附件一

行政院國家科學委員會補助專題研究計畫 ■成果報告

損失函數管制圖之研究

計畫類別：■個別型計畫　□整合型計畫
計畫編號：NSC　98-2118-M-004 -005 -MY2
執行期間：98　年 8 月 1　日至 100　年 7 月 31　日

執行機構及系所：國立政治大學統計學系

計畫主持人：楊素芬　教授
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計畫參與人員：林政憲 歐嘉玲 葉金田 呂雨築 楊志清 鄭鈞遠
蔡佳宏 沈依潔

成果報告類型(依經費核定清單規定繳交)：□精簡報告　■完整報告

本計畫除繳交成果報告外，另須繳交以下出國心得報告：
□赴國外出差或研習心得報告
□赴大陸地區出差或研習心得報告
■出席國際學術會議心得報告
□國際合作研究計畫國外研究報告

處理方式：除列管計畫及下列情形者外，得立即公開查詢
□涉及專利或其他智慧財產權，□一年■二年後可公開查詢

中　華　民　國　100　年　10　月　10　日

(二)中、英文摘要及關鍵詞 (keywords)

中文摘要

製程管制的目的在能快速診斷出製程上平均數 和/或變異數之異常。唯隨著生產型態的改變，
傳統的舒華特管制圖並不一定都具高度偵測出製程失控的能力，是以設計符合各種生產型態及能快速診斷出製程發生變異的適當管制技術是迫切必要的。

本二年期計畫主要探討如何設計單一管制圖以同時偵測單一製程和多階段相依製程之平均值和變異數或製程不合格率和不合格數，爲提升偵測速度並同時考慮適應性管制技術。我們完成，1. 單一製程下(1)單一計量值品質特性平均損失管制圖之設計，如適應性(含VSI ，VSS, VSSI 和VP)平均損失管制圖以用於同時偵測製程平均值和變異數而達到管制損失和製程品質之目的並提出其績效量測方法;(2)多元品質特性之平均損失管制圖以用於同時偵測製程平均值向量和變異數向量，並提出其績效量測方法;(3)設計單一計數值品質特性之平均損失管制圖，適應性平均損失管制圖，多元計數值品質特性之管制圖和其適應性管制圖以管制損失和製程不合格率或不合格數，並提出其績效量測方法; 2. 推廣(1)(2)(3)的研究結果爲多階段相依製程之管制技術; 3. 完成 1 和 2 內部份的EWMA和CUSUM平均損失管制圖之設計以加速提升小偏移失控之偵測力; 4. 上述的管制技術都以數據分析結果與相關文獻之管制圖做績效比較，結果顯示我們的方法績效大多比較好些。這些研究目前皆尚未有文獻探討，是以具有學術價值，在實務應用上相信對高科技公司或精密工業之品質提升更是有用。另外，這些方法也可應用於服務業上，我們已有應用於服務業數據的一篇文章被接受。另外多元計數值品質特性之平均損失管制圖應尚有探討空間。

關鍵詞: 損失函數,管制圖,相依製程,多元品質特性,馬可夫鍊.

英文摘要

A single chart, instead of X-bar and R charts or X-bar and S charts, to monitor simultaneously the process mean and variability if found would cut down the time and effort. Some researches have been done in finding such charts. In reality, process target is more important than process mean and in-control process mean may not be the target. Some much easier new average loss charts and weighted average loss charts with adaptive/fixed control scheme are proposed to detect the increases in the difference between the process mean and the target and the process variability for a single process step and multiple process steps. Furthermore, numerical analyses demonstrated that these average loss charts with adaptive control scheme are performs better than the average loss charts with fixed control scheme, the traditional joint X-bar and S charts and others. For better performance in detecting small shifts in mean and variance, EWMA and CUSUM loss charts are developed. Multivariate average loss chart with fixed control scheme and adaptive control scheme are also addressed. The process control scheme for dependent process steps with attribute data is discussed. All these results could be applied not only in technology industry but in service industry, like, one of the two accepted papers was applied in the process of service industry. Some study manuscripts are writing. We hope at least 4 reports of the project could be finished.

Keywords: Loss function, control chart, dependent process steps, multivariate characteristics, Markov chain

(三)報告內容

A single chart, instead of X-bar and R charts or X-bar and S charts, to monitor simultaneously the process mean and variability if found would cut down the time and effort. In the last ten years, a few researches in this area have been done, such as the T chart (Chen, Cheng and Li (1996)), the single B chart (Grabov and Ingman (1996)), the Likelihood Ratio chart (Sullivan and Woodall (1996)), the Max chart (Chen and Cheng (1996)), the MSE chart (Cheng and Spiring (1998)) and the non-central Chi-square chart (Costa and Rahim (2004)). Cheng and Thaga[1] gave an overview on the single charts developed. Later, some advanced study, like, the weighted-loss chart (Wu and Tian (2006)), a loss-Function based adaptive control chart (Wu, Wang and Wang (2009)), LRT chart (Zhang, Zou, and Wang 2010), the SR chart (Zhang, Zou, and Wang (2011)) and the SPRT chart (Ou, Wu and Goh (2011)) are addressed.

