Adaptive Safe Experimentation Dynamics for Data-Driven Neuroendocrine-PID Control of MIMO Systems

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ABSTRACT

A safe experimentation dynamics (SED) is a game theoretic method that randomly perturbs several elements of its design parameter to search for the optimal design parameter. However, the accuracy of the standard SED can be further improved by proposing an adaptive SED method. This paper aims to develop a method based on adaptive safe experimentation dynamics (ASED) where the updated design parameter is modified to adapt to the change of the objective function. The proposed ASED is then used to tune the parameters of the neuroendocrine-PID controller. The neuroendocrine-PID controller, which is based on the secretion rule of hormone regulation in the human body and well known for its high control accuracy, is chosen to improve the conventional PID controller structure for the MIMO systems. Moreover, it is shown that the proposed neuroendocrine-PID based ASED can solve an unstable convergence problem in the existing neuroendocrine-PID based Simultaneous Perturbation Stochastic Approximation (SPSA). The performance of the proposed neuroendocrine PID based on the ASED method is evaluated by tracking its performances and computational time. Additionally, the performance of the ASED based method is compared to the standard SED and SPSA based methods. The results of the simulation showed that the ASED method could provide stable convergence by minimizing the function of the given objective. The ASED also obtains a value for the objective function and the total norm error for tracking performance accuracy that is lower compared to other methods.

KEYWORDS

Nonlinear control systems; Optimization methods; MIMO; Control design; Intelligent control; Control accuracy; Performance evaluation

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