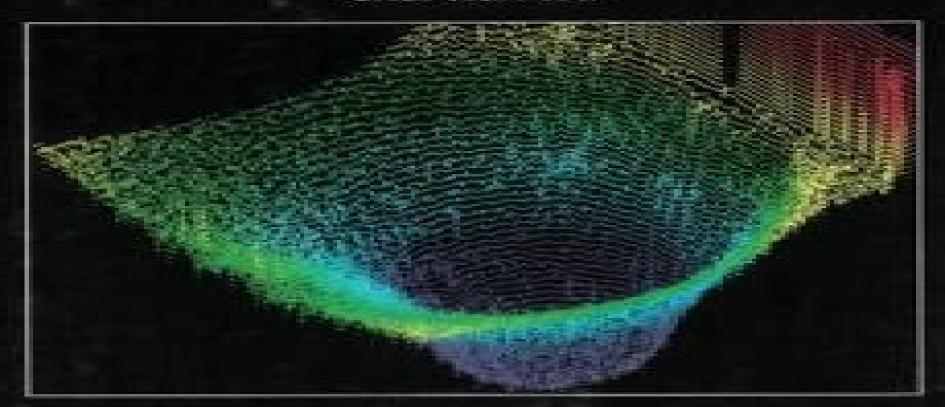
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# SYNCHRONIZATION IN COUPLED CHAOTIC CIRCUITS AND SYSTEMS

Chai Wah Wu



World Scientific

# **Synchronization In Coupled Chaotic Circuits And Systems**

**Ljupco Kocarev** 

# **Synchronization In Coupled Chaotic Circuits And Systems:**

Synchronization in Coupled Chaotic Circuits and Systems Chai Wah Wu, 2002 Studies synchronization of coupled chaotic circuits and systems as well as its applications Chaos in Circuits and Systems Guanrong Chen, Tetsushi Ueta, 2002 In this volume leading experts present current achievements in the forefront of research in the challenging field of chaos in circuits and systems with emphasis on engineering perspectives methodologies circuitry design techniques and potential applications of chaos and bifurcation A combination of overview tutorial and technical articles the book describes state of the art research on significant problems in this field It is suitable for readers ranging from graduate students university professors laboratory researchers and industrial practitioners to applied mathematicians and physicists in electrical electronic mechanical physical chemical and biomedical engineering and science **Complex Dynamics in Communication Networks** Ljupco Kocarev, 2005-06-13 Computer and communication networks are among society s most important infrastructures The internet in particular is a giant global network of networks without central control or administration It is a paradigm of a complex system where complexity may arise from different sources topological structure network evolution connection and node diversity or dynamical evolution. The present volume is the first book entirely devoted to the new and emerging field of nonlinear dynamics of TCP IP networks It addresses both scientists and engineers working in the general field of communication networks

Recent Advances in Nonlinear Dynamics and Synchronization Kyandoghere Kyamakya, Herwig Unger, Jean Chamberlain Chedjou, Nikolai F. Rulkov, Zhong Li, 2009-09-28 The selected contributions of this book shed light on a series of interesting aspects related to nonlinear dynamics and synchronization with the aim of demonstrating some of their interesting applications in a series of selected disciplines This book contains thirteenth chapters which are organized around five main parts The first part containing five chapters does focus on theoretical aspects and recent trends of nonlinear dynamics and synchronization. The second part two chapters presents some modeling and simulation issues through concrete application examples. The third part two chapters is focused on the application of nonlinear dynamics and synchronization in transportation The fourth part two chapters presents some applications of synchronization in security related system concepts The fifth part two chapters considers further applications areas i e pattern recognition and communication engineering Systems with Hidden Attractors Viet-Thanh Pham, Christos Volos, Tomasz Kapitaniak, 2017-03-10 This brief provides a general overview of nonlinear systems that exhibit hidden attractor behavior a topic of interest in subjects as divers as physics mechanics electronics and secure communications The brief is intended for readers who want to understand the concepts of the hidden attractor and hidden attractor systems and to implement such systems experimentally using common electronic components Emergent topics in circuit implementation of systems with hidden attractors are included The brief serves as an up to date reference on an important research topic for undergraduate graduate students laboratory researchers and lecturers in various areas of engineering and physics

