

JAYESH M. DHADPHALE

@jayeshmdhadphale@gmail.com

jayesh-m-dhadphale

+91 9623101271

JayeshMD

Chennai, India

0000-0003-3502-9009

in jayeshmdhadphale

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SUMMARY

Doctoral student (submitted thesis) with experience in computational combustion, thermoacoustics, and machine learning. Experienced in implementing and validating Navier–Stokes characteristic boundary conditions (NSCBC) for large eddy simulation (LES) of reacting flows. Proficient in data-driven modeling of thermoacoustic systems and predicting the onset of thermoacoustic instability. Proposed a novel MAPSR method for data-driven modeling of dynamical systems. Built a computer using a field programmable gate array (FPGA), including an ALU, assembler, stack machine, compiler for an object-oriented language, operating system, and games that run on the same computer.

FIELDS OF INTEREST

Machine learning, combustion, combustion instability, nonlinear dynamics, time series analysis, numerical methods, CFD, FPGA.

RESEARCH EXPERIENCE

Indian Institute of Technology Madras (IIT Madras), Chennai, India

- Spatiotemporal modeling of thermoacoustic systems
 - Developed a framework to combine data of disparate spatial dimensions and sampling frequencies to model a dynamical system.
 - The framework involves integration of techniques from the field of machine learning and nonlinear dynamics.
 - The proposed method of integrating techniques from nonlinear dynamics enhances model accuracy compared to applying machine learning techniques alone. (Draft is under preparation)
- Model adaptive phase space reconstruction (MAPSR).
 - The MAPSR method integrates the phase space reconstruction (PSR) with the machine learning framework.
 - The MAPSR method is applicable to model unequally sampled time series data.
 - The prediction accuracy for the MAPSR method is significantly better compared to existing PSR methods.
- Neural ODE to model and prognose thermoacoustic instability.
 - Proposed a method to model the dynamics of thermoacoustic systems using neural ODE with only a few observed variables, i.e., time series of pressure and heat release rate fluctuations.
 - Proposed a measure to quantify the proximity of combustor dynamics to thermoacoustic instability.

Indian Institute of Science, Bengaluru, India

- Contributed to the implementation of the Navier–Stokes characteristic boundary conditions (NSCBC) for reacting flows.
- Investigated the dynamics of methane-air flame for steady and perturbed equivalence ratios.
 - Validated the LES solver using the experimental results of Varea et al. 2012 for Markstein's length.

EDUCATION

Ph. D. in Aerospace Engineering

Indian Institute of Technology Madras, Chennai, India

August 2019 - December 2025 (Expected)

(Thesis is under review) CGPA: 9.5/10.0

Pattern Recognition and Machine Learning

Acoustics and Noise Control

Dynamical Systems

Aerospace Propulsion

Acoustic Instabilities in Aerospace Propulsion

M.E. in Aerospace Engineering

Indian Institute of Science, Bengaluru, India

August 2015 - August 2017

CGPA: 6.4/8.0

Fluid dynamics

Aerodynamics

Mechanics and Thermodynamics of Propulsion

Gas Dynamics

Applied Combustion

Computational Gas Dynamics

Computation of Viscous Flows

Advanced Combustion

B.E. in Mechanical Engineering

Savitribai Phule Pune University, Pune, India

July 2011 - May 2015

Percentage: 66%

ACHIEVEMENTS



Institute Research Award, IIT Madras, 2024

As a recognition for exceptional research contributions.



International Immersion Experience (IIE) Award, IIT Madras, 2022

Developed *model adaptive phase space reconstruction* (MAPSR) method during the visit to Potsdam Institute for Climate Impact Research (PIK), Germany.



Prime Minister's Research Fellow (PMRF), 2019

Selected as a PMRF fellow for Ph. D. in Aerospace Engineering.



All India Rank 23 in GATE, 2015

Graduate Aptitude Test in Engineering, Mechanical Engineering-stream.

- Studied the effect of the strain rate and curvature on the flame speed.
- Assessed the applicability of the dynamic flammability limit extinction criterion to methane-air flame experiencing equivalence ratio fluctuations.

