ROBUST RELIABLE CONTROL FOR NEUTRAL-TYPE NONLINEAR SYSTEMS WITH TIME-VARYING DELAYS

K. MATHIYALAGAN[1], R. SAKTHIVEL[2] and JU H. PARK[1]

[1]Department of Electrical Engineering, Yeungnam University, 280 Daehak-Ro, Kyongsan 712-749, Republic of Korea
[2]Department of Mathematics, Sungkyunkwan University, Suwon-440 746, Republic of Korea
(e-mails: krsakthivel@yahoo.com, jessie@ynu.ac.kr)

(*Received May 6, 2014 – Revised July 7, 2014*)

The problem of robust reliable stabilization against actuator failures for a class of uncertain nonlinear neutral systems with time-varying delays is considered. Based on a new Lyapunov–Krasovskii functional, by employing linear matrix inequality technique and free weighting matrix approach, we derived a set of sufficient conditions for the existence of a reliable controller. The derived controller is applied for the robust stabilization of the nonlinear neutral system in the presence of known actuator failure matrix and uncertainties. Further, the results are extended to study the stabilization of neutral systems with unknown actuator failure matrix. The failure of actuators are considered by variables, which are varying in a given interval. The developed theoretical results are established in the form of linear matrix inequalities, which can be easily solved via standard numerical software. Finally, two numerical examples are presented to demonstrate the validity and less conservatism of the obtained results.

Keywords: robust reliable control, neutral systems, actuator failure, time-varying delays.

1. Introduction

The robust control design that can handle model uncertainties for dynamical systems has attracted a considerable amount of interest in the past decades. It should be mentioned that time delay phenomenon exists widely in science and engineering problems, for instance, long-distance transportation systems, hydraulic pressure systems, network control systems and so on [19, 25, 29, 37]. Moreover, the existence of time delay may cause instability or bad performances in dynamic systems. Hence, the robust stabilization problems for time delay dynamical systems have received much attention [8, 16, 23, 24, 31]. New delay-dependent conditions for robust stability and robust stabilization for uncertain neutral systems by using the integral inequality technique and descriptor system approach is studied in [1]. Phat [20] established H_∞ controller design for switched nonlinear systems with mixed time-varying delays. Liu and Lin [13] derived robust sliding controller design for fuzzy nonlinear systems with mismatched parameter uncertainty in the state matrix and external disturbances. Xiang and Wang [34] investigated the robust reliable L_∞ control for a class of uncertain switched nonlinear systems with time delay. Ma and

Yang [15] studied the fault-tolerant control design for a class of nonlinear systems by using the sum of squares optimization approach. Recently, there was investigated [11] the output-feedback-based H_∞ control for vehicle suspension systems with control delay. Further, the delay-dependent stability analysis for neural networks with different types of delays has been studied in [9, 22].

Recently, the delay differential systems of neutral type have received much attention of researchers (see [3, 5, 6, 12, 33] and the references therein). The stability analysis of neutral type systems is more complex because unlike simple delay systems, neutral system contains delays in both its state and derivatives of state, so these systems are very much sensitive to delays and can be easily destabilized [17, 18, 32]. Considerable attention has been paid to the delay-dependent stability and control problems of linear neutral systems. These problems cover a wide range of areas such as circuit systems, population dynamics and vibrating masses and so on [4]. Zhao et al. [38] derived the delay-dependent robust stability for delay neutral type control system with time-varying structured uncertainties and time-varying delay. Sun et al. [30] studied the delay-dependent stability and stabilization criteria for neutral systems with time-delays. The problem of robust stability of neutral systems with mixed time-varying delays and nonlinear perturbations has been studied in [10].

In particular, actuators are very important in transforming the controller output to the plant. In practical applications, temporal failures may happen to actuators and subsequently the control signals cannot be successfully delivered [14]. The presence of such a phenomenon may affect the performance of the dynamical system and even lead to instability of the controlled systems. So it is of practical significance to design the reliable controllers in the presence of possible actuator failures. In actual operation, the actuators may be subjected to failures in real environment [35]. Therefore, it is important and necessary to design reliable controllers for neutral system which can tolerate faults of actuators. In the last decades, reliable control has attracted many researchers and a number of results have been reported [26, 27]. Yang et al. [26, 27] studied the reliable control problem for nonlinear systems with actuator faults. Liu et al. [14] studied the reliable control problem against actuator failures for a class of uncertain discrete-time stochastic nonlinear time-delay systems.

However, in the real world problems, most physical systems and processes are nonlinear. To the best of authors' knowledge the robust reliable control problem for uncertain neutral systems with nonlinear perturbations has not been fully investigated. Motivated by the above discussion, in this paper we study the reliable controller design problem for uncertain neutral system with time-varying delays, nonlinear perturbations and norm-bounded uncertainties. The main objective of this work is to derive the delay-dependent reliable control scheme for robust asymptotical stabilization of the considered nonlinear neutral system for known and as well as unknown actuator fault matrix. The main contributions of the paper are highlighted as follows: (i). The obtained results are applicable for the cases of fixed actuator failures and as well as failure occurs in a range of interval. (ii). By employing the

Download English Version:

https://daneshyari.com/en/article/1899603

Download Persian Version:

https://daneshyari.com/article/1899603

Daneshyari.com