Raghav Gnanasambandam

Virginia Tech, Blacksburg, VA

✉ raghavg@vt.edu   🏠 raghavg97.github.io   in raghav-g

PROFESSIONAL EXPERIENCE

Assistant Professor, FAMU-FSU College of Engineering   (incoming Fall)
    Department of Industrial and Manufacturing Engineering

Research Assistant, Virginia Tech   2020 - Present
    Department of Industrial and Systems Engineering

EDUCATION

Virginia Tech, Blacksburg, VA   2019 - Present
    Ph.D. in Industrial and Systems Engineering
- Dissertation: *Physics-informed Machine Learning for Digital Twin in Metal Additive Manufacturing*

Indian Institute of Technology (IIT) Madras, Chennai, India   2014 - 2019
    Dual Degree (B.Tech & M.Tech) in Mechanical Engineering
- Specialization: *Intelligent Manufacturing*

RESEARCH STATEMENT

*My research utilizes **Process Physics** and **Data Science** for enabling **Digital Twins** for **Advanced Manufacturing**. I developed a novel activation function for **Physics-Informed Neural Networks** (PINNs) to solve multi-scale **Partial Differential Equation** (PDE) systems. I proposed a novel **Bayesian Optimization** algorithm for optimizing the process parameters. I am working on first-of-its-kind simulators for **Laser Powder Bed Fusion** (L-PBF) and **Additive Friction Stir Deposition** (AFSD) with PINNs.*

AWARDS & ACHIEVEMENTS

- **Outstanding PhD Student** (2023), ISE at Virginia Tech
  - *For research work, honors, and service*
  - *Awarded cash prize of $600*
- **Winner**, IISE QCRE ProcessMiner Industrial Data Challenge 2023
  - *Proposed Seq-2-Seq LSTM model for Fungal Spores prediction in paper industry*
  - *Achieved highest prediction accuracy among 8 participants*
  - *Awarded cash prize of $1,000*
- **Winner**, IISE QCRE ProcessMiner Industrial Data Challenge 2022
  - *Developed a novel activation function for deep learning*
  - *Awarded cash prize of $2,000*
- **Winner**, INFORMS DMDA Workshop Poster Competition 2022
  - *Presented a <u>video</u> of my research poster*
  - *Awarded cash prize of $500*
- **Finalist**, INFORMS QSR Data Challenge 2022
  - *Developed a novel method for anomaly detection and root-cause analysis for Ford Motor Company*
  - *One of the four finalists*
- **Travel Awards** (2022-2023), ISE at Virginia Tech
  - *Conference Travel Awards worth $2,000*
- **ISE Graduate Fellowship** (2019-2020), Virginia Tech
  - *Awarded $9,765 over 9 months*
- **Undergraduate Scholarship** (2014-2019), NLC India Ltd.

PUBLICATIONS

1. **R. Gnanasambandam**, B. Shen, J. Chung, X. Yue, and Z.J. Kong. "Self-scalable Tanh (Stan): Multi-scale Solutions for Physics-Informed Neural Networks". IEEE Transactions on Pattern Analysis and Machine Intelligence 45.12 (2023) (Impact Factor 23.6). [Paper] [Code]
   - *Winner, IISE QCRE ProcessMiner Data Challenge Competition 2022*
   - *Winner, INFORMS DMDA Workshop Poster Competition 2022*

2. **R. Gnanasambandam**, B. Shen, A.C.C. Law, C. Dou, and Z.J. Kong. "Deep Gaussian Process for Enhanced Bayesian Optimization and its Application in Additive Manufacturing". IISE Transactions 2024. [Paper] [Code]

3. B. Shen, **R. Gnanasambandam**, R. Wang, and Z.J. Kong. "Multi-task Gaussian Process Upper Confidence Bound for Hyperparameter Tuning and its Application for Simulation Studies of Additive Manufacturing". IISE Transactions 55.5 (2023): 496-508. [Paper]

4. V. Akhil, **R. Gnanasambandam**, N. Arunachalam, and D.S. Srinivas. "Image Data-Based Surface Texture Characterization and Prediction Using Machine Learning Approaches for Additive Manufacturing." J. Comput. Inf. Sci. Eng. 20.2 (2020): JCISE-19-1222. [Paper] [Code]

