

# Aravind Baskar

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## PROFESSIONAL SUMMARY

- A mechanical engineer/numerical scientist with interest in designing robotic mechanisms for various workspace and force requirements.
- Specializes in research on numerical continuation algorithms for solving non-convex optimization and nonlinear root-finding problems.
- Developed visualization techniques for higher-dimensional optimization design spaces using machine learning.
- Designed constrained mechanisms for applications such as humanoid fingers, legged robots, material handling grippers, and deployable wing mechanisms for Unmanned Aerial Vehicles.

## TECHNICAL SKILLS

**Expertise.** Optimization methods, robotics, numerical algebraic geometry, CAD, 3D printing.

**Programming.** Python, Wolfram, MATLAB, SOLIDWORKS, Scikit-learn, PyTorch, R, Bertini

## EDUCATION

**PhD** in Robotics and Controls, University of Notre Dame, USA Dec 2023

*Thesis:* Optimal design of robotic mechanisms using random monodromy loops

*Adviser:* Prof. Mark Plecnik, Aerospace and Mechanical Engineering

**Master of Science** in Applied and Computational Mathematics and Statistics, University of Notre Dame Jan 2023

*Adviser:* Prof. Jonathan Hauenstein, Applied and Computational Mathematics and Statistics

**Master of Science** in Engineering Design, Indian Institute of Technology Madras (IIT Madras), India July 2019

*Thesis:* Design of mechanisms free of kinematic defects using polynomial continuation

*Adviser:* Prof. Sandipan Bandyopadhyay, Engineering Design, IIT Madras, India

**Bachelor of Engineering** (Mech.) *First Class with distinction*, PSG College of Technology, India May 2013

## PROFESSIONAL EXPERIENCE

- Graduate Research Assistant, University of Notre Dame, USA  
Optimal design of robots for desired kinematic and dynamic requirements (Jan 2019 – Dec 2023)
- Summer Intern, Calculus and Algebra, Wolfram Research, Inc., USA  
**NSolveByMonodromy** for numerically solving nonlinear systems using monodromy (May 2023 – July 2023)
- Graduate Research Assistant, IIT Madras  
Robot kinematics, Symbolic computer algebra, Product design (Aug 2015 – Dec 2018)
- Project Associate, Industrial Consultancy and Sponsored Research, IIT Madras  
Novel design of a static-balanced shelf; User-friendly and ergonomic product design (Aug 2014 – June 2015)
- Mechanical Engineer, Piping and Systems Design, Larsen and Toubro Shipbuilding, India  
Detailed computer aided design of offshore platform support vessel systems (July 2013 – July 2014)
- Summer Intern, Supercomputer Education and Research Centre, Indian Institute of Science  
Coding iterative solvers for sparse linear systems with application to PDEs (May 2012 – July 2012)

## AWARDS AND GRANTS

- ◇ Departmental Fellowship and full tuition scholarship (\$53,416) as a Ph.D. student, University of Notre Dame, IN, USA
- ◇ Wolfram Student Ambassador 2022
- ◇ Travel grant (\$300) to present at the Applied Algebra Seminar Fall 2022, University of Wisconsin-Madison, USA, September 22, 2022
- ◇ Travel grant (\$250) to attend the Meeting on Applied Algebraic Geometry, Georgia Tech, Atlanta, USA, April 13–14, 2019
- ◇ Travel grant (\$500) to attend the Summer school on Numerical Computing in Algebraic Geometry, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, August 13–17, 2018
- ◇ Best student paper at the 2nd International and 17th National Conference on Machines and Mechanisms, Indian Institute of Technology Kanpur, India, December 16–19, 2015
- ◇ Runner-up at the National Qualifier to represent India at the WorldSkills Competition, Leipzig 2013 under Mechanical Engineering Design CAD
- ◇ Proficiency award for academic excellence in the semesters I, IV and VI of the Bachelor's, Department of Mechanical Engineering, PSG College of Technology, Coimbatore, India

