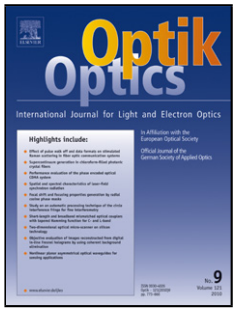

Title: Generation of grid multi-scroll chaotic attractors via hyperbolic tangent function series

Author: Zhong Chen Guilin Wen Huaan Zhou Junyao Chen

PII: S0030-4026(16)31272-4
DOI: http://dx.doi.org/doi:10.1016/j.ijleo.2016.10.085
Reference: IJLEO 58357

To appear in:

Received date: 26-8-2016
Accepted date: 25-10-2016

Please cite this article as: Zhong Chen, Guilin Wen, Huaan Zhou, Junyao Chen, Generation of grid multi-scroll chaotic attractors via hyperbolic tangent function series, Optik - International Journal for Light and Electron Optics http://dx.doi.org/10.1016/j.ijleo.2016.10.085

Generation of grid multi-scroll chaotic attractors via hyperbolic tangent function series

Zhong Chen[1,2,3] Guilin Wen[1,3,*] Huaan Zhou[1,3] Junyao Chen[4,5]
[1]State Key Laboratory of Advanced Design and Manufacturing for Vehicle Body;
[2]Department of Computer Science, Hengyang Normal University, Hengyang 421008, China
[3]Key Laboratory of Advanced Design and Simulation Techniques for Special Equipment, Ministry of Education, Hunan University, Changsha 410082, China
[4]Department of Physics and Electronic Information Science, Hengyang Normal University, Hengyang 421008, China
[5]College of information technology, Ajou University, Suwon 16499, Korea
[*]E-mail: glwen@hnu.edu.cn
E-mail: middlechen@sohu.com

Abstract

A chaotic model for generating multi-directional multi-scroll attractors via hyperbolic tangent function series is proposed in this paper. The dynamical mechanisms of this chaotic model are further investigated, including M-scroll, $M \times N$-grid scroll, $M \times N \times L$-grid scroll chaotic attractors. Moreover, the dynamical behaviors of this system are theoretically analyzed and numerically simulated, such as equilibria and their stability, Lyapunov exponents and bifurcation diagrams. This system can be widely used in data encryption and secure communication.

Keywords: Multi-scroll chaotic attractor; Hyperbolic tangent function; Lyapunov exponents

1. Introduction

Over the past few decades, chaos has been intensively investigated within the mathematics, physics, engineering. Since Chua found the Chua's double-scroll circuit[1–3] in 1984, many methods for generating multi-scroll chaotic attractors have been proposed. Recently, study on generating multi-scroll attractors has been a hot topic, and gradually become mature research direction. So, based on Chua's circuit, by using piecewise linear function, saw tooth function, step wave function, hysteresis series, switching function, sine function and saturated sequence, many multi-scroll chaotic attractors is presented.

Suykens and Vandewalle [4, 5] firstly introduced a family of *n*-double scroll chaotic attractors by application of the quasi-linear function approach. Later Suykens *et al*.[6] presented a piecewise linear (PWL) function method for generating *n*−scroll chaotic attractors. A similar approach [6, 7]was used to generate n-scroll in modifying Chua's circuit. Lü et al. proposed a hysteresis series method [8], a saturated function series approach [9] and