QUANTIZATION EFFECT ANALYSIS OF DIGITAL SYSTEM AND ITS DESIGN BASED ON CELL MAPPING

Liang Wang [1], Qiu-An Huang[1,2], Wei-Ming Yang [2] and Wang Bing-Wen[1]

[1]Department of Control Science and Control Engineering
Huazhong University of Science and Technology, WuHan, P. R. China

[2]Faculty of Physics and Electronic Technology
Hubei University, Wuhan, P.R. China
Corresponding author email: Q.A.Huang@Hubu.Edu.Cn

Abstract. Quantization problem in digital control system has attracted more and more attention in these years. Several quantization models have been proposed to design and analyze the digital control system with quantization effect. But most of these methods still can't give the detail analysis for impact of quantization to controllability, robustness, etc. They could give the stabilizing solution, but can't deal with the common optimal design problem. In this paper, we present a new model for quantization based on cell mapping concept. This new model could clearly describe the global dynamics of quantized system. The impact of quantization to the main characteristics of control system could be well analyzed by this model. Corresponding finite precision control design method for common optimal problem is also proposed. As an example, a global warming offset design based on cell method is shown at last.

Keywords. Quantization effect, digital controller, cell mapping, Bellman dynamic programming, finite precision design.

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1   Introduction

Now almost all the advanced control systems are digital control system. Its infinite precision design theory and application have been well studied for a long time. However, for the finite word length limitation resulting from actual devices, modules or subsystems, the system performance will always deviate from the ideal performance in practice. So the quantization effects need to be considered when a digital controller is designed and implemented, especially for the fixed-point system. The new motivation for considering quantization in feedback control systems is the recent boom of interest in networked control systems. In these systems, the output measurements to be used for feedback are transmitted via a digital communication channel.

Some researchers are concerned with the finite word length (FWL) effects in digital controller. For example, the calculations performed by digital