■ In industry, quality and loss of products are important competitive factors among companies. Loss function is widely used in industry to measure the loss due to poor quality (Spiring, and Yeung (1998)) From Taguchi's philosophy (Gopalakrishnan,. Jaraiedi, Iskander and Ahmad (2007)), the target value is a vital process measurement. However, all the above papers of the single charts discussed either not the loss-based charts or the loss-based charts but assuming the process mean was the process target. In practice, the in-control process mean may not be the target and the loss is important. Hence, a single loss related control chart is effective if it could detect the increases in the difference between the process mean and the target and the process variability with smaller loss. For improving its detecting ability, the adaptive control scheme is considered. Many papers demonstrated its effectiveness, like Chengular, Arnold and Reynolds (1989), Costa (1998), Reynolds and Stoumbos (2001), Zhang and Wu (2006), Costa and Magalh (2007), Costa and Rahim (2008), Yang and Chen (2009), Yang and Yang (2009), Yang and Yu, Yi (2009), Wang and Wang (2009), Prajapati and Mahapatra (2009), Yang (2010), Yang and Chen (2010),Yang, Ko and Yeh (2010).

The average loss chart with fixed and adaptive control scheme is proposed. To detect small shifts in process parameters, EWMA and CUSUM average loss charts are extended. The adaptive control scheme and dependent process steps are also addressed in the EWMA and average loss charts. Another statistic MSE chart with adaptive control scheme is also proposed. The asymptotic distribution of weighted loss statistic is derived and the optimal weighted loss chart and EWMA weighted loss chart are constructed. These results overcome Wu, Tian and Zhan (2005)'s problem since they do nothing about EWMA average loss charts. Bivariate average loss chart is also studied and for detecting small shifts in mean vector and covariance, the adaptive control scheme is proposed. For dependent process steps with dependent attributes data, the EWMA control charts are proposed. The performance of all the proposed charts is measured using Markov chain approach

and calculated by optimization techniques. Numerical examples demonstrated their performance.

In the two-year project, we finished the following topics.

1. Shewhart-type average loss charts with fixed control scheme for a single process step.
2. Shewhart-type average loss charts with fixed control scheme for double process steps.
3. EWMA average loss charts with fixed control scheme for a single process step.
4. EWMA average loss charts with fixed control scheme for double process steps.
5. EWMA average loss charts with adaptive control scheme for a single process step and double process steps, respectively.
6. EWMA average loss charts with adaptive control scheme for double process steps.
7. CUSUM average loss charts with fixed and adaptive control scheme for a single process step.
8. Shewhart-type weighted average loss charts with adaptive control scheme for a single process step
9. Shewhart-type weighted average loss charts with adaptive control scheme for double process steps.
10. EWMA weighted average loss charts with fixed and adaptive control scheme for a single process step.
11. EWMA weighted average loss charts with fixed and adaptive control scheme for double process steps.
12. Adaptive control charts for dependent process steps with attribute data.
13. Bivariate average loss chart with fixed and adaptive control scheme for a single process step

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Numerical examples demonstrated that most of the proposed control charts with adaptive control scheme have better performance than the Shewharts charts, the proposed charts with fixed adaptive control scheme and others charts in detecting small to mediate shifts in the difference of mean and target and process variance.

In above study, probability distributions, approximated probability distributions, Markov chain approached, Numerical analysis and optimization techniques are used to derive the distributions of statistics and calculate average run lengths for various control charts, respectively.

Two submitted papers have been accepted, two papers have been presented in international conference and some manuscripts are writing.

Accepted papers:

1. Optimal variable sample size and sampling interval MSE chart, 2011, The Service Industries Journal. Accepted. (SSCI)

2. Using cause selecting control charts to monitor dependent process stages with attributes data, 2011, Expert Systems with Applications. Accepted. (SCI)

International conference papers:

1. A New Chart for Monitoring Targets and Variances on Dependent Process Steps, 2010, SPWA, OSAKA JAPAN.
2. A New EWMA Loss Chart, 2011, ISI, Dublin, Ireland.

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附件二

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估
   - ■ 達成目標
   - □ 未達成目標（請說明，以 100 字為限）
     - □ 實驗失敗
     - □ 因故實驗中斷
     - □ 其他原因

   說明：研究內容與原計畫相符程度高達 85%以上，可以寫成文章至少 4 篇，目前已有 2 篇被接受，1 篇投稿期刊，其他內容正在整理和撰寫中.

2. 研究成果在學術期刊發表或申請專利等情形：

   論文：■已發表 ■未發表之文稿 ■撰寫中 □無

   專利：□已獲得 □申請中 □無

   技轉：□已技轉 □洽談中 □無

   其他：（以 100 字為限）

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以500字為限）

In the past ten years, using a single control chart to monitor both mean and variance under a single process step has been discussed. However, under a single process or dependent process steps, the related study of the average loss control charts for a single quality characteristic or multiple quality characteristics with variable data or attribute data has not addressed. In the past two years, we proposed various single adaptive (or fixed control scheme) average loss charts (Shewhart-type or EWMA or CUSUM loss chart) to monitor process mean and variance for a variable quality characteristic, attribute quality characteristic, and multivariate quality characteristics under a single process step and dependent process steps. Those charts have better detection performance than other proposed charts from data analyses results. Hence, they would have definite contribution in academic study. Those charts could also be applied to detect special causes occurred in a real process step or dependent process steps.

So far, we have two related papers have been accepted by SCI and SSCI journals. Some study papers are writing. We expect at least 4 papers could be submitted to journals.

We did little in the study of Multivariate loss charts for attributes data. However, the study should have potential space.

Keywords: Loss function, control chart, dependent process steps, multivariate characteristics, Markov chain.

附件四

國科會補助專題研究計畫項下出席國際學術會議心得報告

已於 NSC 網頁中上載