OPEN ACCESS Freely available online

Journal of Chemical Engineering & Process Technology

Reduced-order modeling of linear time-invariant systems using nature-inspired metaheuristic algorithms: issues and challenges

Ganguli S

Thapar Institute of Engineering and Technology, India

Abstract

The mathematical modeling of physical systems leads to a comprehensive description of the models. But the difficulty arises while analyzing the system or developing its control scheme. Thus, it is required to constitute a diminished model that preserves the inherent features of the parent system. Parallel to the classical techniques, researchers have also started exploring in recent times the problem of model reduction with the help of nature-inspired metaheuristic algorithms. But there are certain perennial problems of order reduction using metaheuristic approaches for which it is still not a popular choice. Most of the metaheuristic techniques are stochastic and give rise to different solutions on each independent run. Hence, multiple runs are required to test the accuracy of the results. Some statistical measures like best, worst, average, and standard deviation of the error function need to be calculated. Even some non-parametric statistical tests may also be conducted to validate the results with reference to the other metaheuristic techniques. Kruskal Wallis test, Wilcoxon's signed-rank, and rank-sum tests, etc. are usually some of the commonly used tests available in the literature that can be employed to test the significance of the results. Moreover, the dc gain of the original and the reduced systems must match. This can be made possible by applying suitable equality constraints. In addition to this, a reduced system must preserve the stability of the parent model. This can also be satisfied with some constraint to have the poles of the reduced-order model on the left half of the s-plane. Further, the reduced system should not have a zero on the right half of the s-plane. This can be avoided by an appropriate inequality constraint. Even constraints can be set for matching the important time and frequency domain measures. So, it is thereby proved that the model reduction techniques using metaheuristic-based methods will require to solve the constrained optimization problem. There are moreover choices like population size, the maximum number of iterations, and search bounds of the model parameters to be estimated that are arbitrary. So far decision is taken either on the prior experience or through trial and error. A higher choice of population size, say for example 50 or 100 will stabilize the result on each run. The number of function evaluations, obtained by the product of the population size and the number of iterations can be checked out from the number of decision variables considered to be estimated. Some researchers also estimate the parameters of the denominator polynomial with the aid of classical based approaches.

Biography

Souvik Ganguli is presently working as the Assistant Professor in the Department of Electrical & Instrumentation Engineering, Thapar Institute of Engineering and Technology, Patiala. He has pursued B. Tech (Electrical Engineering) and M. Tech (Mechatronics) in the years 2002 and 2008 respectively. He has completed his Ph.D. degree in system identification and control from the Thapar Institute of Engineering and Technology in October 2019. He has a total of 16 years of work experience in industry, teaching, and research. His research interests include model order reduction, identification and control, nature-inspired metaheuristic algorithms, electronic devices, and renewable energy applications. He has nearly 100 publications that have been cited around 128 times, and his publication H-index is 6, and has been serving as a reviewer of several reputed journals.

5th Global Innovators Summit | February 24, 2021

Citation: Ganguli S, Reduced-order modeling of linear time-invariant systems using nature-inspired metaheuristic algorithms: issues and challenges, Innovators 2021, 5th Global Innovators Summit, February 24, 2021, Pages 03