Nirmal Jayaprasad Nair

Contact Information

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Education

University of Illinois at Urbana-Champaign, Urbana, Illinois — 2018 – present
Ph.D., Aerospace Engineering — GPA: 3.96/4.0
Concentration: Computational Science and Engineering

University of Illinois at Urbana-Champaign, Urbana, Illinois — 2016 – 2018
M.S., Aerospace Engineering — GPA: 4.0/4.0

Indian Institute of Technology Gandhinagar, Gujarat, India — 2012 – 2016
B.Tech. (*Honors*), Mechanical Engineering — GPA: 9.24/10.0

Research Interests

- Computational fluid dynamics
- Fluid-structure interaction
- High performance computing
- Deep learning
- Reduced-order modeling
- Machine learning

Research Experience

Graduate Research Assistant — September 2018 – present
Ph.D. thesis adviser: Prof. Andres Goza, UIUC, Champaign, IL
Integrating sensor data into reduced-order models (ROMs) using deep learning.

- Developing a state estimation methodology where real-time sensor data is mapped to the ROM state space using deep neural networks in Pytorch.

Data-driven flow field estimation around an airfoil using passively deployed flaps.

- Passively deployed flaps will be modeled as flow-field estimating sensors by mapping the dynamics of the flaps to the flow-field using snapshot data.

Scalable solver for simulating strongly coupled fluid-interaction flows.

- Developing a parallel CFD solver for simulating fluid-structure interaction problems consisting of rigid and torsionally hinged bodies using MPI and PETSC.

CSRI Summer Intern — June 2019 – August 2019
Adviser: Dr. Kevin Carlberg, Sandia National Laboratories, Livermore, CA
Guaranteeing convergence of ROMs on nonlinear manifold using transfer learning.

- Developed an adaptive manifold refinement strategy to enable convergence of ROMs on manifolds built using deep convolutional autoencoders on Tensorflow.

Graduate Research Assistant — August 2016 – August 2018
M.S. thesis adviser: Prof. Maciej Balajewicz, UIUC, Champaign, IL
Data-driven reduced-order modeling of advection-dominated fluid flows.

- Developed a novel data-driven model order reduction method for parametric, steady-state fluid flows containing evolving shocks.

Summer Undergraduate Research Fellow — May – July 2015
Adviser: Prof. Austin Minnich, California Institute of Technology, Pasadena, CA

- Designed and fabricated a prototype consisting of thermoelectric generators to power wireless temperature sensors in aircraft.

Summer Research Internship Program May 2014 – April 2015
Adviser: Prof. Vinod Narayanan, IIT Gandhinagar, India

- Studied the stability characteristics of axisymmetric thermal boundary layer of various fluids in response to heating and cooling.

Skills

Programming: Python, Matlab, Fortran, C.
Machine Learning: Pytorch, Tensorflow.
High Performance Computing: PETSC, MPI, OpenMP.
CFD and CAD: Ansys Fluent, Star CCM+, Autodesk Inventor.
Miscellaneous: Latex, Git.

Publications

4. N.J.Nair and A. Goza. A strongly coupled immersed boundary method for fluid-structure interaction that mimics the efficiency of stationary body methods. *Preprint arXiv:2103.06415*, 2021.
3. N.J. Nair and A. Goza. Leveraging reduced-order models for state estimation using deep learning. *Journal of Fluid Mechanics*, 897, 2020.
2. N.J. Nair and M. Balajewicz. Transported snapshot model order reduction approach for parametric, steady-state fluid flows containing parameter-dependent shocks. *International Journal for Numerical Methods in Engineering*, 2019; 117:1234–1262.
1. N. Jayaprasad, et al. Exploring viscous damping in undergraduate Physics laboratory using electromagnetically coupled oscillators. *Preprint arXiv:1311.7489*, 2013.

Conference Talks

Invited Talks

1. N.J. Nair and M. Balajewicz. Transported snapshot model order reduction approach for parametric, steady-state fluid flows containing parameter dependent shocks. *SIAM Conference on Computational Science and Engineering*, 2019.

Contributed Talks

5. N.J. Nair and A. Goza. Numerical study of a passively deployable flap for aerodynamic flow control. *APS, Division of Fluid Dynamics*, 2020.
4. N.J. Nair and A. Goza. Integrating sensor data into reduced-order models with deep learning. *APS, Division of Fluid Dynamics*, 2019.
3. N.J. Nair and M. Balajewicz. Physics based interpolation for steady parametric partial differential equations. *APS, Division of Fluid Dynamics*, 2017.
2. N.J. Nair and U. Shah. A simple computational tool for studying acoustic waves in nonlinear medium. *ASME, International Design Engineering Technical Conferences*, 2017.
1. N. Jayaprasad and V. Narayanan. Effect of viscosity stratification on stability of axisymmetric boundary layer. *APS, Division of Fluid Dynamics*, 2015.

Honors & Awards

AE Outstanding Graduate Student Fellowship, UIUC 2020
Conference Travel Grant, APS DFD 2019
SIAM Student Travel Award, SIAM CSE 2019
Conference Travel Award for Graduate Students, UIUC 2017
MSNDC Student Travel Grant, ASME IDETC 2017
Award for 'Best Performance in the core subjects of Engineering Graphics, Manufacturing and Workshop Practice', IIT Gandhinagar 2016

Summer Undergraduate Research Fellowship, Caltech 2015

Dean's List, IIT Gandhinagar 2013, 2014, 2015

Merit cum Means Scholarship, IIT Gandhinagar 2012, 2013, 2014

Winner of Ricoh Printer Design Challenge, IIT Gandhinagar 2014

Projects

Aeroacoustics, UIUC Spring 2021

- Developed a nonlinear modal decomposition framework to accurately represent transient fluid flows and extract meaningful flow structures using deep convolution autoencoders.

Nonlinear modal decomposition of transient fluid flows, UIUC Spring 2020

- Developed a nonlinear modal decomposition framework to accurately represent transient fluid flows and extract meaningful flow structures using deep convolution autoencoders.

MPI and OpenMP based parallel 2D CFD solver, UIUC Fall 2018

- Developed a parallel solver based on finite difference methods to solve the 2D advection-diffusion equation using MPI and OpenMP.

Passive flow control using vortex generators, UIUC Fall 2016

- Studied passive flow control using vortex generators to delay shock induced flow separation on an Onera M6 wing in transonic flow regime using Ansys Fluent.

Academic Services and Affiliations

Reviewer, Journal of Computational Physics 2018–

Reviewer, International Journal for Numerical Methods in Engineering 2018–

Student Member, Society of Industrial and Applied Mathematicians (SIAM) 2018 –

Student Member, American Physical Society (APS) 2017 –

Teaching

Teaching Assistant, UIUC Fall 2019, Fall 2020
AE 433: Aerospace Propulsion

Tutor, IIT Gandhinagar Spring 2016
ES 212: Momentum, Heat and Mass Transfer

Teaching Assistant, IIT Gandhinagar Fall 2013
ES 101: Engineering Graphics

Leadership

Mentor, Summer Undergraduate Research, UIUC May – July 2017
Mentored and supervised an undergraduate student on his research project and provided the necessary guidance to maintain progress.

Events Coordinator, Amalthea' 13, IIT Gandhinagar May – October 2013
Led a team of 21 students to plan and organize various technical events at Amalthea'13 which is the annual technical summit of IIT Gandhinagar.