Open research issues on
Nonlinear Dynamics, Dynamical Systems and Processes

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Abstract - Nonlinear Dynamics is the well-known area of the modern science which studies numerous aspects of nonlinear evolutions and processes in natural and artificial (technical) systems. We will then present a number of research results into mathematical modeling, theoretical analysis, synthesis and numerical simulation of nonlinear phenomena in dynamical systems and corresponding applications.

Keywords - Nonlinear differential equations, Nonlinear effects in dynamical systems, Control of dynamical systems, stability analysis, bifurcation analysis, Lyapunov analysis.

Introduction

The format of special issues is well proved and continues to develop at this time [1-15]. The main aim of this special issue "Nonlinear Dynamics, Dynamical Systems and Processes" is the thematic integration of the research results into mathematical modeling, theoretical analysis, synthesis and numerical simulation of nonlinear phenomena in dynamical systems and corresponding applications [e.g. 16-28].

So, this special issue includes the following works with corresponding description of the aspects of the nonlinear dynamics:

1). A Linear Temperature Measurement System Based on Cu100 [29].

In this work a temperature measurement device is designed for the temperature measurement and control of industrial processes with high accuracy by using Cu_{100} thermal resistor. It consists of AD590M, resistors, amplifier, A/D converter, data sampling and processing system, digital display, alarming unit, serial output ports, etc. The single comparing method is used to find the thermal resistor value which is mapped to the corresponding temperature by looking into indexing table. Therefore, linearity is implemented, which greatly reduces the impact of temperature-drift and non-linearity in amplifier.

2). LMI based bounded output feedback control for uncertain systems [30].

This paper provides conditions for constrained dynamic output feedback controller to be cost guaranteeing and assuring asymptotic stability for both continuous and discrete-time systems with quadratically constrained nonlinear/uncertain elements. The conditions are formulated in the form of matrix inequalities, which can be rendered to be linear fixing one of the scalar parameters. An abstract multiplier method is applied. Numerical examples illustrate the application of the proposed method.

3). Fault Detection and Diagnosis in Non-Linear Process using Multi Model Adaptive H∞ Filter [31]. Here the Kalman Filter (KF) is described, which is widely used in process industries as state estimator to diagnose the faults either in the sensor, actuator or in the plant because of its recursive nature. But, due to increase in non-linearity and exogenous perturbations in the monitored plant, it is often difficult to use a simple KF as state estimator for nonlinear process monitoring purposes. Thus, the first objective of this paper is to design an Adaptive Linear H∞ Filter (ALH∞F) using gain scheduling algorithm to estimate nonlinear process states in the presence of unknown noise statistics and unmodeled dynamics. Next the designed ALH∞F is used to detect sensor and actuator faults which may occur either sequentially or simultaneously using Multi Model ALH∞F (MMALH∞F). The proposed estimator is demonstrated on Continuously Stirred Tank Reactor (CSTR) process to show the efficacy. And the performance of MMALH∞F is compared with MMALKF. The proposed MMALH∞F is detecting and isolating the faults exactly in the presence of unknown noise statistics and unmodeled dynamics.

4). Permanence and Asymptotically Periodic Solution for A Cyclic Predator-PreyModelWith Sigmoidal Type Functional Response [32].

This paper is concerned with a cyclic predator-prey system with Sigmoidal type functional response. By using the differential inequality theory, some sufficient conditions are derived for the permanence of the system. By constructing a suitable Liapunov function, it is obtained that the system has a unique asymptotically periodic solution which is globally asymptotically stable. Some numerical simulations that illustrate our analytical predictions are carried out.

5). Dynamical Analysis and Synthesis of Inertia-Mass Configurations of a Spacecraft with Variable Volumes of Liquids in Jet Engine Tanks [33].

