Sethupathy S

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WORK

Indian Institute of Technology (ISM) — Dhanbad, India
Assistant Professor — 2024 - current

University of Notre Dame — IN, USA
Research Associate — 2023 - 2024
Research/Teaching Assistant — 2017 - 2023

Indian Institute of Science — Bangalore, India
Research Associate — 2016 - 2017

EDUCATION

Ph.D. Physics, **University of Notre Dame,** IN, USA
Ph.D. Electrical Engineering, **Indian Institute of Science**, Bangalore, India
M.E. Electrical Engineering, **Indian Institute of Science**, Bangalore, India
B.E. Electrical and Electronics Engineering, **Anna University**, Chennai, India

RESEARCH AREAS

- **Electromagnetic Analysis**
- **Power Electronics**
- **High-Speed Machines**
- **Magneto-Hydrodynamics (MHD)**
- **Computational Methods**
- **Finite Element Method**
- **High Performance Computing (HPC)**
- **Wireless Power Transfer (WPT)**
- **Electric Vehicles (EVs)**
- **Eddy Currents**
- **Parallel Computing**
- **Electric Braking**

EXTERNALLY FUNDED PROJECTS

- **Next-Generation Electric Braking: Designing Compact, Efficient, and Reliable Systems for Heavy-Duty Electric Transport and Beyond**
  Funding Agency : ANRF - PM-ECRG 2024
  Budget : 57.81 lakhs
  Role : PI
  Status : Ongoing

- **Bioscopy - Towards modern transdisciplinary education and research in microscopy**
  Collaboration : UiT The Arctic University of Norway
  Funding Agency : Indo-Norwegian Cooperation Programme (INCP2), UGC
  Budget : 1.14 Crores
  Role : Co-PI
  Status : Ongoing

- **A Circulating Power Test Setup to Evaluate Key Aspects of Static and Dynamic Wireless Power Transfer Technologies for Electric Vehicle**
  Funding Agency : ANRF - ARG 2025
  Budget : 96.78 lakhs
  Role : HI (Honorary Investigator)
  Status : Approved for Funding

RESEARCH EXPERIENCE

Eddy Currents in High-Speed Machines, Computational Electromagnetics, Finite Element Method (FEM):

- Developed a new class of stabilization technique to handle the strong magnetic advection in the simulation of high-speed machines. It is *parameter-free* and free of interface/boundary errors unlike the upwinding strategies. Since the numerical stability is brought in by a suitable representation of the source-term, it carries the name *Source-Stabilized* formulation.

- First of its kind is developed and tested for the simulation of electromagnetic flowmeters that handle liquid-sodium in liquid-metal-cooled nuclear reactors *(Published 2016)*.
- Then a second kind is developed to include wider class of high-speed machines such as, linear induction motors and electromagnetic brakes *(Published 2016)*.
- It is worth noting that these research advancements have likely made a significant contribution to enhancing the safety of liquid-metal-cooled nuclear reactors at the Indira Gandhi Center for Atomic Research (IGCAR), Kalpakkam. (*Part of Ph.D. work at IISc, Guidance: Prof. Udaya Kumar*)
- Subsequently, worked on eliminating erroneous solutions in Upwinding scheme at conductor-air interface in high speed machine simulations *(Published 2022)*.
- Developed a novel finite element formulation to completely avoid the numerical instability issues in the simulation of Eddy currents in high speed machines *(Published 2022)*.
- Developed the *Source-Stabilized* formulation for the state-of-the-art Edge elements *(Published 2023)*.
- Working collaboratively on developing the *Source-Stabilized* formulation for the Quadratic finite elements, to achieve higher computational efficiency, as well as, for the accurate evaluation of magnetic fields and currents in the simulation of high-speed machines.

