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CONSTRAINED PI TRACKING CONTROL FOR THE OUTPUT PDFS BASED ON T-S FUZZY MODEL

Yang Yi[1] and Lei Guo[1,2]

[1]Research Institute of Automation
Southeast University
Nanjing 210096, P. R. China
yiyangcontrol@163.com; lguo@buaa.edu.cn

[2]Institute of Instrumentation and Opto-Electronics Engineering
Beijing University of Aeronautics and Astronautics
Beijing 100083, P. R. China

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Abstract. *This paper presents a new proportional-integral (PI) tracking control strategy for general non-Gaussian stochastic systems based on neural network approximation and T-S fuzzy model identification. The objective is to control the conditional probability density function (PDF) of system output to follow a desired PDF. Following the B-spline approximation on the measured output PDFs, the PDF tracking is transformed to a constrained dynamic tracking control problem for weighting vectors. Different from previous related works, the time delay T-S fuzzy model is applied to identify the nonlinear weighting dynamics. Meanwhile, an improved PI controller design procedure based on LMIs is proposed which can guarantee the required tracking convergence. Furthermore, the robust peak-to-peak measure is applied to optimize the tracking performance.*
Keywords: Probability density function, Non-Gaussian stochastic systems, PI controller, B-spline neural network, T-S Fuzzy model, Peak-to-peak performance

1. **Introduction.** Control and filtering for Gaussian systems have received much attention in the past decades (see [1-4]), where only mean and variance are the objectives in the design. For non-Gaussian systems, mean and variance are insufficient to characterize the stochastic properties in terms of signal processing. As such, with the development of advanced instruments and data processing techniques, a group of new strategies that control the shape of output PDF for general stochastic systems have been developed [5-11]. Different from previous stochastic control approaches, the variables can be non-Gaussian and the concerned output is, in fact, the whole shape of output PDF.

In order to obtain some feasible design algorithms, B-spline neural network has been introduced to approximate the output PDF so that the problem can be reduced to a tracking control for weighting systems (see [6, 9, 10, 11]). However, three drawbacks still exist in PDF tracking problem: (i) Due to lack of model knowledge, most published results only concerned linear precise models (see [6, 9, 10]). The nonlinear models used in [11] were actually difficult to obtain through traditional identification approaches; (ii) The constraint (see [9, 11]) related to the characteristics of PDF was neglected in most existing results. It is noted that without such a constraint, the weighting vectors are irrelevant to a PDF; (iii) It is noted that B-spline expansions and weight modeling may result in modeling errors, which were ignored in most cases [5-11]. In [10], a bound was given to show how the modeling error influences on the tracking error. However, only analytical results were provided which was difficult to use for controller design.