Journal of Engineering and Applied Sciences 13 (9): 2799-2802, 2018
ISSN: 1816-949X

New Approach of Intelligent Technique to Optimize Artificial Immune Algorithm for High Performance of High Order Non-linear System

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Abstract: In this study, a novel non-linear system identification procedure is established using the structures of the Artificial Immune System (AIS). The high order non-linear system has many difficulties such as need high computation time, slow response and has more oscillation with high steady state error. In order to resolve these problems, a simplified method for AIS combined with immediate feedback mechanism is suggested to optimize the system's parameters simultaneously. To confirm and validate the effectiveness of the proposed algorithm, a simulation example on high order non-linear system based on AIS was studied. This intelligent algorithm realized robustness system with high efficiency by optimizing the complex high order non-linear systems. The simulation results show that the recognized immune models are robust to noise of the system dynamics. The algorithms are naturally modelled after the immune system's characteristics for solving the system problem and optimizing the output signals.

Key words: Artificial Immune System (AIS), high order non-linear system, MATLAB Simulink, parameters, robustness, feedback mechanism

INTRODUCTION

Artificial Immune System (AIS) is a class of an artificial intelligence domain based on rule-based machine learning systems. It is one of the computational intelligent techniques which is inspired by the basics of the "vertebrate immune system". Recently, the Artificial Immune Systems (AISs) are become an interesting field and are successfully applied for solving different engineering and computer science problems (Hunt and Cooke, 1996; Dasgupta and Forrest, 1999; Hofmeyr and Forrest, 1999; De Castro and Timmis, 2002; Castro and Zuben, 1999, 2000; Nazri *et al*., 2013).

The domains of application of AIS are like other computational intelligence techniques for example evolutionary algorithms, swarm intelligence techniques, neural networks techniques and fuzzy logic based systems (Lewis, 1992; Qu and Cloutier, 2002; De Castro and Timmis, 2002; Berek and Ziegner, 1993).

To improve the intrusion detection system, numerous methods such as neural network, probability optimization, support vector machine, genetic algorithm and artificial immune system were proposed to network intrusion detection (Fessi *et al*., 2014; Guo *et al*., 2014; Kumar and Mohan, 2014). Moreover, the AIS-based anomaly detection structures have been developed by Prieto *et al*. (2013), Khan *et al*. (2015), Soualhi *et al*. (2013) and Gao *et al*. (2010). Mainly, AIS is a general anomaly detection method, distinguished from the conventional classifiers in its independent of a priori knowledge about system model and underlying principle (Prieto *et al*., 2013; Khan *et al*., 2015).

The anomaly detection problem is treated as an antigen detection in the biological immune system for AIS-based non-linear system approach (Gonzalez *et al*., 2003). To educate antibodies to distinguish between system self-data "self-antigens" and system fault-data "exogenous", the Negative Selection Algorithm (NSA) is employed.

In the literature, a non-linear system efforts are done on vibration and existing signal analysis using the NSA and its variations. There were many variations of NSA have been stated through detector matching rule variations, diverse geometric shaped detectors and numerous detector generation approaches such as randomized native (Wen *et al*., 2014), clonal selection optimized and grid-file (Gao *et al*., 2010).

However, the detection rate and detector generation is low efficacy because of the algorithm has high computational complexity that exponentially growths with "self-sample size". Rashag *et al*. (2013) areused fuzzy logic to enhance the non-linear machine performance based on close loop estimation. In this study, the AIS is developed to optimize the high order non-linear system and to convert the complexity behaviour of non-linear system to simple system with fast response and low consumption time.

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MATERIALS AND METHODS

In this new approach of AIS, the high order non-linear system is optimized via convert the complex system performance to simple system with low computation time. The proposed intelligent system AIS is executed depending on MATLAB/Simulink and toolbox. The proposed method is shown in Fig. 1. The feedback output signal is applied to block which convert complex data to magnitude data for more simplicity and the data type conversion block is also used for matching with inputs data.

In addition, the three input signals are multiplexing and apply to AIS in parallel. These signals areenhanced by AIS and the optimized signals are generated. These optimized signals will passes through high order non-linear system. Therefore, the efficiency of whole system is improved.

RESULTS AND DISCUSSION

The comparison response of system is shown in Fig. 2 and it can be say that the AIS with high order non-linear system is smooth with fast response while the classical non-linear system has drawbacks at the starting of response.

Additionally, the rippling of system based on AIS is very low and equal to 1 but in traditional high order non-linear system, the ripple is almost equal to 3 as shown on Fig. 3.

In Fig. 4, the time delay of system via. AIS is approach to (100 msec) of iteration time that is more less than the time delay of conventional system which is nearly (1000 msec) of iteration time.

The error of proposed AIS is approximately 1 as appear in Fig. 5. However, the error in the traditional system is >2 which can be seen in Fig. 5.