WORK EXPERIENCE

Project Associate

Indian Institute of Science, Bengaluru, India

📅 January 2018 - July 2019

- Developed a solver for stability analysis of thermoacoustic systems for high-pressure conditions.
 - Validated the solver for a duct with different flame locations.
 - The solver is implemented with a Soave-Redlich-Kwong equation of state.

Teaching Assistant

National Programme on Technology Enhanced Learning (NPTEL)

📅 Computational science in engineering, February 2023 - March 2023

📅 Numerical methods, July 2022 - November 2022

📅 Steam and gas power systems, January 2022 - April 2022

PUBLICATIONS

📄 Journal Articles

- J. M. Dhadphale, K. Hauke Kraemer, M. Gelbrecht, J. Kurths, N. Marwan, and R. I. Sujith, "Model adaptive phase space reconstruction," *Chaos: An Interdisciplinary Journal of Nonlinear Science*, vol. 34, no. 7, p. 073 125, Jul. 2024, ISSN: 1054-1500. DOI: 10.1063/5.0194330.
- S. Singh, A. Roy, J. M. Dhadphale, S. Chaudhuri, and R. I. Sujith, "Continuous and explosive synchronization transition in turbulent combustors," *AIP Advances*, vol. 14, no. 6, p. 065 106, Jun. 2024, ISSN: 2158-3226. DOI: 10.1063/5.0187980.
- A. Sahay, A. Kushwaha, S. A. Pawar, M. P. R., J. M. Dhadphale, and R. I. Sujith, "Mitigation of limit cycle oscillations in a turbulent thermoacoustic system via delayed acoustic self-feedback," *Chaos: An Interdisciplinary Journal of Nonlinear Science*, vol. 33, no. 4, p. 043 118, Apr. 2023, ISSN: 1054-1500. DOI: 10.1063/5.0129512.
- S. Singh, A. K. Dutta, J. M. Dhadphale, A. Roy, R. I. Sujith, and S. Chaudhuri, "Mean-field model of synchronization for open-loop, swirl controlled thermoacoustic system," *Chaos: An Interdisciplinary Journal of Nonlinear Science*, vol. 33, no. 4, p. 043 104, Apr. 2023, ISSN: 1054-1500. DOI: 10.1063/5.0136385.
- J. M. Dhadphale, V. R. Unni, A. Saha, and R. I. Sujith, "Neural ODE to model and prognose thermoacoustic instability," *Chaos: An Interdisciplinary Journal of Nonlinear Science*, vol. 32, no. 1, p. 013 131, Jan. 2022, ISSN: 1054-1500. DOI: 10.1063/5.0064215.

👤 Patent

- J. Dhadphale, E. A. Ruiz, V. R. Unni, A. Saha, and S. I. Nair, *Device and method to predict the onset of oscillatory instabilities in systems with turbulent flow*, US Patent App. 17/377,918, Jan. 2022.

SELF ASSESSMENT

Machine Learning and data-driven modeling

Neural ODE	●	●	●	●	●
Phase space reconstruction					
Sparse modeling	●	●	●	●	●
Bayesian methods	●	●	●	●	●
Neural networks	●	●	●	●	●

Combustion and simulation

Thermoacoustics	●	●	●	●	●
LES	●	●	●	●	●
NSCBC	●	●	●	●	●
Finite difference methods	●	●	●	●	●
Stability analysis of the thermoacoustic system for high-pressure conditions	●	●	●	●	●

Computing Tools and Languages

Python	●	●	●	●	●
PyTorch	●	●	●	●	●
MATLAB	●	●	●	●	●
C	●	●	●	●	●
C++	●	●	●	●	●
C#	●	●	●	●	●
GitHub	●	●	●	●	●
Linux	●	●	●	●	●
Ansys ICEM CFD	●	●	●	●	●
SOLIDWORKS	●	●	●	●	●
LaTeX	●	●	●	●	●
FPGA	●	●	●	●	●
Vivado	●	●	●	●	●
Unity	●	●	●	●	●
TensorFlow	●	●	●	●	●
Cuda C	●	●	●	●	●

Scales

Limited knowledge	●	●	●	●	●
Working knowledge	●	●	●	●	●
Competent	●	●	●	●	●
Significant experience	●	●	●	●	●
Expert	●	●	●	●	●