FUZZY OPTIMIZATION AND MODELLING 2(1) (2021) 37-41

E-ISNN: 2676-7007

Contents lists available at FOMJ

Fuzzy Optimization and Modelling

Journal homepage: http://fomj.qaemiau.ac.ir/

Paper Type: Research Paper

# Chaotification of Discrete Dynamical Systems Governed by Continuous Maps and Evolved Fuzzy NN Control

**Tim Chen[a], YC Huang[b,c], J CY Chen[d,*]**

[a] *Faculty of Information Technology, Ton Duc Thang University, Ho Chi Minh City, Vietnam.*

[b] *Department of Earth Science, National Taiwan Normal University, Taipei, China.*

[c] *Center of Natural Science, Kaohsiung Municipal Fushan Junior High School, Kaohsiung, China*

[d] *Faculty of Engineering, King Abdulaziz University, Jeddah 21589, Saudi.*

A R T I C L E I N F O

*Article history:*
Received 2 January 2021
Revised 2 February 2021
Accepted 6 February 2021
Available online 10 April 2021

*Keywords:*
Evolved control
Nonlinear systems
Neural network

A B S T R A C T

The bat algorithm is a meta-heuristic optimization algorithm. The bat algorithm uses different pulse emission rates and loudness based on the echolocation behaviour of microbats. In order to verify the asymptotic state with a false reality can be considered by discrete systems, this article calculates a neural network (NN) controller with a mean bat algorithm. This view is performed using the domain of false reality can be considered from model to model transformation poly linear rule of thumb, and the new measures on asymptotic stability.

## 1. Introduction

It is wrong to choose the truth in the control system. The idea is a process. Everything is true, as long as the false reality can be extracted from the control system. The truth of the false extraction method of digital control system is developed in the false reality to overcome the challenge and continue to design controllers for real systems. However, the scheme to control the false extraction of real system is complex, so it is not suitable for use in practice [9]. Therefore, we need to develop a simple model to create the controller. In the past decades, the successful soft control design for control systems can be extracted from the false reality (see [10, 1-3] and references). In this paper, we use the so-called nonlinear power plant to ensure the availability. Soft play model Takagi [10] and decision model are based on the developed software model to stabilize the soft sun. However, when we study the soft copies of all these things, we ignore the truth of the wrong nature between the model and the false

* Corresponding author
E-mail Address: timchen@tdtu.edu.vn (Tim Chen), yuch1221@gmai.com (YC Huang), jc343965@gmail.com (J CY Chen).

DOI: 10.30495/fomj.2021.681566

pattern, and extract it from them. The error before simulation may be a potential source of instability designed for the control plan, provided that the soft model is the ideal model of the equipment [3]. In the past two years, Chen et al. [9] and kyriakidis [3] have been able to extract the actual situation of the new road of this working face and include the system based on the control model to overcome the influence of soft error. In recent years, President y has actively participated in the field of modeling research, because it has the same special value in solving complex problems, and the power system can be extracted from the false reality (see [7-9] and its references). Simple neural networks are inspired by the elements of parallel biological neural systems. N means that a specific task can be composed of element ready weights. For this reason, you can achieve the expected effect of repeated exercise after four models. When you change the operation of the power supply, the soft battery controller is optimized to reduce the conversion gain and generate pulses [17, 18]. However, the analysis of system stability can be extracted, the false reality has not been completed, and the published research is very few. In order to fill the gap in the research of the software see developed by the local design institute, the analysis can extract the state of the false reality. This work seems to be true, because it can extract false solutions due to the expansion of control problems. As for other aspects, the organization is as follows. In general, Section 2. It may be a nonlinear part of the model state, so it is not enough to ensure asymptotic stability. The simulation results show that the method proposed in Section 3 is absolutely effective. Finally, the conclusion of this paper is given in Section 4.

## 2. System Description

In this section, we aim to discuss the reason of the falsities of discrete or extracted out of them what the true time, from the following equation:

$$\boldsymbol{x}(k+1) = f(\boldsymbol{x}(k), \boldsymbol{u}(k)) \tag{1}$$

where there is a non-linear value vector $x(k)$ $m$-dimensional state of a passenger; The $u(k)$ is an n-dimensional approach vector.

