

Shuvayan Brahmachary

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[Website](#)



Education

- 2013 Jan -2019 June **Doctor of Philosophy in Fluids and Thermal Engineering**
Department of Mechanical Engineering, Indian Institute of Technology, Guwahati, India
Thesis Title: Finite Volume/Immersed Boundary Methods for Compressible Flows: Development and Applications
Short Description: The objective of the thesis is the development of a robust and an accurate Finite Volume/Immersed Boundary based compressible flow solver for inviscid and viscous laminar flows. **Development** involves addition of novel reconstruction approaches for accurate estimation of forces, surface skin-friction and heat-flux distribution **Applications** includes fluid-rigid body interaction, aerodynamic shape optimisation ([thesis](#)).
Advisor: Dr. Ganesh Natarajan ([website](#)) and Prof. Nirranjan Sahoo ([website](#))
- 2008-2012 **Bachelor of Engineering in the Department of Mechanical Engineering**
May *Girijananda Chowdhury Institute of Management and Technology, India*
Percentage: 85.3%
(2nd position in the merit list of the university.)

Experience

- 2022 Jan. - Present **Postdoctoral Research Fellow**
Department of Informatics, Technical University of Munich, Germany
Research topic: Development of an in-house immersed boundary based differentiable flow solver for fluid flow control assisted by artificial intelligence
Advisor: Dr. Nils Thuerey ([website](#))
- 2019 Sept. -2021 Sept. **Postdoctoral Research Fellow**
Space Transportation Systems Engineering Laboratory, Department of Aeronautics and Astronautics, Kyushu University, Japan
Research topic: Design of optimal scramjet engine for ascent flight using data-driven techniques.
Short Description: The objective of the research topic is the design of efficient and robust scramjet engines (inlet and combustor injector) followed by their in-house experimental investigation **Collaborator** Japan Aerospace Exploration Agency (**JAXA**) **sub-topics** surrogate assisted evolutionary algorithms, reduced order modelling using proper orthogonal decomposition, machine learning
Advisor: Dr. Hideaki Ogawa ([website](#))
- 2019 Jan. - 2019 Apr. **Subject Matter Expert**
Nanobiz India Pvt Ltd. ([website](#))
Research topic: Technology landscape on artificial intelligence in the field of computational fluid dynamics
Client: Daimler, India ([website](#))
- 2018 Feb. - 2018 Dec. **Junior Research Fellow**
Department of Mechanical Engineering, Indian Institute of Technology Guwahati, India
Research topic: Compressible flow solver with immersed boundary approach (in collaboration with Indian Space Research Organisation **ISRO**)
PI: Prof. Vinayak Kulkarni ([website](#))
- 2012 Sept. - 2012 Dec. **Assistant Project Engineer**
Department of Mechanical Engineering, Indian Institute of Technology Guwahati, India
Research topic: Shock tube development and verification of existing correlations for stagnation point heat transfer
PI: Prof. Nirranjan Sahoo ([website](#))

Supervision

2022 Apr. - **Aravind Karthik M, Research Intern**

July *Aeronautical Engineering, Manipal Institute of Technology, India*

Research topic: Effective use of Machine Learning and non-intrusive reduced-order modelling for flow field prediction and shape optimization of transonic airfoils

Advisors: Dr. Shuvayan Brahmachary and Prof. Hideaki Ogawa

2021 Jan. - **Ananthkrishnan Bhagyarajan, Research Intern**

March *Mechanical Engineering, Indian Institute of Technology, Palakkad*

Research topic: Fast Estimation of Internal Flowfields in Scramjet Intakes via Reduced-Order Modeling and Machine Learning

Advisors: Dr. Shuvayan Brahmachary and Prof. Hideaki Ogawa

Teaching

2022 October. **Master Seminar: Deep Learning in Physics**

- Present *Department of Informatics, Technical University of Munich, Germany*

Topic: Using deep learning methods for physical problems

Lecturers: Prof. Nils Thuerey, Dr. Shuvayan Brahmachary and Nilam Tathawadekar ([website](#))

