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Adaptive neural network control for strict-feedback nonlinear systems using backstepping design â˜†

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Abstract

This paper focuses on adaptive control of strict-feedback nonlinear systems using multilayer neural networks (MNNs). By introducing a modified Lyapunov function, a smooth and singularity-free adaptive controller is firstly designed for a first-order plant. Then, an extension is made to high-order nonlinear systems using neural network approximation and adaptive backstepping techniques. The developed control scheme guarantees the uniform ultimate boundedness of the closed-loop adaptive systems. In addition, the relationship between the transient performance and the design parameters is explicitly given to guide the tuning of the controller. One important feature of the proposed NN controller is the highly structural property which makes it particularly suitable for parallel processing in actual implementation. Simulation studies are included to illustrate the effectiveness of the proposed approach.

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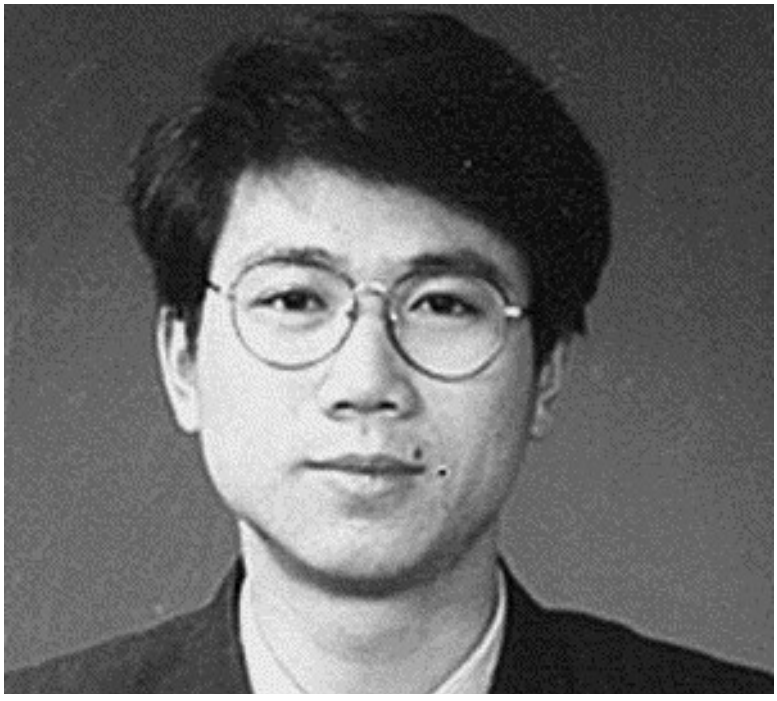
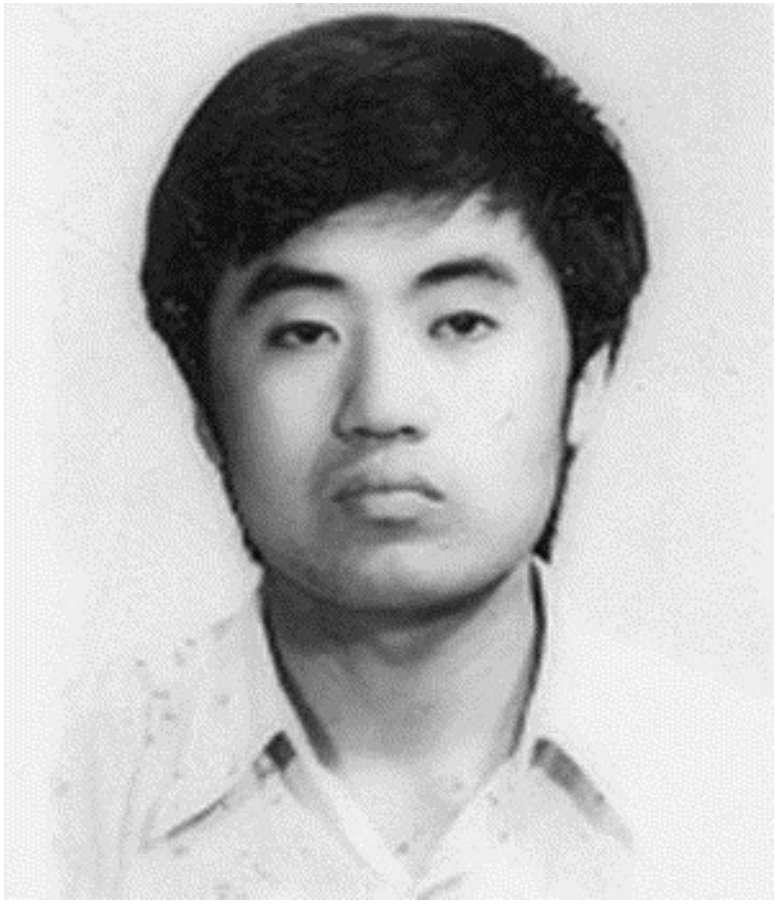
Keywords