Power Electronics:

- Designed and constructed two high-current low-voltage 3-Φ inverters of rating 48V, 100A. Performed load test on these inverters in back-to-back connection with closed loop control using TMS320F2812 TI-processor. The design considerations include magnetic and thermal analysis of the inductors and the MOSFET switches. (*M.E. Project at IISc, Guidance: Prof. Vinod John*)

High Performance Computing, Computational Magnetohydrodynamics:

- Worked collaboratively on integrating high-order isoparametric mappings with the other high accuracy algorithms that are needed for divergence-free MHD simulations on geodesic meshes *(Published 2019)*.
- Worked on developing WENO based adaptive mesh refinement (AMR) - prolongation strategies for divergence-preserving vector fields such as electric and magnetic fields *(Published 2022)*.
- Simulated and analyzed the magnetically channeled winds from massive stars in 3D on a symmetric spherical mesh for varying magnetic tilt angles and magnetic strength. *(Published 2022)*.
- Developed a Cubesphere based 3D MHD simulation tool on a spherical mesh with MPI and GPU parallelization and achieved more than 100x speedups on GPUs. Also worked extensively on GPU parallelization of hyperbolic PDEs *(Published 2024)*.
- Worked on a specialized MPI communication strategy for the simulation of anisotropic fields present in weakly collisional plasmas, with relatively strong magnetic fields *(Published 2025)*.

JOURNAL PUBLICATIONS

- V. Florinski, D. Balsara, D. Bhoriya, G.P. Zank, S. Biswas, S. Sharma and **Sethupathy S**, "An Anisotropic Plasma Model of the Heliospheric Interface" in *The Astrophysical Journal,* vol. 985, no. 1, pp. 1-10, 2025.
- **Sethupathy S**, D. Balsara, D. Bhoriya and H. Kumar, "Techniques, Tricks and Algorithms for Efficient GPU-Based Processing of Higher Order Hyperbolic PDEs" in *Communications on Applied Mathematics and Computation,* vol. 6, pp. 2336–2384, 2024.
- S. Bhowmick and **Sethupathy S**, "The Source Stabilized Galerkin Formulation for Linear Moving Conductor Problems with Edge Elements" in *IEEE Transactions on Magnetics,* vol. 59, no. 9, pp. 1-10, Sept. 2023.
- D. Balsara, S. Samantaray and **Sethupathy S**, "Efficient WENO-Based Prolongation Strategies for Divergence-Preserving Vector Fields" in *Communications on Applied Mathematics and Computation,* vol. 5, pp. 428-484, 2023.
- **Sethupathy S** and S. Bhowmick, "A Stable Weighted Residual Finite Element Formulation for the Simulation of Linear Moving Conductor Problems" in *IEEE Journal on Multiscale and Multiphysics Computational Techniques,* vol. 7, pp. 220-227, 2022.

- **Sethupathy S**, D. Balsara, A. Ud-Doula, and M. Gagné, "Modelling magnetically channeled winds in 3D–I. Isothermal simulations of a magnetic O supergiant" in *Monthly Notices of the Royal Astronomical Society*, vol. 515, pp. 237-255, 2022.
- **Sethupathy S**, U. Kumar and S. Bhowmick, "On overcoming the Transverse Boundary Error of the SU/PG Scheme for Moving Conductor problems" in *IEEE Transactions on Magnetics,* vol. 58, no. 1, pp. 1-8, Jan. 2022.
- D. Balsara, V. Florinski, S. Garain, **Sethupathy S** and K. Gurski, "Efficient, Divergence-free, High Order MHD on 3D Spherical Meshes with Optimal Geodesic Meshing" in *Monthly Notices of the Royal Astronomical Society,* vol. 487 no. 1, pp 1283-1314, Jul. 2019.
- **Sethupathy S** and U. Kumar, "Stable Galerkin finite-element scheme for the simulation of problems involving conductors moving rectilinearly in magnetic fields" in *IET Science, Measurement & Technology,* vol. 10, no. 8, pp. 952-962, Nov. 2016.
- **Sethupathy S** and U. Kumar, "Augmenting numerical stability of the Galerkin finite element formulation for electromagnetic flowmeter analysis" in *IET Science, Measurement & Technology,* vol. 10, no. 4, pp. 288-295, July 2016.