The first is set for the device model. Then controller is synthesized based on a software model to stabilize the individual ratio can be extracted false reality. Consider an N, S class, with each layer of neural which is variable and chili. The number is added after the variable name. The weight matrix that represents the kind of the transfer function of a vector Q. classes defined.

$$\boldsymbol{\Psi}^q(v) \equiv [\mathrm{T}_1(v) \quad \mathrm{T}_2(v) \quad \cdots \quad \mathrm{T}_{R^q}(v)]^T \tag{2}$$

when the mobile connection features. From all this a conclusion can be seen from the example of, furnished with the ultimate resolution is in the 4:

$$x(k+1) = \boldsymbol{\Psi}^S(\boldsymbol{W}^S \times \boldsymbol{\Psi}^{S-1}(\boldsymbol{W}^{S-1} \times \boldsymbol{\Psi}^{S-2}(\cdots\cdots\boldsymbol{\Psi}^2(\boldsymbol{W}^2 \times \boldsymbol{\Psi}^1(\boldsymbol{W}^1 \times \boldsymbol{Z}(k)))\cdots\cdots))) \tag{3}$$

where

$$\boldsymbol{Z}(k)^T = [x(k) \quad \cdots \quad x(k-m+1) \quad u(k) \quad \cdots \quad u(k-n+1)] \tag{4}$$

The system, including the linear differential equation (LDI), the state enters into the representation, to a space described as follows [12]:

$$\boldsymbol{y}(k+1) = D(\boldsymbol{a}(k))\boldsymbol{y}(k) \tag{5}$$

where $\Psi$ is a integer; $a(k)$ is vector the dependence of $h_j$ ; and

$$\boldsymbol{y}(k)=[y_1(k) \quad y_2(k) \quad \cdots \quad y_\phi(k)]^T \tag{6}$$

The translation functions and vectors that they approach pure vectors of the factor $\boldsymbol{\Psi}^q$ in which $G(v^q,\Psi^q)$ are defined as follows:

$$\boldsymbol{G}(V^q,\boldsymbol{\Psi}^q)\equiv diag(g(\mathrm{T}_r)) \quad r=1,2,\cdots,R^q \tag{7}$$

Further, according to the interpolation process and the equation (4) Fourth, if it cannot obtain

$$\begin{aligned} x(k+1) &= \{\sum_{j_1^S=1}^{2}\cdots\sum_{j_{R^S}^S=1}^{2} h_{j_1^S}^S(k)\cdots h_{j_{R^S}^S}^S(k)\boldsymbol{G}(V^S,\boldsymbol{\Psi}^S)(\boldsymbol{W}^S\times[\cdots\cdots[\sum_{j_1^2=1}^{2}\cdots\sum_{j_{R^2}^2=1}^{2} h_{j_1^2}^2(k)\cdots h_{j_{R^2}^2}^2(k) \\ &\cdot\boldsymbol{G}(V^2,\boldsymbol{\Psi}^2)(\boldsymbol{W}^2\times[\sum_{j_1^1=1}^{2}\cdots\sum_{j_{R^1}^1=1}^{2} h_{j_1^1}^1(k)\cdots h_{j_{R^1}^1}^1(k)\boldsymbol{G}(V^1,\boldsymbol{\Psi}^1)(\boldsymbol{W}^1\times\boldsymbol{Z}(k))])]\cdots\cdots])\} \\ &= \sum_{v^S}\cdots\sum_{v^1} h_{v^S}^S(k)\cdots h_{v^1}^1(k)\boldsymbol{G}(V^S,\boldsymbol{\Psi}^S)\boldsymbol{W}^S\cdots\boldsymbol{G}(V^1,\boldsymbol{\Psi}^1)\boldsymbol{W}^1\boldsymbol{Z}(k) \\ &= \sum_{v} h_v(k)\boldsymbol{J}_v(\boldsymbol{W},\boldsymbol{\Psi})\boldsymbol{Z}(k) \end{aligned} \tag{8}$$

According to (5), the dynamics of the model X. (8) can have this LDI representation;

$$\boldsymbol{x}(k+1)=\sum_{i=1}^{\phi} h_i(k)\boldsymbol{J}_i\boldsymbol{Z}(k)=\sum_{i=1}^{\phi} h_i(k)\{\boldsymbol{A}_i\boldsymbol{x}(k)+\boldsymbol{B}_i\boldsymbol{u}(k)\} \tag{9}$$

where

$\boldsymbol{x}(k)^T=[x(k) \quad x(k-1) \quad \cdots \quad x(k-m+1)]$, $\boldsymbol{u}(k)^T=[u(k) \quad u(k-1) \quad \cdots \quad u(k-n+1)]$