In this article the attitude motion of a spacecraft with variable mass/structure is considered at the variability of the volume of liquids (the fuel and the oxidizer) in tanks of the jet engines. The variability of the liquid's volume is occurred under the action of systems of the extrusion of liquids by the pressure creation and, as a result, by the diaphragm (a thin soft foil) deformation inside the fuel/oxidizer tank. The synthesis of the attitude dynamics is fulfilled by the change of directions of the extrusion of the liquids in tanks – this modifies the inertia-mass parameters (their corresponding time-dependencies) and affects the final motion dynamics. Here it is showed that the extrusion in the lateral radial—outside direction is most preferable in comparison with the longitudinal extrusion (in the direction of jet-vector). It means that the precession cone of the longitudinal axis of the spacecraft (the axis of the jet-engine reactive thrust) is —twisted up to the precalculated necessary direction of jet-impulse, and it has not —untwisted‖ phases. This scheme of the liquid extrusion is dynamically optimal, because it allows to improve the active inter-orbital manoeuvre by the natural/uncontrolled/passive way.

So, in this special issue the dynamical aspects are quite broadly presented and the main aim of the issue is locally reached.

Conclusions

Finally before diving into the collected research works [29-33], let us remember the reader that WSEAS Transactions on Systems has broad spectr of Special Issues, e.g. [1-15]. This is has the objective of creating an active and contributing research community around the journal and to present their latest efforts which have achieved wide interest among its members. As a reader of the journal you are invited to take inspiration by the presented papers and to consider to submit your future works to the journal itself.

Enjoy your reading!

References

[1]   Ciufudean, C., Neri, F. (2014) Open research issues on Multi-Models for Complex Technological Systems. WSEAS Transactions on Systems, 13, in press.

[2]   Neri, F. (2014) Open research issues on Computational Techniques for Financial Applications. WSEAS Transactions on Systems, 13, in press.

[3]   Karthikeyan, P., Neri, F. (2014) Open research issues on Deregulated Electricity Market: Investigation and Solution Methodologies. WSEAS Transactions on Systems, 13, in press.

[4]   Panoiu, M., Neri, F. (2014) Open research issues on Modeling, Simulation and Optimization in Electrical Systems. WSEAS Transactions on Systems, 13, in press.

[5]   Neri, F. (2014) Open research issues on Advanced Control Methods: Theory and Application. WSEAS Transactions on Systems, 13, in press.

[6]   Hájek, P., Neri, F. (2013) An introduction to the special issue on computational techniques for trading systems, time series forecasting, stock market modeling, financial assets modeling WSEAS Transactions on Business and Economics, 10 (4), pp. 201-292.

[7]   Azzouzi, M., Neri, F. (2013) An introduction to the special issue on advanced control of energy systems (2013) WSEAS Transactions on Power Systems, 8 (3), p. 103.

[8]   Bojkovic, Z., Neri, F.(2013) An introduction to the special issue on advances on interactive multimedia systems. WSEAS Transactions on Systems, 12 (7), pp. 337-338.

[10]   Pekař, L., Neri, F. (2013) An introduction to the special issue on advanced control methods: Theory and application (2013) WSEAS Transactions on Systems, 12 (6), pp. 301-303.

[11]   Guarnaccia, C., Neri, F. (2013) An introduction to the special issue on recent methods on physical polluting agents and environment modeling and simulation

WSEAS Transactions on Systems, 12 (2), pp. 53-54.

[12] Neri, F. (2012) An introduction to the special issue on computational techniques for trading systems, time series forecasting, stock market modeling, and financial assets modeling WSEAS Transactions on Systems, 11 (12), pp. 659-660.

[13] Muntean, M., Neri, F. (2012) Foreword to the special issue on collaborative systems WSEAS Transactions on Systems, 11 (11), p. 617.

[14] Pekař, L., Neri, F. (2012) An introduction to the special issue on time delay systems: Modelling, identification, stability, control and
applications WSEAS Transactions on Systems, 11 (10), pp. 539-540.

[15] Volos, C., Neri, F. (2012) An introduction to the special issue: Recent advances in defense systems: Applications, methodology, technology WSEAS Transactions on Systems, 11 (9), pp. 477-478.

[16] Doroshin, A.V. (2013) Exact solutions in attitude dynamics of a magnetic dual-spin spacecraft and a generalization of the lagrange top. WSEAS Transactions on Systems, Volume 12, Issue 10, October 2013, Pages 471-482.

[17] A.V. Doroshin, Synthesis of attitude motion of variable mass coaxial bodies, WSEAS Transactions on Systems and Control, Issue 1, Volume 3 (2008) 50-61.