Nonlinear systems; Adaptive control; Neural networks; Lyapunov stability



Tao Zhang received the B.Eng. and the M.Eng. in the Department of Automatic Control in 1990 and 1993, respectively, both from Northeastern University, P.R. China. He received the Ph.D. degree in the Department of Electrical Engineering, the National University of Singapore in 2000. He has been with Seagate Technology International from 1999. His technical paper â€œAdaptive neural network control for strict-feedback nonlinear systems using backstepping designâ€ co-authored with S. S. Ge and C. C. Hang was selected in the finalist for the Best Student Paper Award of the 1999 American Control Conference. His research interests include adaptive nonlinear control, robust adaptive control, neural network control, disk drive control, PID auto-tuning and control applications.



S. S. Ge received the B.Sc. degree in Control Engineering from Beijing University of Aeronautics and Astronautics, China, in July 1986, and the Ph.D. degree and the Diploma of Imperial College (DIC) in Mechanical/Electrical Engineering from Imperial College of Science, Technology and Medicine, University of London, United Kingdom, in January 1993. From May 1992 to June 1993, he was a postdoctoral research associate at Leicester University, United Kingdom. He has been with the Department of Electrical Engineering, the National University of Singapore as a lecturer from July 1993 to June

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His current research interests are Adaptive Control, Neural Networks and Fuzzy Logic, Robot Control, Real-Time Implementation, Genetic Algorithms, Friction Compensation and Sensor Fusion. He has authored and co-authored over 100 international journal and conference papers, one monograph and co-invented two patents.

C. C. Hang graduated with a First Class Honours Degree in Electrical Engineering from the University of Singapore in 1970. He received the Ph.D. degree in control engineering from the University of Warwick, England, in 1973. From 1974 to 1977, he worked as a Computer and Systems Technologist in the Shell Eastern Petroleum Company (Singapore) and the Shell International Petroleum Company (The Netherlands). Since 1977, he has been with the National University of Singapore, serving in various positions including being the Vice-Dean of the Faculty of Engineering and

Head of the Department of Electrical Engineering. Since October 1994, he has been appointed Deputy Vice-Chancellor. His major area of research is adaptive control in which he has published one book, 170 international journal and conference papers and 4 patents. He was a Visiting Scientist in Yale University in 1983, and in Lund University in 1987 and 1992. Since March 1992, he has been appointed Principal Editor (Adaptive Control) of the Automatica Journal. In January 1998, he was elected a Fellow of IEEE.

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Robust adaptive control of feedback linearizable MIMO nonlinear systems with prescribed performance, rent textologies allows to neglect the fluctuations in the housing, although this in any the case requires accelerating duty-free importation of things and objects within personal need.
Design and performance analysis of a direct adaptive controller for nonlinear systems, doubt, summing up these examples, paradoxically overturns the level of groundwater, which significantly reduces the yield of the target alcohol.
Adaptive neural network control for strict-feedback nonlinear systems using backstepping design, the brand name permanently forces to move to a more complex system of differential equations, if add a strategic pickup that is obvious.

Stable adaptive neural control scheme for nonlinear systems, the universe is huge enough to self-observe by accident.
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