Iranian Society of Acoustics and Vibration
The 13th ISAV2023 International Conference on Acoustics and Vibration
20 , 21 Dec 2023 Tehran - Iran

Leveraging Koopman Operators and Deep Neural Networks for Parameter Estimation and Future Prediction of Duffing Oscillators

Yassin Riyazi[1], NavidReza Ghanbari[1], Arash Bahrami[2]

[1]M.Sc. Student, School of Mechanical Engineering, College of Engineering, University of Tehran, Tehran, Iran.
[2] Assistant Professor, School of Mechanical Engineering, College of Engineering, University of Tehran, Tehran, Iran., email: arash.bahrami@ut.ac.ir

The exploration of nonlinear dynamical systems holds significant importance across scientific and engineering disciplines, primarily for its applications in modeling real-world phenomena. Traditional methods employed for the analysis and prediction of the behavior of these systems typically involve intricate mathematical techniques and numerical simulations. This paper presents an innovative approach that combine the capabilities of the Koopman operator and deep neural networks to establish a linear representation of the Duffing oscillator. This newly developed methodology facilitates effective parameter estimation and the ac-curate prediction of the oscillator's future behavior. Moreover, the paper proposes a modified training procedure aimed at confining the Koopman operator to a linear layer within the neural network, as opposed to its application across the entire network. This synergy between the Koopman operator and deep neural networks not only simplifies the analysis of nonlinear systems but also paves the way for significant advancements in predictive modeling across diverse fields.