

Raghav Gnanasambandam

Virginia Tech, Blacksburg, VA

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EDUCATION

Virginia Tech, Blacksburg, VA 2019 - Present

Ph.D. in Industrial and Systems Engineering

- Advisor: *Prof. Zhenyu (James) Kong*
- Dissertation: *Physics-informed Machine Learning for Digital Twin in Metal Additive Manufacturing*
- Graduate Certificate: *Future Professoriate Certificate*
- GPA: 3.9/4

Indian Institute of Technology (IIT) Madras, Chennai, India 2014 - 2019

Dual Degree (B.Tech & M.Tech) in Mechanical Engineering

- Specialization: *Intelligent Manufacturing*
- Thesis: *Machine Vision-Based Surface Characterization & Roughness Prediction of Machined Surfaces*
- Minor: *Materials Science*
- GPA: 8.2/10

RESEARCH STATEMENT

*My research is to enable **Digital Twins** for **Advanced Manufacturing** by process modeling. I developed a novel activation function for **Physics-Informed Neural Networks (PINNs)** to solve multi-scale **Partial Differential Equation (PDE)** systems. I am working on first-of-its-kind simulator for **Laser Powder Bed Fusion (L-PBF)** with PINNs. I proposed a novel **Bayesian Optimization** algorithm for optimizing the process parameters.*

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
- **Travel Awards** (2022-2023), ISE at Virginia Tech
 - Conference Travel Awards worth \$2,000
- **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 video 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
- **ISE Graduate Fellowship** (2019-2020), Virginia Tech
 - Awarded \$9,765 over 9 months
- **Undergraduate Scholarship** (2014-2019), NLC India Ltd.

JOURNAL PUBLICATIONS

Published/Accepted

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* (Impact Factor 23.6). [Paper] [Codes]
 - **Winner**, IISE QCRE ProcessMiner Data Challenge Competition 2022
 - **Winner**, INFORMS DMDA Workshop Poster Competition 2022
2. 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]
 - *Developed and implemented the Single-task version of algorithm*
3. 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]
 - *Handled the entire image-feature extraction and machine learning* [Codes]
4. 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 Engineering Manufacture* (2020). [Paper]
 - *Built the characterization models* [Codes]

Under Review/Revision

5. **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”. Minor Revision (2nd round). *IISE Transactions*. [Preprint]
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”. Manuscript Submitted (August 2023). *Nature Communications*.
 - *Developed the machine learning framework*

In Preparation

7. **R. Gnanasambandam**, C. Dou, and Z.J. Kong. “Physics-informed Machine Learning based Fast Prediction for Dynamic Thermal Distribution of Additive Manufacturing”. *To be submitted to IISE Transactions by November 2023*.
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 December 2023*.
9. J. Chung, **R. Gnanasambandam**, Y. Zhang, Z.J. Kong, and B. Shen. “Automatic Thresholding by Reconstruction Error in Unsupervised Anomaly Detection in Automotive Industry”. *To be submitted to Journal of Intelligent Manufacturing Systems by December 2023*.
 - *Equal contribution with first author*
 - **Finalist**, INFORMS QSR Data Challenge 2022

PROJECTS

- **Office of Naval Research** Multidisciplinary University Research Initiatives (MURI) 2019-2024
 - *Topic: Rationalization of Interphase Instabilities During Thermo-Mechanical Gyration 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*

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 TALKS

- **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*

RESEARCH POSTERS

- **Physics-informed NN Modeling and Closed-loop Control for Metal Additive Manufacturing**
- *MELD (Friction Stir AM) User Meeting, 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

- **Mentor**, Project EduAccess 2022-2023
- *Assisted 2 students from marginalized communities (in India) for graduate admissions in the US*
- **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 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)