NONPARAMETRIC CONTROL CHARTS
BASED ON MAHALANOBIS DEPTH

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Abstract
This study concerns the use of r and Q control charts based on data depth to control process involving multivariate quality measurements. In this paper, firstly the concept of data depth is introduced in order to construct quality control chart structures, the characteristics of data depth are given and statistics based on this concept are obtained. Following this, the structures and interpretations of mainly nonparametric r and Q control charts are explained for the Mahalanobis depth measure used in statistical quality control by means of an example.

Keywords: Control Charts, r Chart, Q Chart, Multivariate statistical process control, Depth function.

1. Introduction
In statistical process control, control charts are very important tools for monitoring and/or controlling whether a manufacturing process is statistically in control or not. Shewart’s (X, X̄) and CUSUM charts are widely used for this purpose. In addition to their efficiency, these charts are preferred because they are simple to construct and interpret. However, as these charts are based on an assumption of normality of the quality variable and are used when there is only one quality variable, they are not always appropriate. In many cases, two or more variables may need to be monitored, and following these two (or more) quality variables separately may be misleading. The Type I error α occurring when the variables are monitored separately differs from the Type I error α occurring when the variables are monitored simultaneously. Therefore, multivariate control charts are required when there is more than one quality variable. Monitoring the process of related variables is usually called a multivariate quality control problem.

Studies of multivariate quality control were first carried out by Hotelling in 1947; later, Hicks, Jackson, Crosier, Hawkins, Lowry, Montgomery, Pignatiello, Runger, Tracy, Young, Mason, Wadsworth, Alt and others also carried out studies on this subject. The work of these authors is given in [5], together with detailed references. The multivariate control charts considered by these authors are also based on the normality assumption

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