Electronic Design Automation of Multi-scroll Chaos Generators Jesus Manuel Muñoz Pacheco, Esteban Tlelo Cuautle, 2010 This book is unique when compared with books on non linear circuits and systems The book introduces novel concepts of physics computer and electrical engineering The synthesis of Multi scroll chaotic oscillators is performed through Advances in System Dynamics and Control Azar, Ahmad Taher, Vaidyanathan, Sundarapandian, 2018-02-09 Complex systems are pervasive in many areas of science With the increasing requirement for high levels of system performance complex systems has become an important area of research due to its role in many industries Advances in System Dynamics and Control provides emerging research on the applications in the field of control and analysis for complex systems with a special emphasis on how to solve various control design and observer design problems nonlinear systems interconnected systems and singular systems Featuring coverage on a broad range of topics such as adaptive control artificial neural network and synchronization this book is an important resource for engineers professionals and researchers interested in applying new computational and mathematical tools for solving the complicated problems of mathematical modeling simulation and control Chaos, CNN, Memristors and Beyond Andrew Adamatzky, 2013 This invaluable book is a unique collection of tributes to outstanding discoveries pioneered by Leon Chua in nonlinear circuits cellular neural networks and chaos It is comprised of three parts The first OCo cellular nonlinear networks nonlinear circuits and cellular automata OCo deals with Chua's Lagrangian circuits cellular wave computers bio inspired robotics and neuro morphic architectures toroidal chaos synaptic cellular automata history of Chua s circuits cardiac arrhythmias local activity principle symmetry breaking and complexity bifurcation trees and Chua's views on nonlinear dynamics of cellular automata Dynamical systems and chaos is the scope of the second part of the book where we find genius accounts on theory and application of Julia set stability of dynamical networks chaotic neural networks and neocortical dynamics dynamics of piecewise linear systems chaotic mathematical circuitry synchronization of oscillators models of catastrophic events control of chaotic systems symbolic dynamics and solitons First hand accounts on the discovery of memristors in HP Labs historical excursions into OCyancient memristorsOCO analytical analysis of memristors and hardware memristor emulators are presented in the third and final part of the book The book is quintessence of ideas on future and emergent hardware analytic theories of complex dynamical systems and interdisciplinary physics It is a true Renaissance volume where bright ideas of electronics mathematics and physics enlighten facets of modern science The unique DVD covers the artistic aspects of chaos such as several stunningly melodious musical compositions using chaotic atttractors a virtual gallery of hundreds of colorful attractors and even a cartoon like play on the genesis of Chua's circuit that was based on a widely acclaimed performance in Rome and other venues in Italy In short it is a veritable kaleiscope of never before published historical pedagogical and futuristic technical visions on three timely topics of intense interest for both lay readers and experts alike Controlling Chaos and Bifurcations in Engineering Systems Guanrong Chen, 1999-09-28 Over the

last two decades chaos in engineering systems has moved from being simply a curious phenomenon to one with real practical significance and utility Engineers scientists and mathematicians have similarly advanced from the passive role of analyzing chaos to their present active role of controlling chaos control directed not only at suppression but also at exploiting its enormous potential We now stand at the threshold of major advances in the control and synchronization of chaos for new applications across the range of engineering disciplines Controlling Chaos and Bifurcations in Engineering Systems provides a state of the art survey of the control and anti control of chaos in dynamical systems Internationally known experts in the field join forces in this volume to form this tutorial style combination of overview and technical report on the latest advances in the theory and applications of chaos control They detail various approaches to control and show how designers can use chaos to create a wider variety of properties and greater flexibility in the design process Chaos control promises to have a major impact on novel time and energy critical engineering applications Within this volume readers will find many challenging problems yet unsolved regarding both the fundamental theory and potential applications of chaos control and anti control Controlling Chaos and Bifurcations in Engineering Systems will bring readers up to date on recent development in the field and help open the door to new advances Control of Chaos in Nonlinear Circuits and Systems Wing-Kuen Ling, 2009 In this book leading researchers present their current work in the challenging area of chaos control in nonlinear circuits and systems with emphasis on practical methodologies system design techniques and applications A combination of overview tutorial and technical articles the book describes state of the art research on significant problems in this area The scope and aim of this book are to bridge the gap between chaos control methods and circuits and systems It is an ideal starting point for anyone who needs a fundamental understanding of controlling chaos in nonlinear circuits and systems

