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An Evaluation of Average Run Length of MaxEWMA and MaxGWMA Control Charts

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Abstract— Exponentially weighted moving average control chart (EWMA) is a popular chart used for detecting shift in the mean of parameter of distributions in quality control. The objective of this paper is to compare the efficiency of control chart to detect an increases in the mean of a process. In particular, we compared the Maximum Exponentially Weighted Moving Average (MaxEWMA) and Maximum Generally Weighted Moving Average (MaxGWMA) control charts when the observations are Exonential distribution. The criteria for evaluate the performance of control chart is called, the Average Run Length (ARL). The result of comparison show that in the case of process is small sample size, the MaxEWMA control chart is more efficiency to detect shift in the process mean than MaxGWMA control chart. For the case of large sample size, the MaxEWMA control chart is more sensitive to detect small shift in the process mean than MaxGWMA control chart, and when the process is a large shift in mean, the MaxGWMA control chart is more sensitive to detect mean shift than MaxEWMA control chart.

Keywords — Maximum Exponentially Weighted Moving Average, Maximum General Weighted Moving Average, Average Run Length

I.INTRODUCTION

SOME of the most widely used form of control charts such as $\bar{X}-R$ charts and Individuals charts. These are often referred to as Shewhart control charts and it was first introduced by Walter Shewhart. The Shewhart control charts are sensitive to detecting relatively large shifts in the process mean. An alternative control chart is primarily used to detect smaller shifts, namely Exponentially Weighted Moving Average (EWMA) control chart. Roberts, S.W. [10] originally developed the EWMA control chart. It has been used in various industries especially the chemical industry. An abbreviation of EWMA control chart, this technique is used in statistical process control to monitor the output of manufacturing process by traking the moving average of performance over lifetime of the process. The Cumulative Sum (CUSUM) procedure introduced by Page[2] and the Shiryaev-Roberts procedure introduced by Shiryaev for the Brownian motion case

Its properties have been throughly studies in the literature [see, e.g., Hawkins and Olwell [1]. A numerical comparison of EWMA and CUSUM control charts was given by Lucas and Saccucci [7] and Yashchin [3], [4]. Srivastava and Wu [8], [9] and Wu [12] considred design of the optimal EWMA control chart and compared it with the CUSUM and Shiryaev-Roberts control charts. Xie [6] was introducing the MaxEWMA control chart and Chen et al. [5] extended Xie's research. The MaxEWMA combines two EWMA charts into a single chart such that its can detect the change-point in the process mean and variability.

A common characteristic used for comparing the performance of control charts is Average Run Length (ARL), the expected number of observations taken from an in-control process until the control chart falsely signals out-of-control is denoted by ARL_0. An ARL_0 will be regarded as acceptable if it is large enough to keep the level of false alarms at an acceptable level. A second common characteristic is the expected number of observations taken from an out-of-control process until the control chart signals that the process is out-of-control is denoted by ARL_1.

The objective of this paper is concerned with the use control charts for detecting change-point in mean of exponential distribution. Our goal is to provide a comparative study of the main competitor control charts: the Maximum Exponentially Weighted Moving Average (MaxEWMA) and Maximum Generally Weighted Moving Average (MaxGWMA) control chrts when the observations are exponential distribution.

This paper is divided into five section: in Section I, we introduce the statistical process control charts. Section II presents the characteristics of the MaxEWMA and MaxGWMA control charts. In Section III, we show the results of comparison when the process are exponential distribution. Finally, we present the conclusions.

II. THE CHARACTERISTICS OF CONTROL CHARTS

A. MaxEWMA control chart

Xie [6] was first introduced the MaxEWMA control chart. The MaxEWMA control chart can be use to monitor the process mean and variability. In this section, we describe the characteristics of MaxEWMA control chart for exponential distribution. The MaxEWMA control chart based on a weighted average of current and previous data. In this article, we consider the simplest version of the change-point detection problem where we assume that the observations are exponential distributed before the change-point in the mean with a common density function and after the change-point in the mean with a different density function, both of which are considered known.

Let X be a quality characteristic of a process and it has a exponential distribution with the process mean (β). In situation the process is in-control with exponential parameter $\beta=\beta_0$ and the process is out-of –control with exponential parameter