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A S^2 EWMA Control Chart Based on a Johnson's Type Transformation ⋆

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Abstract

This article demonstrates how a four parameters (bounded) Johnson S_B transformation combined with an EWMA approach can be used to monitor the sample variance of a process. The computation of the parameters of the Johnson S_B transformation and the control limits are explained. The distributional properties of the transformed sample variance are derived. An easy-to-use table is provided and an illustrative example is given. An optimal design strategy based on the *ARL* is presented and a list of optimal design parameters is provided.

Key words: Sample Variance, EWMA, Johnson S_B distribution

1 Introduction

Statistical Process Control (SPC) is a collection of statistical techniques able to provide a systematic monitoring of a manufacturing process, which allows high quality final products to be produced. Among these techniques, during the last decade, the use of the Exponentially Weighted Moving Average (EWMA) statistic as a process monitoring tool has become more and more popular in the statistical process control field. Implementing an EWMA chart to control a manufacturing process requires the computation and plotting of a random variable which is a function of the current sample statistic and of the past samples collected from the process. This allows the EWMA to prevail over the traditional Shewhart chart in terms of statistical sensitivity when small shifts in the process position and/or dispersion are expected. The properties and design strategies of the EWMA control chart for the mean (introduced by Roberts [19]) have been thoroughly investigated by Robinson & Ho [20], Crowder [9] [10], Lucas & Saccucci [16] and Steiner [22]. The use of the EWMA as a tool for monitoring the process variability has received attention by Wortham & Ringer [24], Sweet [23], Ng & Case [18], Crowder & Hamilton [11], Hamilton & Crowder [13] and MacGregor & Harris [17], Gan [12], Amin et al. [2], Lu & Reynolds [15] and Acosta-Mejia et al. [1] and, more recently, by Castagliola [4], Castagliola et al. [7,5,6,8] and Shu & Jiang [21]. In his paper, Castagliola [4] developed a new two-sided S^2-EWMA control chart as an extension of the Crowder & Hamilton [11,13] initial approach, but based on a three parameters logarithmic transformation. The main advantages of this EWMA-ln-S^2 control chart are (a) the easy-to-use scheme for computing the control limits and the parameters a, b and c of the logarithmic transformation; (b), the improved performance in terms of normality/symmetry of the transformed sample variances; and (c) the same statistical sensitivity

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