CONFERENCE PUBLICATIONS

- S. K. Roshan and **Sethupathy S**, "Parametric Study on the Effect of Pole Area and Radial Placement of Poles in Disk Eddy Current Braking Systems for Electric Transportation", IEEE International Conference on Power Electronics Smart Grid and Renewable Energy, IIT Dharwad, India, 2025 (Accepted).
- S. K. Roshan and **Sethupathy S**, "Optimal Distribution of Pole Area and Its Angular Separation on Braking Performance in Eddy Current Brakes", IEEE International Conference on Power Electronics Smart Grid and Renewable Energy, IIT Dharwad, India, 2025 (Accepted).
- **Sethupathy S** and U. Kumar, "Existence of boundary error transverse to the velocity in SU/PG solution of moving conductor problem", IEEE MTT-S International Conference on Numerical Electromagnetic and Multiphysics Modeling and Optimization, Beijing, China, 2016.

TALKS AND CONFERENCE PRESENTATIONS

- "3D Wind Simulations from Magnetic Massive Stars - Effects of Multipolar Magnetic Field", Joint Space-Science Institute (JSI), University of Maryland & NASA's Goddard Space Flight Center, MD, USA, 2023.
- "High Performance Computational Astrophysics on GPUs with Applications", Tata Institute of Fundmental Research - Center for Applicable Mathematics (TIFR-CAM), Bangalore, India, 2023.
- "Use of Control System Principles in the Numerical Simulation of Motion-Induced Magnetic Fields", Department of Electrical, Electronics and Communications, IIT Dharwad, India, 2023 (*Invited*).
- "Magnetized Winds Around Massive Stars; Comparison with Chandra Observations", Midwest Magnetic Fields Workshop, University of Wisconsin-Madison, USA, 2023 (*Invited*).
- "Existence of boundary error transverse to the velocity in SU/PG solution of moving conductor problem", IEEE MTT-S International Conference on Numerical Electromagnetic and Multiphysics Modeling and Optimization, Beijing, China, 2016.
- "Stable Galerkin Finite Element Formulation for the Simulation of Electromagnetic Flowmeter", EECS Research Students Symposium, IISc, Bangalore, India, 2016.
- "Efficacy of SUPG Scheme in Simple Moving Conductor Problems", Indo-Swedish Colloquium on Electrotechnology, IIT Madras, India, 2015.
- "Numerical Problems in the Simulation of Electromagnetic Flowmeter", Electrical Engineering Seminar Series, Indian Institute of Science (IISc), Bangalore, India, 2015.

ACADEMIC ACHIEVEMENTS AND AWARDS

- **All India Rank - 5** in GATE Electrical Engineering 2009.
- **CRC Graduate Award - 2022 for Computational Science and Visualization**, from CRC, Notre Dame.
- **Outstanding Graduate Teaching Award - 2021** from Kaneb Center, Notre Dame.
- Awarded IISc research fellowship (July 2016 - July 2017) served as Research Associate at IISc.
- Awarded GARP funding of INR 100,000 for IEEE MTT-S Conference held in Beijing, China, 2016.

JOURNAL REVIEWER

- IEEE Transactions on Power Delivery
- IET High Voltage
- IET Science, Measurement & Technology
- Monthly Notices Royal Astronomical Society
- Sadhana, Springer Nature
- Measurement Science Review

HARDWARE SKILLS

Power Electronics: Designed and constructed two high-current low-voltage 3-Φ inverters of rating 48V, 100A. Performed load test on these inverters in back-to-back connection with closed loop control using TMS320F2812 TI-processor. The design considerations include magnetic and thermal analysis of the inductors and the MOSFET switches. (*M.E. Project at IISc, Guidance: Prof. Vinod John*)

COMPUTATIONAL SKILLS

Electromagnetic Analysis: Developed a specialized 3D Finite Element Analysis code in C, for the electromagnetic design and multi-physics analysis of high-speed moving conductors in magnetic field (*Eddy Current Brakes, Linear-Induction Motors, Electromagnetic Flowmeters, etc.*). The code can run very fast on a supercomputer using multiple processors in parallel.

GPU Computing: Developed and worked on a supercomputer ready 3D MHD Finite Volume Code with MPI and GPU parallelization for the simulation of Magnetic Plasmas.

Programming Langauges: C, Fortran, Matlab, C++, Python, Mathematica, and Bash Script

Parallel Computing Paradigms: MPI, OpenMP, and OpenACC

Softwares and Libraries: VisIt, Gmsh, Simulink, LAPACK, BLAS, and SuperLU