Hindawi Publishing Corporation
Abstract and Applied Analysis
Volume 2012, Article ID 306583, 14 pages
doi:10.1155/2012/306583

Research Article

New LMI-Based Conditions on Neural Networks of Neutral Type with Discrete Interval Delays and General Activation Functions

Guoquan Liu,[1] Shumin Zhou,[1] and He Huang[2]

[1] *School of Mechanical and Electronic Engineering, East China Institute of Technology, Nanchang 330013, China*
[2] *Science and Technology on UAV Laboratory, Northwestern Polytechnical University, Xi'an 710072, China*

Correspondence should be addressed to Guoquan Liu, guoquanliu1982@hotmail.com

Received 23 August 2012; Accepted 6 October 2012

Academic Editor: Sabri Arik

The stability analysis of global asymptotic stability of neural networks of neutral type with both discrete interval delays and general activation functions is discussed. New delay-dependent conditions are obtained by using more general Lyapunov-Krasovskii functionals. Meanwhile, these conditions are expressed in terms of a linear matrix inequality (LMI) and can be verified using the MATLAB LMI toolbox. Numerical examples are used to illustrate the effectiveness of the proposed approach.

1. Introduction

During the past decades, artificial neural networks have received considerable attention due to their applicability in solving signal processing, pattern recognition, associative memories, parallel computation, image processing, and optimization problems [1–6]. Research problems on dynamic behavior such as Chaos control, Hopf bifurcation analysis, and Stability analysis have arisen in such applications and received attention in recent years. In addition, time delays occur frequently in neural networks model [7, 8], which reduce the rate of transmission, as well as cause instability and poor performance of neural networks. Thus, the study of stability of neural networks with time delays is practically required for an engineering system. In recent years, various methods have been proposed to deal with the problem of global stability analysis for neural networks with time delays [9–13]. For example, Singh, 2007 [12], proposed an LMI method for delayed neural networks. Liu et al. 2008 [13] developed a delayed bidirectional associative memory neural network based on

If $\tau_2 = 2$, the conditions in Rakkiyappan and Balasubramaniam, 2008 [21], cannot be satisfied, but by Corollary 3.6 in this paper, one can find that system (3.15) is globally asymptotically stable. Therefore, the proposed result is less conservative than that in Rakkiyappan and Balasubramaniam, 2008 [21].

5. Conclusions

The problem of stability for neural networks of neutral type with discrete interval delays and general activation functions is investigated in this paper. An integrated approach based on a Lyapunov-Krasovskii functional and linear matrix inequality is proposed. In the proposed approach, a corresponding Lyapunov-Krasovskii functional is constructed for neural networks of neutral-type model. Then, by using inequality analysis technique, a reasonably general sufficient condition is obtained in terms of LMI, which can be tested easily using the MATLB LMI toolbox. Moreover, the proposed stability conditions extend and improve the exiting results. Two numerical examples show that the proposed stability result is effective, which can be used to guide engineering design.

In many real world systems, stochastic perturbations often affect the stability of neural networks. Therefore, considering the presence of stochastic perturbations is critical to the stability analysis of networks systems, and some recent progress has been made. In this paper, the proposed neural network of natural type with discrete model was studied by an integrated approach. For future researches, more theoretical analysis should be performed on stochastic neural networks of natural type with mixed delays.

Acknowledgments

The authors would thank the referee and the editor for their valuable comments and suggestions. This work is supported by the Start-up Foundation for Doctors of East China Institute of Technology, the National Natural Science Foundation (nos. 11065002, 61075029). Mr. Ho Simon Wang has provided tutorial assistance to improve the linguistic presentation of the paper.

References

[1] Y. He and L. Wang, "Chaotic neural networks and their application to optimization problems," *Control Theory & Applications*, vol. 17, pp. 847–852, 2000.

[2] V. Miljković, S. Milosevic, R. Sknepnek, and I. Zivic, "Pattern recognition in damaged neural networks," *Physica A*, vol. 295, no. 3-4, pp. 526–536, 2001.

[3] H. Kirschner and R. Hillebrand, "Neural networks for HREM image analysis," *Information sciences*, vol. 129, no. 1–4, pp. 31–44, 2000.

[4] A. Cichocki and R. Unbehauen, *Neural Networks for Optimization and Signal Processing*, John Wiley & Sons, Chichester, UK, 1993.

[5] M. Itoh and L. O. Chua, "Star cellular neural networks for associative and dynamic memories," *International Journal of Bifurcation and Chaos in Applied Sciences and Engineering*, vol. 14, no. 5, pp. 1725–1772, 2004.

[6] G. Labonte and M. Quintin, "Network parallel computing for SOM neural networks," *High Performance Computing Systems and Applications*, vol. 541, pp. 575–586, 2000.

[7] C. X. Huang and J. D. Cao, "Almost sure exponential stability of stochastic cellular neural networks with unbounded distributed delays," *Neurocomputing*, vol. 72, no. 13–15, pp. 3352–3356, 2009.