MULTIVARIATE CONTROL CHARTS FOR COMPLEX PROCESSES

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Abstract

Frequently manufactured items need the values of several different quality characteristics for an adequate description of their quality. Each of a number of these quality characteristics must satisfy certain specifications. The quality of the product depends on the combined effect of these characteristics, rather than on their individual values. When the number of quality characteristics is high the use of conventional methods may be very inappropriate. Moreover with complex products, generally, not all of quality characteristics are equally important. If a particular item has some leading quality characteristics and some moderate ones it will be convenient to employ a control procedure that is based on the leading quality characteristics but enables to identify special causes that may affect the overall process. The paper deals with multivariate control charts for complex processes and the influence function of eigenvalues derived from a generalized principal components analysis is proposed to distinguish between random and special causes of variation. Generally assignable causes that affect the variability of the output do not increase significantly each component of total variance. Instead, they may have a large influence in some components and small effect in the remaining directions. For this reason, it seems promising to detect any significant departure from the stable level of variability according each component. An approach to build up such control charts consists to monitor the stable level of variability of the process according to the directions settled by a generalized PCA which is based on the leading variables. To find such principal components Rao [1964]'s approach on principal components of instrumental variables will be used. Then the influence functions of eigenelements of the generalized PCA may be evaluated by using the perturbation theory of eigenvalue problems, Tanaka & Mori [1995]. Finally, the derived influence functions are used to set up control charts to monitor process variability. The decision procedure is the same as in all control charts. It means that, points lying outside the control limits indicate the time at which special causes that effect the variability are present in the process. A numerical example from the field of automobiles will be used to illustrate the proposed control charts and compare them with some existing ones.

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