsible for this out-of-control signal. This determination is crucial for process improvement, for it can greatly help identify the root causes of the malfunction. As a consequence, this determination becomes a promising research issue in multivariate SPC applications. In this study, we are motivated to propose two mechanisms to solve this difficulty: (1) the integration of the neural network (NN), the Hotelling T^2 SPC chart and RAM; and (2) the integration of the support vector machine (SVM), the Hotelling T^2 SPC chart and RAM. The performance of various process designs was investigated in this study and is compared with the existing RAM method. Using a series of simulations, the results clearly demonstrate greatly enhanced identification rates.*

Keywords: SPC, Disturbance, Multiple quality characteristics, Neural networks, Support vector machine

1. **Introduction.** With advanced technologies and data-collection systems, there are more and more quality characteristics to jointly describe the products. Processes with two or more quality characteristics are commonly seen in industries. Statistical process control (SPC) charts are widely and successfully used in monitoring the processes. However, with the increased numbers of quality characteristics, the traditional univariate SPC charts cannot effectively monitor multivariate processes. As a consequence, the use of multivariate SPC charts becomes increasingly popular.

When applying multivariate SPC charts to monitoring multivariate processes, an out-of-control signal would be triggered if disturbances were to occur. In order to bring the process back under control, proper remedial actions should then be taken. Nevertheless, the use of "proper" remedial actions mainly depends on which set of quality characteristics is responsible for the signal.

In a multivariate process, although process personnel can employ the multivariate SPC charts to determine the status of a process, they usually have difficulties in determining which of the monitored quality characteristics trigger the out-of-control signal. When the SPC signal is generated, process personnel could take more time (and of course,