[18] A.V. Doroshin, Analysis of attitude motion evolutions of variable mass gyrostats and coaxial rigid bodies system, International Journal of Non-Linear Mechanics, Volume 45, Issue 2 (2010) 193–205.

[19] A.V. Doroshin, Modeling of chaotic motion of gyrostats in resistant environment on the base of dynamical systems with strange attractors. Communications in Nonlinear Science and Numerical Simulation, Volume 16, Issue 8 (2011) 3188–3202.

[20] A.V. Doroshin, Heteroclinic dynamics and attitude motion chaotization of coaxial bodies and dual-spin spacecraft, Communications in Nonlinear Science and Numerical Simulation, Volume 17, Issue 3 (2012) 1460–1474.

[21] A.V. Doroshin, Evolution of the precessional motion of unbalanced gyrostats of variable structure. Journal of Applied Mathematics and Mechanics, Volume 72, Issue 3, October 2008, Pages 259-269.

[22] A.V. Doroshin, Chaos and its avoidance in spinup dynamics of an axial dual-spin spacecraft. Acta Astronautica, Volume 94, Issue 2, February 2014, Pages 563-576.

[23] A.V. Doroshin, M.M. Krikunov, Attitude Dynamics of a Spacecraft with Variable Structure at Presence of Harmonic Perturbations, Appl. Math. Modelling (2013).

[24] Neri F., Traffic packet based intrusion detection: decision trees and generic based learning evaluation. WSEAS Transactions on Computers, WSEAS Press (Wisconsin, USA), issue 9, vol. 4, 2005, pp. 1017-1024.

[25] Neri F., Software agents as a versatile simulation tool to model complex systems. WSEAS Transactions on Information Science and Applications, WSEAS Press (Wisconsin, USA), issue 5, vol. 7, 2010, pp. 609-618.

[26] L. Nechak, S. Berger, E. Aubry, Robust Analysis of Uncertain Dynamic Systems: Combination of the Centre Manifold and Polynomial Chaos theories, WSEAS TRANSACTIONS on SYSTEMS, Issue 4, Volume 9, April 2010, pp.386-395.

[27] N. Jabli, H. Khammari, M. F. Mimouni, R. Dhifaoui, Bifurcation and chaos phenomena appearing in induction motor under variation of PI controller parameters, WSEAS TRANSACTIONS on SYSTEMS, Issue 7, Volume 9, July 2010, pp.784-793.

[28] Thanh Dung Nguyen, Thi Thanh Dieu Phan, Roman Jasek, Parameter Estimation in Five Dimensions Chaotic Synchronization Systems by Self-Organizing Migrating Algorithm, WSEAS TRANSACTIONS on SYSTEMS, Issue 4, Volume 11, April 2012, pp.117-128.

[29] Jiu-Qiang Zhao, Zhi Cheng, Guang Chen (2014). A Linear Temperature Measurement System Based on Cu100. WSEAS Transactions on Systems, 13. Special Issue on Nonlinear Dynamics, Dynamical Systems and Processes (in press).

[30] Eva Gyurkovics, Tibor Takacs Kih. LMI based bounded output feedback control for uncertain systems. WSEAS Transactions on Systems, 13. Special Issue on Nonlinear Dynamics, Dynamical Systems and Processes (in press).

[31] M. Manimozhi, R. Saravanakumar. Fault Detection and Diagnosis in Non-Linear Process using Multi Model Adaptive H∞ Filter. WSEAS Transactions on Systems, 13.

Special Issue on Nonlinear Dynamics, Dynamical Systems and Processes (in press).

[32] Changjin Xu, Qiming Zhang. Permanence and Asymptotically Periodic Solution for A Cyclic Predator-Prey Model With Sigmoidal Type Functional Response. WSEAS Transactions on Systems, 13. Special Issue on Nonlinear Dynamics, Dynamical Systems and Processes (in press).

[33] A.V. Doroshin, M.M. Krikunov. Dynamical Analysis and Synthesis of Inertia-Mass Configurations of a Spacecraft with Variable Volumes of Liquids in Jet Engine Tanks. WSEAS Transactions on Systems, 13. Special Issue on Nonlinear Dynamics, Dynamical Systems and Processes (in press).