5. V. Akhil, N. Arunachalam, **R. Gnanasambandam**, and D.S. Srinivas. "Surface Texture Characterization of Selective Laser Melted Ti-6Al-4V Components using Fractal Dimension and Lacunarity Analysis." Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Eng. Manuf. (2020). [Paper] [Code]

6. R. Wang , R. Wang , C. Dou , S. Yang , **R. Gnanasambandam**, A. Wang, and Z.J. Kong. "Novel Fiber Optic Sensing with Extra High Spatial Resolution Enabled by Machine Learning and its Application for Sub-surface Thermal Measurement in Additive Manufacturing Processes". Major Revision. Nature Communications.

In Preparation

7. **R. Gnanasambandam**, X. Wu, C. Dou, Y.Zhu, H. Yu, and Z.J. Kong. "Transient Modeling of Additive Friction Stir Deposition with coupled Physics-informed Machine Learning". To be submitted to the Journal of Manufacturing Processes by February 2024.

8. **R. Gnanasambandam**, J. Chung, Y. Zhang, C. Li, M. Marena, N.R. Jordan, B. Shen, and Z.J. Kong. "A Holistic Data Analytics Framework for Laser Powder Bed Fusion". To be submitted to Journal of Intelligent Manufacturing Systems by March 2024.

9. A.I. Saimon, **R. Gnanasambandam**, and Z.J. Kong. "Physics-informed PointNet for Thermal Modeling in Metal Additive Manufacturing". To be submitted to IISE Transactions by May 2024.

10. C. Dou, R. Wang, and **R. Gnanasambandam**. "Spatially Dynamic Printing Parameter Optimization for Laser Powder Bed Fusion". To be submitted to the IISE Transactions by February 2024.

Conference Papers

11. **R. Gnanasambandam** and Z.J. Kong. "Physics-informed Machine Learning based Fast Prediction for Dynamic Thermal Distribution of Additive Manufacturing". Refereed Extended Abstract. IISE Annual Conference and Expo 2023.

12. **R. Gnanasambandam**, Chaoran Dou, and Z.J. Kong. "Thermal Simulation for Metal Additive Manufacturing: Traditional Numerical Simulations vs Physics-informed Neural Networks". Refereed Extended Abstract. IISE Annual Conference and Expo 2024 (Accepted).

PROJECTS

- **Office of Naval Research** Multidisciplinary University Research Initiatives (MURI) — 2019-2024
  - *Topic: Rationalization of Interphase Instabilities During Thermo-Mechanical Gyrations Typical to Metal Additive Manufacturing (AM)*
  - *Collaboration with Materials Scientists*
  - *Contributed in Physics-informed Machine Learning for Laser Powder Bed Fusion*

- **IIT Madras & Prisms India Pvt. Ltd.** — 2017-2018
  - *Topic: Automation of Straightness Measurement in Autocollimator with a Vision System*
  - *Built the software interface to process real time video data from Autocollimator*

TEACHING EXPERIENCE

- Industrial Cost Control (ISE 3004), GTA, Virginia Tech — Spring 2021
  - *One of the two GTAs for a class of 120 students*
- Facilities and Logistics (ISE 3214), GTA, Virginia Tech — Fall 2019 & 2020
  - *One of the four GTAs for a class of 200 students*
- Manufacturing Processes Lab (ISE 2214), GTA, Virginia Tech — Spring 2020
  - *Sole lab instructor for 8-10 students per experiment (with 250 enrolled students)*
  - *Handled the online transition due to COVID-19*
- Measurement, Instrumentation, and Control (ME 2400), GTA, IIT Madras — Spring 2019
  - *Instructor for tutorial classes (1 class per week) with 75 students*
- Machine Drawing Practice (Lab Instructor) (ME 2050), GTA, IIT Madras — Fall 2018
  - *Assisted students on 3D CAD modeling*
  - *One of the two TAs for a class of 200 students*
- Guest Lecturer, AI in Manufacturing (ME 7150), IIT Madras — Spring 2019
  - *Invited for presenting my course project from Spring 2018*