Unlocking Dynamical Diversity Deborah M. Kane, K. Alan Shore, 2005-11-01 Applications of semiconductor lasers with optical feedback systems are driving rapid developments in theoretical and experimental research. The very broad wavelength gain bandwidth of semiconductor lasers combined with frequency filtered strong optical feedback create the tunable single frequency laser systems utilised in telecommunications environmental sensing measurement and control. Those with weak to moderate optical feedback lead to the chaotic semiconductor lasers of private communication. This resource illustrates the diversity of dynamic laser states and the technological applications thereof presenting a timely synthesis of current findings and providing the roadmap for exploiting their future potential Provides theory based explanations underpinned by a vast range of experimental studies on optical feedback including conventional phase conjugate and frequency filtered feedback in standard commercial and single stripe semiconductor lasers Includes the classic Lang Kobayashi equation model through to more recent theory with new developments in techniques for solving delay differential equations and bifurcation analysis Explores developments in self mixing interferometry to produce sub nanometre sensitivity in path length measurements Reviews tunable single frequency semiconductor lasers and systems and

their diverse range of applications in sensing and optical communications Emphasises the importance of synchronised chaotic semiconductor lasers using optical feedback and private communications systems Unlocking Dynamical Diversity illustrates all theory using real world examples gleaned from international cutting edge research Such an approach appeals to industry professionals working in semiconductor lasers laser physics and laser applications and is essential reading for researchers and postgraduates in these fields Nonlinear Dynamics In Circuits Louis M Pecora, T Carroll, 1995-11-16 This volume describes the use of simple analog circuits to study nonlinear dynamics chaos and stochastic resonance The circuit experiments that are described are mostly easy and inexpensive to reproduce and yet these experiments come from the forefront of nonlinear dynamics research The individual chapters describe why analog circuits are so useful for studying nonlinear dynamics and include theoretical as well as experimental results from some of the leading researchers in the field Most of the articles contain some tutorial sections for the less experienced readers The audience for this book includes researchers in nonlinear dynamics chaos and statistical physics as well as electrical engineering and graduate and advanced undergraduate students in these fields Topics in Time Delay Systems Jean Jacques Loiseau, Wim Michiels, Silviu-Iulian Niculescu, Rifat Sipahi, 2009-08-10 Time delays are present in many physical processes due to the period of time it takes for the events to occur Delays are particularly more pronounced in networks of interconnected systems such as supply chains and systems controlled over c munication networks In these control problems taking the delays into account is particularly important for performance evaluation and control system's design It has been shown indeed that delays in a controlled system for instance a c munication delay for data acquisition may have an ambiguous nature they may stabilize the system or in the contrary they may lead to deterioration of the clos loop performance or even instability depending on the delay value and the system parameters It is a fact that delays have stabilizing effects but this is clearly con i ing for human intuition Therefore speci c analysis techniques and design methods are to be developed to satisfactorily take into account the presence of delays at the design stage of the control system The research on time delay systems stretches back to 1960s and it has been very active during the last twenty years During this period the results have been presented at the main control conferences CDC ACC IFAC in specialized wo shops IFAC TDS series and published in the leading journals of control engine ing systems and control theory applied and numerical mathematics **Advances in Chaos Theory and Intelligent** Control Ahmad Taher Azar, Sundarapandian Vaidyanathan, 2016-04-15 The book reports on the latest advances in and applications of chaos theory and intelligent control Written by eminent scientists and active researchers and using a clear matter of fact style it covers advanced theories methods and applications in a variety of research areas and explains key concepts in modeling analysis and control of chaotic and hyperchaotic systems Topics include fractional chaotic systems chaos control chaos synchronization memristors jerk circuits chaotic systems with hidden attractors mechanical and biological chaos and circuit realization of chaotic systems The book further covers fuzzy logic controllers evolutionary