Here synthesized a software controller is based on establishing a system for discrete time model that can be extracted false reality. IF

$$x_1(k) \text{ is } M_{i1} \text{ and} \cdots \text{and } x_m(k) \text{ is } M_{im}$$

THEN

$$\boldsymbol{u}(k)=\boldsymbol{K}_i\boldsymbol{x}(k), \qquad i=1,2,\cdots,l \tag{10}$$

where l is the number TIME laws ; The soft $M_{ij}(j=1,2,...,m)$. The end result of this software controller looks like this:

$$\boldsymbol{u}(k)=\frac{\sum_{i=1}^{l} w_i(k)\boldsymbol{K}_i\boldsymbol{x}(k)}{\sum_{i=1}^{l} w_i(k)}=\sum_{i=1}^{l}\bar{h}_i(k)\boldsymbol{K}_i\boldsymbol{x}(k) \tag{11}$$

Here, the closed-loop system of false reality can be extracted through discrete degrees in the power of the model error $e(k)$.

## 3. Evolved fuzzy NN Modeling and Stability Criterion

We prefer (11) and (1) for false reasons and extract the truth, it follows that a separate discrete time:

$$\boldsymbol{x}(k+1)=\sum_{i=1}^{\phi}\sum_{j=1}^{l}h_i(k)\bar{h}_j(k)(\boldsymbol{A}_i+\boldsymbol{B}_i\boldsymbol{K}_j)\boldsymbol{x}(k)+\{F(\boldsymbol{x}(k))-\sum_{i=1}^{\phi}\sum_{j=1}^{l}h_i(k)\bar{h}_j(k)(\boldsymbol{A}_i+\boldsymbol{B}_i\boldsymbol{K}_j)\boldsymbol{x}(k)\}$$
$$=\sum_{i=1}^{\phi}\sum_{j=1}^{l}h_i(k)\bar{h}_j(k)\boldsymbol{H}_{ij}\boldsymbol{x}(k)+\boldsymbol{e}(k) \tag{12}$$

where

$$F(\boldsymbol{x}(k))\equiv f(\boldsymbol{x}(k),\boldsymbol{u}(k)) \quad \boldsymbol{H}_{ij}=\boldsymbol{A}_i+\boldsymbol{B}_i\boldsymbol{K}_j$$
$$\boldsymbol{e}(k)=\{f(\boldsymbol{x}(k))-\sum_{i=1}^{\phi}\sum_{j=1}^{l}h_i(k)\bar{h}_j(k)(\boldsymbol{A}_i+\boldsymbol{B}_i\boldsymbol{K}_j)\boldsymbol{x}(k)\} \tag{13}$$

Then $e(k)$ the closed-loop simulation error is made between non-linear system, the closed-loop system 4. They think that it is that they are in their time of need her womb, but of that.

The matrix of roads and means $\Delta\boldsymbol{H}_{ij}$ such that

$$\|\boldsymbol{e}(k)\|\le\left\|\sum_{i=1}^{\phi}\sum_{j=1}^{\mu}h_i(k)\hat{h}_j(k)\Delta\boldsymbol{H}_{ij}\boldsymbol{x}(k)\right\| \tag{14}$$

for the trajectory $\boldsymbol{x}(k)$ and the bounding matrix $\Delta\boldsymbol{H}_{ij}$ can be described as follows [1, 10]:

$$\Delta\boldsymbol{H}_{ij}=\delta_{ij}\boldsymbol{H}_q \tag{15}$$

where $\|\delta_{ij}\|\le 1$, for $i=1,2,\cdots,\phi$ and $j=1,2,\cdots,\mu$.

a. Initialization: Journal of fitness is defined by the user is updated using the fitness function and the best solution.

b. Termination: Call the term for all of the conditions of the bed, to the S of ten 2, that is, the determination of the program from the nearest places, issues, and it was the best solution.

The simulation criteria are used to be determined via adaptive functions. By means of our own adjustment to find a common consensus and positive aspects, many iterative algorithms can make wise people find better solutions. One chose a place where he could get the material, partly because it was suitable for the bat's natural environment. The composite indicates that the same space is used in the solution during resin regeneration. While population size and all system solutions are moderate, it is possible to install applications.

