Siddharth Nair

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Education

Purdue University   West Lafayette-IN, USA
PhD in Mechanical Engineering,   Jan 2020 - Present
Research Assistant to Prof. Fabio Semperlotti
Thesis: Scientific machine learning for forward and inverse problems in mechanics

Purdue University   West Lafayette-IN, USA
MS in Aeronautical Engineering,   Aug 2017 - Dec 2019
Thesis: Nonlocal acoustic black hole metastructures: Achieving ultralow frequency and broadband vibration attenuation

Vellore Institute of Technology (VIT)   Chennai, India
B.Tech in Mechanical Engineering,   Aug 2013 - May 2017
Capstone project: Noise reduction techniques for micropropellors of unmanned aerial vehicle (UAV) at CSIR-NAL

Experience

Graduate Research Assistant, Ray W. Herrick Laboratories   Aug 2018 - Present
  1. **Jan 2020 - Present (PhD):**
     Under academic alliance program with Sandia National Laboratories -
     - Currently working on the development of reinforcement learning-based design optimization and damage detection in microchips.
     - Developed fully physics-informed network models capable of simulating wave propagation in the presence of multiple rigid scatterers or damages.
     - Developed a novel deep learning based inverse design approach for remote sensing and material design applications in the field of acoustics.
  2. **Aug 2018 - Jan 2020 (MS):**
     - Developed a novel low-frequency vibration attenuation approach using acoustic black holes (ABHs) in mechanical structures. This study introduced the concept of *nonlocal ABH metastructures.*
     - Studied fluid-structure interaction (FSI) problem for acoustic field control through design changes on Helmholtz resonators to improve the vibration attenuation bandwidth of the resonators.

Graduate Teaching Assistant, Purdue University   Jan - May 2021, Aug 2023 - Present
  - Assisted in supervising a class of 110 students for the undergraduate courses of ME-270: Basic Mechanics-I in Fall 2023 and ME-274: Basic Mechanics-II in Spring 2024.
  - Assisted in teaching the graduate courses of ME-562: Advanced Dynamics in Spring 2021 and ME-650: Computational Fracture Mechanics in Spring 2024.
  - Integrated the courses into an online platform using Zoom and Brightspace. Supported students with subject materials, weekly homework packets, and office hours.

Aerospace Associate Intern, Airspace Experience Technologies (ASX)   June 2018 - Aug 2018
  - Worked as structural and CFD engineering intern for the development of a prototype model of vertical take-off and landing (VTOL) aircraft.
  - Developed structural loading pattern for the wing, fuselage, and V-tail and evaluated the structural integrity of individual components using Autodesk NASTRAN. Conducted CFD simulations in Autodesk CFD and modified optimization algorithm for propeller design in MATLAB. The design changes based on these analyses improved the lift-to-drag ratio of the VTOL aircraft prototype by four times.

Project Trainee Intern, CSIR - National Aerospace Laboratories   Jan 2017 - May 2017
  - Design and analysis of propeller blades to develop noise reduction techniques in unmanned aerial vehicles (UAVs).
  - Incorporated propeller design changes in SOLIDWORKS, simulated the updated setup computationally using the acoustics module in ANSYS, and experimentally validated the noise reduction performance.

Areas of Interest

  - **Research Interest:** Structural dynamics, Wave propagation, Acoustics, Computational mechanics, Material design and optimization, Scientific machine learning, and Physics-informed deep neural networks.

  - **Relevant coursework:**
    Structural Mechanics and Dynamics - Elasticity, Mechanical Vibrations, Advanced Dynamics, Continuum Mechanics, Wave Propagation, Fracture Mechanics, and Nonlinear Wave Mechanics.
    Computational Modeling - Numerical Methods, Multidisciplinary Design Optimization, Nonlinear Finite Element Methods, Data Analytics, and Deep Learning.

Journal Publications

1. **S. Nair**, T.F. Walsh, G. Pickrell, and F. Semperlotti. GRIDS-Net: Inverse shape design and identification of scatterers via geometric regularization and physics-embedded deep learning. Computer Methods in Applied Mechanics and Engineering, 2023.

2. **S. Nair**, M. Jokar, and F. Semperlotti. Nonlocal acoustic black hole metastructures: Achieving broadband and low frequency passive vibration attenuation. Mechanical Systems and Signal Processing, 2022.

3. **S. Nair**. Nonlocal acoustic black hole metastructures: Achieving broadband and ultralow frequency passive vibration attenuation. MS Dissertation. Purdue University, 2019.

4. **S. Nair**, T.F. Walsh, G. Pickrell, and F. Semperlotti. Multiple scattering simulation using physics-informed neural network. *Under Review*, Jan 2024.

5. **S. Nair**, T.F. Walsh, G. Pickrell, and F. Semperlotti. Physics-informed neural operator network with geometry adaptability for rigid body scattering. *Under Review*, Jan 2024.

Conference Publications and Patent

1. **S. Nair**, T.F. Walsh, G. Pickrell, and F. Semperlotti. A deep learning approach for the inverse shape design of 2D acoustic scatterers. Oral and paper presentation at *SPIE Smart Structures + Nondestructive Evaluation Conference*, March 2023, Long Beach-CA, USA. [**2nd Best Paper Award**]

2. **S. Nair**, M. Jokar, and F. Semperlotti. Broadband vibration attenuation via nonlocal acoustic black hole metastructures. Invited presentation at the *Program of 181st Meeting of the Acoustical Society of America (ASA)*, Nov 2021, Seattle-WA, USA.

3. F. Semperlotti, **S. Nair**, and M. Jokar. Vibration attenuation via tailored metastructures. Non-provisional patent application filed with USPTO serial no.: 18/217,539.

Major Achievements

- Selected to present in the student poster session at the 3rd annual Purdue Sandia Top Talent Reception (STTaR) Fall 2023 hosted by the Sandia National Laboratories.

- Secured **2nd place** at the **Best Paper Awards** of the Health Monitoring of Structural and Biological Systems conference session organised by the International Society for Optics and Photonics (SPIE) Smart Structures + NDE 2023 in Long Beach, CA.

- Zuura Formula Racing (ZFR) secured 16th position in the IC engine class of student vehicles at FSAE Australasia, Melbourne-2017. ZFR was adjudged the only Indian team to finish in the top 20.

- **Winners** of Purdue cricket league- Fall 2022.

- Awarded for being in the top ten mechanical engineering students at VIT University-Chennai (2015, 2016, and 2017).

- Certified SOLIDWORKS Associate (CSWA).

- Completed trekking and mountaineering course at Atal Bihari Vajpayee Institute of Mountaineering and Allied Sports Manali, Govt. of Himachal Pradesh, India.

Activities

- Provided guidance and mentorship to 6 undergraduate students through the Purdue ME undergraduate research program at Prof. Semperlotti's research lab from 2021-23. The program included the preparation of hands-on learning activities, outlining research tasks, and providing personalized one-on-one mentorship.

- Brakes department head of Zuura Formula Racing (ZFR), a formula student team. ZFR is the official FSAE team from VIT University-Chennai.

- Worked as a volunteer in VITeach, a non-profit organization focused on providing basic English education to primary school children in rural parts of Chennai, India.

- Participated in Purdue cricket league, an indoor inter-college cricket tournament.

Skills

- **Software:** Python, MATLAB, Mathematica, COMSOL, SOLIDWORKS, ABAQUS, ANSYS Workbench, Autodesk NASTRAN, Autodesk CFD, LaTeX, CNC Train.

- **Hardware:** 3-axis CNC milling, 3D printing, Composite layup, Lathe, Welding.