2013 Jan. - **Teaching Assistant**

2016 June *Department of Mechanical Engineering, Indian Institute of Technology Guwahati, India*

Subjects: Fluid Mechanics, Thermal Science

Training

- Data Driven Engineering (DDE), Issac Newton Institute for Mathematical Science, Workshops 2023 ([website](#))
- Institute for Computational and Mathematical Engineering (ICME), Stanford University, Summer Workshops 2021 — Fundamentals of Data Science: Machine learning, Deep learning, High Performance Computing ([website](#))
- GPU programming and applications with hands on training on NVIDIA's CUDA environment at IITG, 2014
- Completed a 6 months long A1 and A1+ French language course at IITG, 2019

Journals

Published

- [Brahmachary, S.](#), Fujio, C., Aksay, M., and Ogawa, H., "Design Optimization and off-design performance analysis of axisymmetric scramjets intakes for ascent flight" (**Physics of Fluids**, 2022) [DOI-Link](#)
- [Brahmachary, S.](#), Bhagyarajan, A., and Ogawa, H., "Fast Estimation of Internal Flowfields in Scramjet Intakes via Reduced-Order Modeling and Machine Learning" (**Physics of Fluids**, 2021, **Selected as featured article**) [DOI-Link](#)
- [Brahmachary, S.](#), and Ogawa, H., "Multi-Point Design Optimization of Busemann Based Intakes for Scramjet-Powered Ascent Flight" (**Journal of Propulsion and Power**, 2021) [DOI-Link](#)
- [Brahmachary, S.](#), Natarajan, G., Kulkarni, V., Sahoo, N., Ashok, V., Kumar, V., "Role of solution reconstruction for hypersonic viscous computations using sharp interface immersed boundary method" (**Physical Review E**, 2021, in collaboration with Indian Space Research Organisation **ISRO**) [DOI-Link](#)
- Fujio, C., [Brahmachary, S.](#), and Ogawa, H., "Numerical investigation of axisymmetric intake flowfield and performance for scramjet-powered ascent flight" (**Aerospace Science and Technology**, 2021) [DOI-Link](#)
- [Brahmachary, S.](#), Fujio, C., and Ogawa, H., "Multi-point design optimization of a high-performance intake for scramjet-powered ascent flight" (**Aerospace Science and Technology**, 2020) [DOI-Link](#)
- [Brahmachary, S.](#), Natarajan, G., Kulkarni, V., and Sahoo, N., "Comment on 'A new approach for the design of hypersonic scramjet inlets'" (**Physics of Fluids**, 2020) [DOI-Link](#)
- Dudas, E., David, N.S., [Brahmachary, S.](#), Kulkarni, V., Benidar, A., Kassi, S., Charles, C., and Georges, R., "High-temperature hypersonic Laval nozzle for non-LTE Cavity Ringdown Spectroscopy" (**Journal of Chemical Physics**, 2020, in collaboration with Institut de Physique de Rennes, France **IPR**, **Selected as featured article**) [DOI-Link](#)
- Desai, S., [Brahmachary, S.](#), Gadgil, H., and Kulkarni, V., "Probing Real Gas and Leading-Edge Bluntness Effects on Shock Wave Boundary-Layer Interaction at Hypersonic Speeds" (**Journal of Aerospace Engineering**, 2019) [DOI-Link](#)
- Deka, M., [Brahmachary, S.](#), Thirumalaisamy, R., Dalal, A., and Natarajan, G., "A new Green-Gauss Reconstruction on Unstructured Meshes. Part I: Gradient Reconstruction" (**Journal of Computational Physics**, 2018) [DOI-Link](#)
- [Brahmachary, S.](#), Natarajan, G., Kulkarni, V., and Sahoo, N., "A sharp interface immersed boundary framework for simulations of high speed inviscid compressible flows" (**International Journal of Numerical Methods in Fluids**, 2018) [DOI-Link](#)
- [Brahmachary, S.](#), Natarajan, G., Kulkarni, V., and Sahoo, N., "On Maximum Ballistic Coefficient Axisymmetric Geometries in Hypersonic Flows" (**Journal of Spacecraft and Rockets**, 2018) [DOI-Link](#)

Under preparation

- [Brahmachary, S., Thuerey, N., "Leveraging Differentiable Physics to Efficiently Learn Flow Past Arbitrary Geometries"](#)
- [Brahmachary, S., Bhagyarajan, A., and Ogawa, H., "RAEA: Reduced Order Model and Machine Learning Assisted Evolutionary Algorithm"](#)