## 4. Conclusions

A discrete-time algorithm for true value extraction and pseudo value control is proposed. Firstly, the method of 40% model is used to extract the pseudo reality of discrete-time system. But the dynamics of the model was transformed into the local design institute, and for their knowledge. The method is based on template to correct errors. Simulation results show that the proposed method can make the system asymptotically stable in discrete time. The dual model of strength and EBA also provides flexibility and efficiency in finding solutions for managed systems. Bat algorithm has been used in engineering design, classification and other applications. Comparing the bat algorithm with genetic algorithm, PSO and other methods, and using it to train neural networks, the conclusions drawn clearly show that the bat algorithm has a good advantage over other algorithms.

**Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References


1. Cagman, N., & Enginoglu, S. (2010). Soft matrix theory and its decision making. *Computers & Mathematics with Applications*, 59(10), 3308-3314.
2. Cagman, N., & Enginoglu, S. (2010). Soft set theory and uni–int decision making. *European journal of Operational Research*, 207(2), 848-855.
3. Cagman, N., Cıtak, F., & Enginoglu, S. (2010). Fuzzy parameterized fuzzy soft set theory and its applications. *Turkish Journal of Fuzzy System*, 1(1), 21-35.
4. Chen, D., Tsang, E. C. C., Yeung, D. S., & Wang, X. (2005). The parameterization reduction of soft sets and its applications. *Computers & Mathematics with Applications*, 49(5-6), 757-763.
5. Conway, JB. (2007). *A Course In Functional Analysis*, 2nd Ed. Speringer-Verlag,New York,1-25.
6. Dubois, D., & Prade, H. (1982). Fuzzy sets and systems: Theory and applications. *American Mathematical Society*, 7(3), 603- 612. Ernst K, Charles, D. (2018). *Basic Appearance Of Circuits and Networks*, First Volume, 32nd Ed. Tehran University, Tehran, 40-108.
7. Ernst K., & Charles, D. (2018). *Basic Appearance of Circuits and Networks*, First Volume, 32nd Ed. Tehran University, Tehran, 40- 108.
8. Feng, F., Jun, Y. B., & Zhao, X. (2008). Soft semirings. *Computers & Mathematics with Applications*, 56(10), 2621-2628.
9. Kumar, R., Srivastava, S., Gupta, J. R. P., & Mohindru, A. (2018). Diagonal recurrent neural network based identification of nonlinear dynamical systems with Lyapunov stability based adaptive learning rates. *Neurocomputing*, 287, 102-117.
10. Kumar, R., Srivastava, S., Gupta, J. R. P., & Mohindru, A. (2019). Temporally local recurrent radial basis function network for modeling and adaptive control of nonlinear systems. *ISA transactions*, 87, 88-115.
11. Li, J., Zeng, W., Xie, J., & Yin, Q. (2016). A new fuzzy regression model based on least absolute deviation. *Engineering Applications of Artificial Intelligence*, 52, 54-64.
12. Nasrabadi, M. M., & Nasrabadi, E. (2004). A mathematical-programming approach to fuzzy linear regression analysis. *Applied Mathematics and Computation*, 155(3), 873-881.
13. Parvathi, R., Malathi, C., Akram, M., & Atanassov, K. T. (2013). Intuitionistic fuzzy linear regression analysis. *Fuzzy Optimization and Decision Making*, 12(2), 215-229.
14. Pushpa, B., & Vasuki, R. (2013). A least absolute approach to multiple fuzzy regression using Tw-norm based operations. *International Journal of Fuzzy Logic Systems*, 3(2), 73-84.
15. Taheri, S. M., & Kelkinnama, M. (2012). Fuzzy linear regression based on least absolutes deviations. *Iranian Journal of Fuzzy Systems*, 9(1), 121-140.
16. Torabi, H., & Behboodian, J. (2007). Fuzzy least-absolutes estimates in linear models. *Communications in Statistics—Theory and Methods*, 36(10), 1935-1944.
17. Zadeh, L. A. (1978). Fuzzy sets as a basis for a theory of possibility. *Fuzzy Sets and Systems*, 1(1), 3-28.
18. Zadeh, L. A., Klir, G. J., & Yuan, B. (1996). *Fuzzy sets, fuzzy logic, and fuzzy systems*: selected papers (Vol. 6). World Scientific.


Chen, T., Huang, Y. C., & Chen, J. C. Y. (2021). Chaotification of Discrete Dynamical Systems Governed by Continuous Maps and Evolved Fuzzy NN Control. *Fuzzy Optimization and Modelling Journal*, 2 (1), 37-41.

https://doi.org/10.30495/fomj.2021.681566

Received: 2 January 2021 Revised: 2 February 2021 Accepted: 6 February 2021