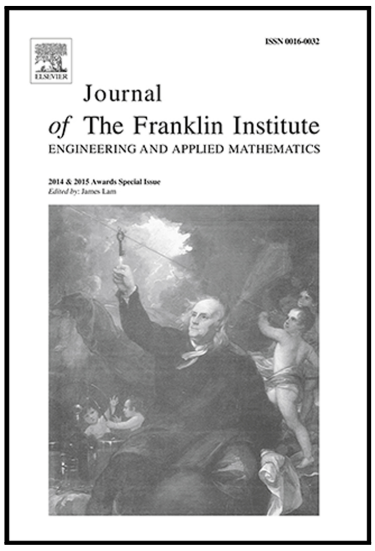

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Probabilistic Fuzzy Logic Controller for Uncertain Nonlinear Systems

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Abstract:

This paper proposes a probabilistic fuzzy proportional - integral (PFPI) controller for controlling uncertain nonlinear systems. Firstly, the probabilistic fuzzy logic system (PFLS) improves the capability of the ordinary fuzzy logic system (FLS) to overcome various uncertainties in the controlled dynamical systems by integrating the probability method into the fuzzy logic system. Moreover, the input/output relationship for the proposed PFPI controller is derived. The resulting structure is equivalent to nonlinear PI controller and the equivalent gains for the proposed PFPI controller are a nonlinear function of input variables. These gains are changed as the input variables changed. The sufficient conditions for the proposed PFPI controller, which achieve the bounded-input bounded-output (BIBO) stability are obtained based on the small gain theorem. Finally, the obtained results indicate that the PFPI controller is able to reduce the effect of the system uncertainties compared with the fuzzy PI (FPI) controller.

Keywords

Fuzzy logic controller, Probabilistic fuzzy logic system, stochastic uncertainties, Probabilistic fuzzy controller, Analytical structure, BIBO stability

1. Introduction

Most practical engineering systems are complex and time-variant with nonlinearity. These systems contain a time-delay, an external disturbance and a modeling error. These problems reduce the performance of the systems [1, 2]. It is undesirable to be worthily controlled these systems using the classical controllers [3]. The design of modern controllers such as adaptive controllers contains complex mathematical analysis and also, have many difficulties in controlling time-varying and highly nonlinear plants [4]. For these reasons, many researchers have attempted to use intelligent controllers such as fuzzy control and neural network control in order to improve the system performance [4 - 7].