



Universiteit
Leiden
The Netherlands

A fixed point approach towards stability of delay differential equations with applications to neural networks

Chen, G.

Citation

Chen, G. (2013, August 29). *A fixed point approach towards stability of delay differential equations with applications to neural networks*. Retrieved from <https://hdl.handle.net/1887/21572>

Version: Corrected Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/21572>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/21572> holds various files of this Leiden University dissertation.

Author: Chen, Guiling

Title: A fixed point approach towards stability of delay differential equations with applications to neural networks

Issue Date: 2013-08-29

A fixed point approach towards stability of delay differential equations with applications to neural networks

Proefschrift

ter verkrijging van
de graad van Doctor aan de Universiteit Leiden,
op gezag van Rector Magnificus prof. mr. C.J.J.M. Stolker,
volgens besluit van het College voor Promoties
te verdedigen op
donderdag 29 Augustus 2013
om 16:15 uur

door

Guiling Chen

geboren te China
in 1983

Samenstelling van de promotiecommissie:

Promotores: Prof. dr. Sjoerd Verduyn Lunel
Copromotor: Dr. ir. Onno van Gaans

Overige leden: Dr. John Appleby (Dublin University College, Ireland)
Prof. dr. Arjen Doelman (Universiteit Leiden)
Prof. dr. Stephan van Gils (Universiteit Twente)
Dr. Sander Hille (Universiteit Leiden)
Prof. dr. Peter Stevenhagen (Universiteit Leiden)

A fixed point approach towards
stability of delay differential equations
with applications to neural networks

Contents

1	Introduction	1
1.1	Outline	1
1.2	Objectives and main results of this thesis	8
1.3	Preliminaries	12
1.4	Structure of this thesis	28
2	Asymptotic behavior of a class of autonomous neutral delay differential equations	31
2.1	Introduction	31
2.2	Asymptotic behavior by a spectral approach	32
2.3	An ODE approach to asymptotic behavior	37
2.4	Discussion of the two approaches	43
2.5	A fixed point method towards asymptotic behavior	47
2.6	An application to a mechanical model of turning processes	50
2.7	Notes and remarks	51
3	Asymptotic behavior of a class of nonautonomous neutral delay differential equations	53
3.1	Introduction and main result	53
3.2	Proof of Theorem 3.1.2	55
3.3	Examples	58
3.4	Notes and remarks	60
4	A fixed point approach to stability of delay differential equations	61
4.1	Stability results for nonlinear neutral delay differential equations	61
4.1.1	Introduction and main results	61
4.1.2	Proof of Theorem 4.1.3	67
4.1.3	Proof of Theorem 4.1.5	76
4.1.4	Proof of Theorem 4.1.7	80
4.1.5	Proof of Theorem 4.1.10	82
4.2	A new criteria for stability of nonlinear functional differential equations based on a fixed point method	94
4.2.1	Introduction and main results	94
4.2.2	Proof of Theorem 4.2.1	96
4.2.3	Proof of Theorem 4.2.3	102
4.2.4	Examples of the main results	106
4.3	Stability of nonlinear difference equations based on a fixed point method	108
4.3.1	Introduction and main results	108
4.3.2	Proof of Theorem 4.3.6	110
4.3.3	Proof of Theorem 4.3.7	113
4.4	Notes and remarks	115

5	Stability of neutral stochastic delay differential equations with impulses	117
5.1	Asymptotic stability of a class of neutral stochastic delay differential equations with linear impulses	117
5.1.1	Introduction and main results	117
5.1.2	Proof of Theorem 5.1.4	123
5.1.3	Proof of Theorem 5.1.9	132
5.1.4	Examples	136
5.2	Exponential stability of a class of impulsive neutral stochastic partial differential equations with variable delays and Poisson jumps	138
5.2.1	Introduction and preliminaries	138
5.2.2	Exponential stability by an impulsive-integral inequality	142
5.2.3	Exponential stability by using fixed point methods	149
5.3	Notes and remarks	156
6	Stochastic delayed neural networks	159
6.1	Stability of stochastic delayed neural networks	159
6.1.1	Introduction and main results	159
6.1.2	Proof of Theorem 6.1.4	166
6.1.3	Proof of Theorem 6.1.5	174
6.1.4	Proof of Theorem 6.1.7	178
6.1.5	Proof of Theorem 6.1.11	180
6.1.6	Proof of Theorem 6.1.13	183
6.1.7	Examples	184
6.2	Stability of stochastic delayed neural networks with impulses	186
6.2.1	Introduction and main results	186
6.2.2	Proof of Theorem 6.2.1	191
6.2.3	Proof of Theorem 6.2.2	198
6.2.4	Proof of Theorem 6.2.6	201
6.2.5	Proof of Theorem 6.2.7	204
6.2.6	Examples	206
6.3	Notes and remarks	207
	Bibliography	209
	Notational conventions	221
	Summary	223
	Samenvatting	225
	Acknowledgments	227
	Curriculum Vitae	229