algorithms swarm intelligence and petri nets among other topics Not only does it provide the readers with chaos fundamentals and intelligent control based algorithms it also discusses key applications of chaos as well as multidisciplinary solutions developed via intelligent control The book is a timely and comprehensive reference guide for graduate students researchers and practitioners in the areas of chaos theory and intelligent control System and Architecture Sunil Kumar Muttoo, 2018-05-15 This book comprises the select proceedings of the annual convention of the Computer Society of India Divided into 10 topical volumes the proceedings present papers on state of the art research surveys and succinct reviews The volumes cover diverse topics ranging from parallel processing to system buses and from computer architecture to VLIW very long instruction word This book focuses on systems and architecture It aims at informing the readers about those attributes of a system visible to a programmer This book also deals with various innovations and improvements in computing technologies to improve the size capacity and performance of modern day computing systems The contents of this book will be useful to professionals and researchers alike Applications of Chaos and Nonlinear Dynamics in Science and **Engineering - Vol. 3** Santo Banerjee, Lamberto Rondoni, 2013-06-12 Chaos and nonlinear dynamics initially developed as a new emergent field with its foundation in physics and applied mathematics. The highly generic interdisciplinary quality of the insights gained in the last few decades has spawned myriad applications in almost all branches of science and technology and even well beyond Wherever quantitative modeling and analysis of complex nonlinear phenomena is required chaos theory and its methods can play a key role This third volume concentrates on reviewing further relevant contemporary applications of chaotic nonlinear systems as they apply to the various cutting edge branches of engineering This encompasses but is not limited to topics such fluctuation relations and chaotic dynamics in physics fractals and their applications in epileptic seizures as well as chaos synchronization Featuring contributions from active and leading research groups this collection is ideal both as a reference and as a recipe book full of tried and tested successful engineering applications Nonlinear Systems Dongbin Lee, Christos Volos, Timothy Burg, 2016-10-19 The book consists mainly of two parts Chapter 1 Chapter 7 and Chapter 8 Chapter 14 Chapter 1 and Chapter 2 treat design techniques based on linearization of nonlinear systems An analysis of nonlinear system over quantum mechanics is discussed in Chapter 3 Chapter 4 to Chapter 7 are estimation methods using Kalman filtering while solving nonlinear control systems using iterative approach Optimal approaches are discussed in Chapter 8 with retarded control of nonlinear system in singular situation and Chapter 9 extends optimal theory to H infinity control for a nonlinear control system Chapters 10 and 11 present the control of nonlinear dynamic systems twin rotor helicopter and 3D crane system which are both underactuated cascaded dynamic systems Chapter 12 applies controls to antisynchronization synchronization in the chaotic models based on Lyapunov exponent theorem and Chapter 13 discusses developed stability analytic approaches in terms of Lyapunov stability. The analysis of economic activities especially the relationship between stock return and economic growth is presented in Chapter 14 **Dynamical Systems with Applications** 