## PEER-REVIEWED PUBLICATIONS

### Journal Articles

1. **A. Baskar**, M. Plecnik, J. D. Hauenstein, Finding straight line generators through the approximate synthesis of symmetric four-bar coupler curves, *Mechanism and Machine Theory* 188 (2023) 105310
2. **A. Baskar**, M. Plecnik, J. D. Hauenstein, Computing saddle graphs via homotopy continuation for the approximate synthesis of mechanisms, *Mechanism and Machine Theory* 176 (2022) 104932
3. **A. Baskar**, M. Plecnik, Synthesis of Watt-Type Timed Curve Generators and Selection From Continuous Cognate Spaces, *Journal of Mechanisms and Robotics* 13 (5) (2021)
4. **A. Baskar**, M. Plecnik, Synthesis of Six-bar Timed Curve Generators of Stephenson-type Using Random Monodromy Loops, *Journal of Mechanisms and Robotics* 13 (1) (2021)
5. M. K. Karnam, **A. Baskar**, R. A. Srivatsan, S. Bandyopadhyay, Computation of the safe working zones of planar and spatial parallel manipulators, *Robotica* 38 (5) (2020) 861–885
6. **A. Baskar**, S. Bandyopadhyay, An algorithm to compute the finite roots of large systems of polynomial equations arising in kinematic synthesis, *Mechanism and Machine Theory* 133 (2019) 493–513
7. **A. Baskar**, S. Bandyopadhyay, A homotopy-based method for the synthesis of defect-free mechanisms satisfying secondary design considerations, *Mechanism and Machine Theory* 133 (2019) 395–416

### Conference Papers

1. S. O'Connor, M. Plecnik, **A. Baskar**, J. Joo, Complete Solutions for the Approximate Synthesis of Spherical Four-bar Function Generators, *International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, 2023 (IDETC 2023, Boston, USA)*
2. P. B. Edwards, **A. Baskar**, C. Hills, M. Plecnik, J. D. Hauenstein, Output mode switching for parallel five-bar manipulators using a graph-based path planner (*ICRA 2023, London, England*)
3. **A. Baskar**, C. Hills, M. Plecnik, J. Hauenstein, Estimating the complete solution set of the approximate path synthesis problem for four-bar linkages using Random Monodromy Loops, Vol. 46th Mechanisms and Robotics Conference of International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, 2022 (*IDETC-CIE 2022, St. Louis, Missouri, USA*)
4. **A. Baskar**, M. Plecnik, J. Hauenstein, Finding straight line generators through the approximate synthesis of symmetric four-bar coupler curves, in: *International Symposium on Advances in Robot Kinematics, Springer, 2022, pp. 277–285 (ARK 2022, Bilbao, Spain)*

5. **A. Baskar**, C. Liu, M. Plecnik, J. D. Hauenstein, Designing rotary linkages for polar motions, in: 2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), IEEE, 2021, pp. 1384–1391 (*IROS 2021 virtual event*)
6. **A. Baskar**, M. Plecnik, Computing all solutions to a discretization-invariant formulation for optimal mechanism design, in: 2021 IEEE International Conference on Robotics and Automation (ICRA), IEEE, 2021, pp. 9745–9751 (*ICRA 2021 virtual event*)
7. **A. Baskar**, M. Plecnik, Higher order path synthesis of four-bar mechanisms using polynomial continuation, in: International Symposium on Advances in Robot Kinematics, Springer, 2020, pp. 303–310 (*ARK 2020*)
8. **A. Baskar**, M. Plecnik, Synthesis of Stephenson III Timed Curve Generators Using a Probabilistic Continuation Method, Vol. 5B: 43rd Mechanisms and Robotics Conference of International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, 2019, v05BT07A067 (*IDETC-CIE 2019, Anaheim, California, USA*)
9. K. Sekar, **A. Baskar**, P. Ramu, Surrogate assisted numerical polynomial continuation for optimization, 2nd National Conference on multidisciplinary design, analysis, and optimization, Bengaluru, India, March 22–23, 2019
10. **A. Baskar**, S. Bandyopadhyay, An exact synthesis of pick-and-place mechanisms using a planar four-bar linkage, in: Machines, Mechanism and Robotics, Springer, 2019, pp. 149–157 (*iNaCoMM 2017, Division of Remote Handling & Robotics, Bhabha Atomic Research Centre, Mumbai, India*)
11. T. K. Mamidi, **A. Baskar**, S. Bandyopadhyay, Kinematic analysis of the 3–RPS manipulator using the geometry of plane curves, International Symposium of Mechanism and Machine Science, Baku, Azerbaijan, 2017
12. T. K. Mamidi, **A. Baskar**, S. Bandyopadhyay, A novel geometric analysis of the kinematics of the 3 RPS manipulator, in: Computational Kinematics, Springer, 2018, pp. 483–490 (*CK2017, Futuroscope-Poitiers, France*)
13. **A. Baskar**, S. Bandyopadhyay, Operation modes of the planar 3 RRR manipulator, in: Computational Kinematics, Springer, 2018, pp. 441–448 (*CK2017, Futuroscope-Poitiers, France*)
14. **A. Baskar**, G. S. Kumar, S. Bandyopadhyay, Design of a static balancing mechanism for coordinated motion of an external load, in: 2nd International and 17th National Conference on Machines and Mechanisms, 2015 (*iNaCoMM 2015, Indian Institute of Technology Kanpur, India*)