Book Chapters

- [Brahmachary, S., Natarajan, G., Kulkarni, V., Sahoo, N., "A sharp-interface Immersed Boundary method for high-speed compressible flows" \(Immersed Boundary Methods, Springer Nature, Singapore, 2020\) DOI-Link](#)
- [Brahmachary, S., Natarajan, G., Kulkarni, V., Sahoo, N., and Nanda, S.R., "Application of greedy and heuristic algorithm based optimisation methods towards aerodynamic shape optimization" \(Soft Computing for Problem Solving. Advances in Intelligent Systems and Computing, Springer, Singapore, 2019\) DOI-Link](#)
- [Brahmachary, S., Natarajan, G., and Sahoo, N., "A Hybrid Aerodynamic Shape Optimisation Approach for Axisymmetric Body in Hypersonic Flow" \(Fluid Mechanics and Fluid Power – Contemporary Research, Springer, India, 2017\) DOI-Link](#)

Conferences

- [Brahmachary, S., Thuerey N., Leveraging Differentiable Physics to Efficiently Learn Flow Past Arbitrary Geometries, 73rd IACM Computational Fluids Conference \(CFC\), Cannes, France, 2023](#)
- [Brahmachary, S., and Ogawa, H., Multi-Point Design Optimization of Busemann Based Intakes for Scramjet-Powered Ascent Flight via Surrogate-Assisted Evolutionary Algorithms", In proceedings of the AIAA SciTech Forum, 11-15 January, USA, 2021](#)
- [Brahmachary, S., Fujio, C., Aksay, M., and Ogawa, H., "Design optimisation and off-design performance study of an axisymmetric scramjet intake for ascent flight", Proceedings of the 8th International and 47th National Conference on Fluid Mechanics and Fluid Power \(FMFP\), December 9-11, 2020 IIT Guwahati, Assam, India](#)
- [Brahmachary, S., Chutia, J., Natarajan, G., Kulkarni, V., and Sahoo, N., "Parametric investigation towards the design of a scramjet intake using low-fidelity approach, Proceedings of the 8th International and 47th National Conference on Fluid Mechanics and Fluid Power \(FMFP\), December 9-11, 2020 IIT Guwahati, Assam, India](#)
- [Brahmachary, S., Tokuda, A., Ogawa, H., Bang, J., Ahn, J., and Ueda, S., "Multi-target rendezvous optimisation for active debris removal via multi-fidelity approach", In proceedings of the SICE International Symposium on Control Systems, Tokushima, Japan, March, 2020 \(in collaboration with **KAIST** and **JAXA**\)](#)
- [Brahmachary, S., Tokuda, A., Ogawa, H., Bang, J., Ahn, J., and Ueda, S., "Multi-Fidelity Optimisation of Multi-Target Rendezvous Problems by Using GPU Super-Parallelisation", In proceedings of the 11th Kyushu-University-KAIST Symposium on Aerospace Engineering, Fukuoka, Japan, December, 2019](#)
- [Ogawa, H., Fujio, C., \[Brahmachary, S.\]\(#\), Watanabe, T., and Ohtani, K., "Numerical and Experimental Investigation of Centreline Shock Reflection in Ring-Shaped Supersonic Intake Geometries", In proceedings of the 19th International Symposium on Advanced Fluid Information \(AFI 2019\), Sendai, Japan, November, 2019](#)
- [Brahmachary, S., Vinod, A., Natarajan, G., Sahoo, N., and Kulkarni, V., "Physics Based Low-Fidelity Framework for Design of Scramjet Inlets", In proceedings of the 7th International and 45th National Conference on Fluid Mechanics and Fluid Power \(FMFP\), IIT Bombay, Mumbai, India, December, 2018](#)
- [Brahmachary, S., Natarajan, G., Kulkarni, V., and Sahoo, N., "Hybrid Cartesian Immersed Boundary Method for High-Speed Viscous Compressible Flows", In proceedings of the 44th National Conference on Fluid Mechanics and Fluid Power \(FMFP\), Amrita University, Amritapuri Campus, Kollam, Kerala, India, December, 2017](#)
- [Brahmachary, S., Natarajan, G., Kulkarni, V., and Sahoo, N., "A Sharp- Interface Immersed Boundary Method for High-Speed Compressible flows", In proceedings of the 18th Annual CFD Symposium, NAL, Bangalore, CFD Division-Aeronautical Society of India AeSI, Bengaluru, India, August, 2016](#)
- [Brahmachary, S., Natarajan, G., Kulkarni, V., and Sahoo, N., "A Sharp Interface Immersed Boundary Method for Inviscid Compressible Flow", In proceedings of the 6th International Congress on Computational Mechanics and Simulation \(ICCMS\), IIT Bombay, Mumbai, India, July, 2016](#)
- [Brahmachary, S., Kulkarni, V., Natarajan, G., and Sahoo, N., "Numerical Investigation of Optimum Power-Effectiveness for Wave Drag reduction", In proceedings of the 4th National Symposium on Shock Wave \(NSSW4\), Karunya University, Hyderabad, India, February, 2016](#)
- [Brahmachary, S., Kulkarni, V., Natarajan, G., and Sahoo, N., "Active and Passive Wave Drag Reduction Technique in Hypersonic Flow", In proceedings of the 1st International ISHMT-ASTFE Heat and Mass Transfer Conference, ISRO, Thiruvananthapuram, India, December, 2015](#)
- [Brahmachary, S., Natarajan, G., and Sahoo, N., "Multi Fidelity Shape Optimization Framework for Hypersonic Flows", In proceedings of the 6th International Conference on Theoretical, Applied, Computational and Experimental Mechanics \(ICTACEM\), IIT Kharagpur, Kharagpur, India, December, 2014](#)
- [Brahmachary, S., Natarajan, G., and Sahoo, N., "Aerodynamic Shape Optimisation Studies in Hypersonic Flow", In proceedings of the 3rd National Symposium on Shock Wave \(NSSW3\), IIT Bombay, Mumbai, India, February, 2014](#)