Using MATLAB® Stephen Lynch, 2025-09-09 This textbook now in its third edition provides a broad and accessible introduction to both continuous and discrete dynamical systems the theory of which is motivated by examples from a wide range of disciplines It emphasizes applications and simulation utilizing MATLAB Simulink the Image Processing Toolbox the Symbolic Math Toolbox and the Deep Learning Toolbox The text begins with a tutorial introduction to MATLAB that assumes no prior programming knowledge Discrete systems are covered in the first part after which the second part explores the study of continuous systems using delay ordinary and partial differential equations. The third part considers chaos control and synchronization binary oscillator computing Simulink and the Deep Learning Toolbox A final chapter provides examination and coursework type MATLAB questions for use by instructors and students For the Third Edition all the material has been thoroughly updated in line with the most recent version of MATLAB R2025a New chapters have been added on artificial neural networks delay differential equations numerical methods for ordinary and partial differential equations and the Deep Learning Toolbox MATLAB program files Simulink model files and other materials are available to download from the author s website and through GitHub The hands on approach of Dynamical Systems with Applications using MATLAB has minimal prerequisites only requiring familiarity with ordinary differential equations It will appeal to advanced undergraduate and graduate students applied mathematicians engineers and researchers in a broad range of disciplines such as population dynamics biology chemistry computing economics nonlinear optics neural networks and physics Praise for the Second Edition This book is a valuable reference to the existing literature on dynamical systems especially for the remarkable collection of examples and applications selected from very different areas as well as for its treatment with MATLAB of these problems Fernando Casas zbMATH The vast compilation of applications makes this text a great resource for applied mathematicians engineers physicists and researchers Instructors will be pleased to find an aims and objectives section at the beginning of each chapter where the author outlines its content and provides student learning objectives Stanley R Huddy MAA Reviews

Complex Computing-Networks Izzet Cem Göknar, Levent Sevgi, 2006-05-31 This book contains the ceremonials and the proceedings pertaining to the Int national Symposium CCN2005 on Complex Computing Networks A Link between Brain like and Wave Oriented Electrodynamics Algorithms convened at Do u University of Istanbul Turkey on 13 14 June 2005 in connection with the bestowal of the honorary doctorate degrees on Professors Leopold B Felsen and Leon O Chua for their extraordinary achievements in electromagnetics and n linear systems respectively The symposium was co organized by Cem G knar and Levent Sevgi in consultation with Leopold B Felsen and Leon O Chua Istanbul is a city with wonderful natural and historical surroundings a city not only interconnecting Asia and Europe but also Eastern and Western cultures Therefore CCN2005 was a memorable event not only in the lifetime of Drs Felsen Chua and their families but also for all the other participants who were there to congratulate the recipients and participate in the symposium Perspectives in Mathematical Sciences Yisong Yang, Jinqiao Duan, Xinchu Fu, 2010 1 Periodic boundary problems for analytic function

including automorphic functions Haitao Cai and Jian Ke Lu 2 Subharmonic bifurcations and chaos for a model of micro cantilever in MEMS Yushu Chen Liangqiang Zhou and Fangqi Chen 3 Canonical sample spaces for random dynamical systems Jinqiao Duan Xingye Kan and Bjorn Schmalfuss 4 Epidemic propagation dynamics on complex networks Xinchu Fu et al 5 Inverse problems for equations of parabolic type Zhibin Han Yongzhong Huang and Ming Jian 6 The existence and asymptotic properties of nontrivial solutions of nonlinear 2 q Laplacian type problems with linking geometric structure Gongbao Li and Zhaofen Shen 7 Chaotic dynamics for the two component Bose Einstein condensate system Jibin Li 8 Recent developments and perspectives in nonlinear dynamics Zengrong Liu 9 Mathematical aspects of the cold plasma model Thomas H Otway 10 Gravitating Yang Mills fields in all dimensions Eugen Radu and D H Tchrakian 11 Hamiltonian constraint and Mandelstam identities over extended knot families symbol and symbol in extended loop gravity Dan Shao Liang Shao and Changgui Shao 12 Lattice Boltzmann simulation of nonlinear Schr dinger equation with variable coefficients Baochang Shi 13 Exponential stability of nonlocal time delayed burgers equation Yanbin Tang 14 Bifurcation analysis of the Swift Hohenberg equation with quintic nonlinearity and Neumann boundary condition Qingkun Xiao and Hongjun Gao 15 A new GL method for mathematical and physical problems Ganquan Xie and Jianhua Li 16 Harmonically representing topological classes Yisong Yang

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