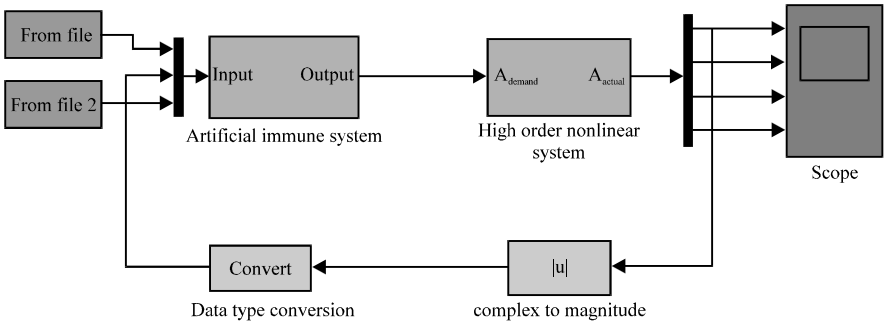

Fig. 1: Simulink of proposed AIS with high order non-linear system

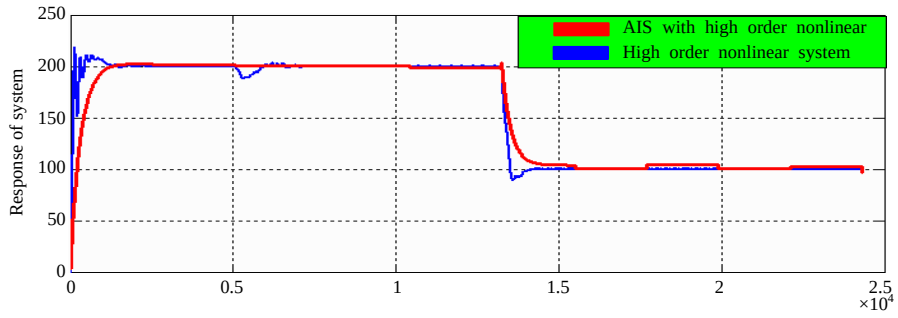

Fig. 2: Response of system

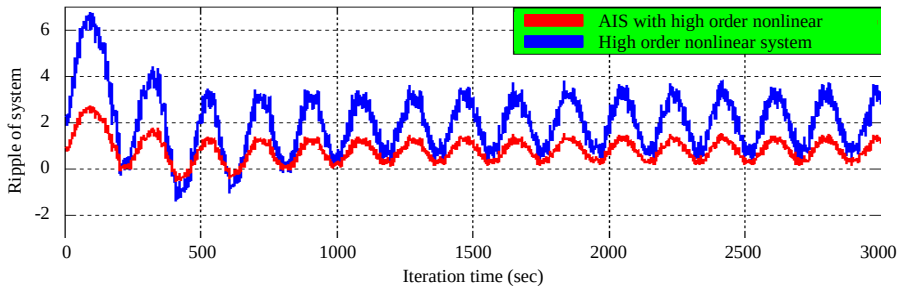

Fig. 3: Comparison of ripple

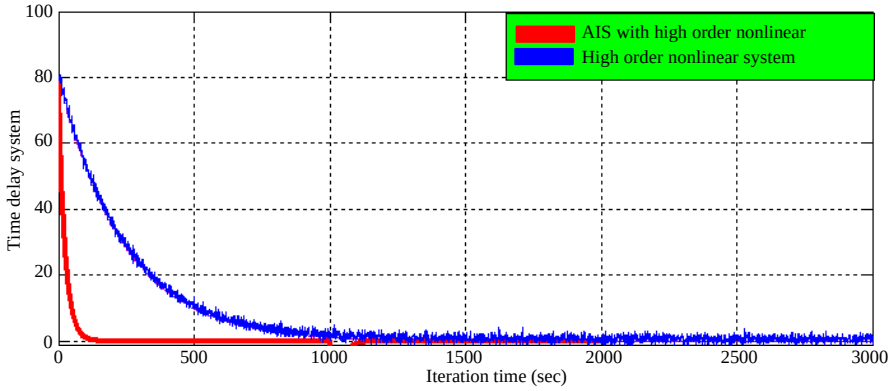

Fig. 4: Time delay of system

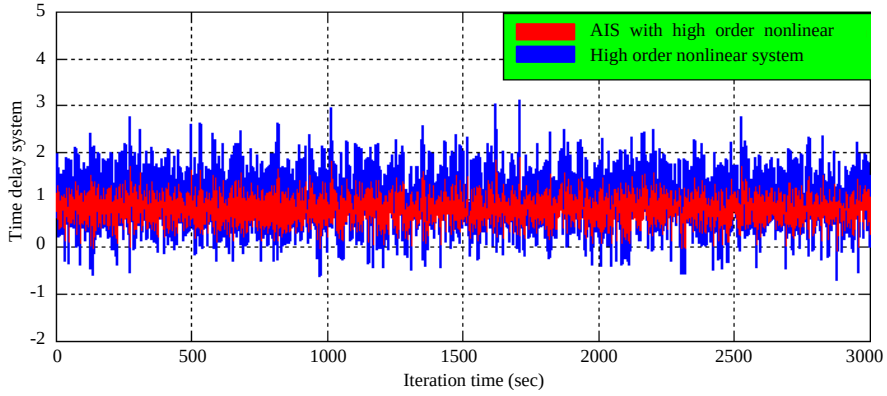

Fig. 5: Error of system

CONCLUSION

The artificial immune system algorithm based high order non-linear system is effectively applied to optimize the entire system in this study. It is revealed that the new adapted AIS algorithm is employed to find the optimal solution of non-linear. Furthermore, it was able to attain fast system response while averting the complex mathematical model. The proposed techniques gave results better than the traditional high order non-linear system and this result can be related with getting the correct parameterization. The benefits of using AIS to attain the highest improvements over the conventional methods are it can be used for both linear and non-linear cases. In addition and dissimilar than the traditional high order non-linear system method which needs high computational time, the optimum outputs are calculated offline and online with low time. In addition, it gave a steady optimal gain for non-linear system comparing with the classical method. The AIS is a compact method for performing optimal acceptably. Hence, it has the ability to optimize the non-linear system over the other artificial intelligent due to its simplicity in design, fast response and low computation time.

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