RESEARCH TALKS

- **Inverse Design of Process Parameters with Physics-informed Machine Learning**
  - *INFORMS Annual Meeting 2023, Phoenix, AZ (Invited)*

- **Thermal Modeling with Physics-Informed Machine Learning**
  - *INFORMS Annual Meeting 2022, Indianapolis, IN (Invited)*
  - *ONR MURI Fifth Year Review (2023), San Diego, CA*
  - *IISE Annual Conference 2023, New Orleans, LA (Invited)*

- **Self-scalable Tanh (Stan) for Multi-scale Solutions in Physics-Informed Neural Networks**
  - *IISE QCRE ProcessMiner Data Challenge 2022, Seattle, WA **(Winner)***
  - *IISE Annual Conference 2022, Seattle, WA (Invited)*
  - *INFORMS DMDA Workshop 2022, Indianapolis, IN*

- **A Holistic Data Analytics Framework for Laser Powder Bed Fusion**
  - *ICQSR Data Challenge 2023, Raleigh, NC (Sole Participant)*

- **Sequence-to-Sequence LSTM for Fungal Spores Concentration Prediction**
  - *IISE QCRE ProcessMiner Data Challenge 2023, New Orleans, LA **(Winner)***

- **Bayesian Optimization with Stochastic Imputation of Deep Gaussian Process**
  - *INFORMS Annual Meeting 2021, Anaheim, CA (Invited)*
  - *INFORMS Annual Meeting 2022, Indianapolis, IN (Invited)*
  - *IISE Annual Conference 2023, New Orleans, LA*

WORK EXPERIENCE

- **RF Wave Technologies Pvt. Ltd.**, Intern, Chennai, India   Summer 2017
  - *Worked on developing sensor and data logging systems for a farm-bot*
  - *Awarded performance-based bonus for the entire duration of internship*

RESEARCH POSTERS

- **Physics-informed NN Modeling and Closed-loop Control for Metal Additive Manufacturing**
  - *MELD (Friction Stir AM) User Meeting, Blacksburg, VA*   August 2023
  - *Manufacturing Day Poster Session, Blacksburg, VA*   August 2023
- **Bayesian Optimization with Stochastic Imputation of Deep Gaussian Process**
  - *IISE Annual Conference, New Orleans, LA*   May 2023
- **Self-Scalable Tanh for Physics-Informed Neural Networks**
  - *IISE Annual Conference, Seattle, WA*   May 2022
  - *INFORMS DMDA Workshop, Indianapolis, IN* **(Winner)**   October 2022

MENTORING EXPERIENCE

- **Project Leader** at Intl. Networked Team for Engg. Des. & Innov. (MANE 4173, UTRGV) 2022
  - *Lead a project on Emergency Deployable Structures*
  - *Interdisciplinary team with 3 undergraduates from UTRGV and a Master's student from Mexico*

SERVICE

- **Session Chair**, *Data-driven Approaches for CPS*, INFORMS Annual Meeting 2023
- **VP Operations**, INFORMS Student Chapter, Virginia Tech 2023-2024
  - ***Winners**, Student Chapter Magna Cum Laude*
- **Panelist**, Graduate School Orientation Spring 2023, Virginia Tech
- **Graduate Student Ambassador** (2022-2023), Virginia Tech
- **Research Poster Judge**, ISE Senior Symposium 2022 & 2023, Virginia Tech
- **Student Volunteer**, HBCU/MSI Research Summit 2022, Virginia Tech
- **Student Volunteer**, ISE Senior Symposium 2021, Virginia Tech
- **Secretary**, Society of Manufacturing Engineers (SME) 2020-2021, Virginia Tech
- **Peer Review**
  - *IEEE Transactions on Automation Science and Engineering (IEEE-TASE)*
  - *Journal of Manufacturing Systems (JMS)*
  - *Journal of Intelligent Manufacturing (JIMS)*
  - *IISE Annual Conference (Manufacturing and Design Track)*
  - *Graduate Research Development Program (GRDP) at Virginia Tech*

PROFESSIONAL MEMBERSHIPS

- Graduate Academy for Teaching Excellence at Virginia Tech (VT GrATE)
- Institute of Industrial and Systems Engineers (IISE)
- Institute for Operations Research and the Management Sciences (INFORMS)