## CO-CURRICULAR ACTIVITIES

### Invited Presentations

1. Applied Algebra Seminar Fall 2022, University of Wisconsin-Madison, USA, “Optimal synthesis of robotic mechanisms using homotopy continuation”, September 22, 2022
2. AMS Special Session on Structured Polynomial Systems In Mathematics and Its Applications, Joint Mathematics Meetings 2022, “Optimal kinematic synthesis of mechanisms using numerical polynomial homotopy continuation”, April 6–9, 2022 (virtual event)
3. 2nd IMA Conference on Mathematics of Robotics, “Optimization-based kinematic synthesis using homotopy continuation”, September 8–10, 2021 (virtual event)
4. Meeting on Applied Algebraic Geometry, Georgia Tech, Atlanta, USA, “A heuristic continuation method to solve timed curve synthesis of mechanisms”, April 13–14, 2019
5. Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, “Cyclic coefficient-parameter continuation”, August 13–17, 2018

### Summer Schools Attended

1. Numerical Computing in Algebraic Geometry, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, August 13–17, 2018
2. Singularities of Mechanisms and Robotic Manipulators, Johannes Kepler University, Linz, Austria, September 18–22, 2017

## TEACHING EXPERIENCE

- Teaching Assistant, Aerospace and Mechanical Engineering, University of Notre Dame (Jan 2019 – Dec 2022)  
Creating weekly assignments and grading; hosting programming sessions on MATLAB and Wolfram Mathematica for the courses AME40423 Mechanisms and Machines and AME60627 Computational Mechanism Design
- Teaching Assistant, Department of Engineering Design, IIT Madras (Aug 2015 – July 2018)  
Presenting guest lectures on kinematics and statics of parallel robotic mechanisms and holding recitations on symbolic algebraic computations using Wolfram Mathematica

## MEMBERSHIPS

The American Society of Mechanical Engineers (ASME)  
Institute of Electrical and Electronics Engineers (IEEE)  
International Federation for the Promotion of Mechanism and Machine Science (IFTToMM)  
Institute of Mathematics and its Applications (IMA)

## VOLUNTEER SERVICES

- Reviewer
  1. Journal of Mechanism and Machine Theory
  2. IEEE Robotics and Automation Letters, IEEE conference on Robotics and Automation (ICRA)
  3. Journal of Mechanisms and Robotics
  4. Sādhana (Indian Academy of Sciences)
- Volunteer Judge of Northern Indiana Regional Science & Engineering Fair held yearly for school students

## REFERENCES

1. Prof. Mark Plecnik (plecnikmark@nd.edu), PhD adviser  
Department of Aerospace and Mechanical Engineering, University of Notre Dame, IN, USA
2. Prof. Jonathan Hauenstein (hauenstein@nd.edu), Doctoral committee member and mentor  
Department of Applied and Computational Mathematics and Statistics, University of Notre Dame, IN, USA
3. Daniel Lichtblau (danl@wolfram.com), Intern supervisor  
Kernel Technology Group, Wolfram Research