Referee

- Physics of Fluids - AIP publishing
- Shock Waves - Springer publishing
- Journal of Aerospace Engineering, Part G - SAGE publishing
- Aerospace Science and Technology - Elsevier publishing

Research Interests

- Machine learning: Fluid flowfield reconstruction (surrogates)
- Computational modeling: FVM for high-fidelity fluid simulations
- Non-conformal solvers: Sharp interface Immersed Boundary (IB) solvers
- Aerodynamic shape optimisation: Scramjets, rocket nose cone, nozzle
- Reduced order modelling: Proper orthogonal decomposition

Skill Set

- Neural Network: Residual Networks, Convolution neural network
- Modelling: Finite Volume Method (FVM), Finite difference Method (FDM)
- Programming Languages/Platform: C, Python (Numpy, TensorFlow), Matlab, CUDA (beginner)
- Mesh Generation Software: Gmsh, Gambit, ANSYS ICEM CFD
- Modelling Software: Solid Edge, Auto CAD, Inkscape
- Flow solvers: ANSYS Fluent-CFX, FoamExtend, [PhiFlow @ Thürey group](#)
- Optimisation toolbox: [NSGA @ KANGAL](#), [SAEA @ MDOLAB](#)
- Operating Platforms: Linux, Mac OS, Windows
- Post Processing Tools: Tecplot, Gnuplot, Paraview
- Draft: \LaTeX

Membership

- Life member of the Society for Shock Wave Research (SSWR)
- Member of the Soft Computing Research Society (SCRS)

Languages

- English - Fluent
- Hindi - Fluent
- Bengali - Fluent
- Assamese - Fluent
- French - A1+ level
- German - Beginner

References

- **Dr. Nils Thuerey** (Postdoc Supervisor)
Associate Professor, Dept. of Informatics, Technical University of Munich, Munich, Germany
Email: nils.thuerey@tum.de
- **Dr. Hideaki Ogawa** (Postdoc Supervisor)
Associate Professor, Dept. of Aeronautics and Astronautics, Kyushu University, Fukuoka, Japan
Email: hideaki.ogawa@aero.kyushu-u.ac.jp
- **Dr. Ganesh Natarajan** (Ph.D. Supervisor)
Associate Professor, Dept. of Mechanical Engineering, IIT Palakkad, Kerala, India
Email: n.ganesh@iitpkd.ac.in
- **Prof. Niranjana Sahoo** (Ph.D. Supervisor)
Professor, Dept. of Mechanical Engineering, IIT Guwahati, Guwahati, India
Email: shock@iitg.ac.in
- **Prof. Vinayak Kulkarni** (Project PI)
Professor, Dept. of Mechanical Engineering, IIT Guwahati, Guwahati, India
Email: vinayak@iitg.ac.in