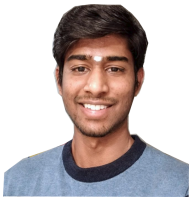
Komahan Boopathy — Curriculum vitae



Doctoral Student
School of Aerospace Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0150
United States

komahan@gatech.edu
komahanb.github.io
github.com/komahanb,numfort,scifort
0000-0002-2543-0942
scholar.google.com/citations?user=YLg4R3sAAAAJ

Research Interests

My research subspace is spanned by broad mathematical divisions of pure and applied mathematics – with special interests in scientific computing for mechanics and aerospace systems design

Technical Specialities

- **mathematics:** numerical methods for differential and algebraic systems, discretization methods (finite-element, finite-volume), analytical methods for sensitivity analysis (adjoint and direct), uncertainty quantification, predictive models (surrogates), variational methods
- **computing:** numerical software architecture, data structures and algorithms, high performance computing
- **physics:** structural and multibody dynamics, fluid mechanics
- **engineering:** design optimization of fixed- and rotary-wing aerospace systems

Academic Degrees

Doctor of Philosophy in Aerospace Engineering — 2015–Current

Georgia Institute of Technology — Atlanta, Georgia, United States

- Thesis: Adjoint Based Robust Design Optimization of Systems with Transient Physics and Probabilistically Modeled Uncertainties
- Advisor: Dr. Graeme J. Kennedy

Master of Science in Aerospace Engineering — 2012–2014

University of Dayton — Dayton, Ohio, United States

- Thesis: Uncertainty Quantification and Optimization Under Uncertainty Using Surrogate Models
- Advisor: Dr. Markus P. Rumpfkeil

Bachelor of Technology in Aerospace Engineering — 2008–2012

SRM University — Chennai, Tamilnadu, India

- Gold medalist for Rank I and final year at University of Dayton under dual-degree Program
- Project: Estimation of Aerodynamic Forces on Wright Flyer II Pedestal
- Advisor: Dr. Nikolai V. Khartchenko

Research Objectives

- Development of computational multiphysics analysis framework that seamlessly integrates areas of pure mathematics for studying fundamental physics and engineering design/optimization applications
- Development of mathematical formalisms driving the numerical solution techniques encapsulated as scalable data structures and algorithms geared towards exascale scientific computing
- Development of higher-dimensional numbers that abstract the analysis complexities arising from one-dimensional real analysis for study of mechanics of fluid and solids and other relevant physics

Research Contributions

4. Analytical first- and second-order derivative evaluation using adjoint and direct methods for static and time-dependent systems (partially published)
3. Development of natural (not requiring conversion to first-order form) implicit multistep/multistage time-marching methods for systems of arbitrary differential-order (under preparation)
2. Development of surrogate-based uncertainty quantification and optimization under uncertainty framework that handles both epistemic and aleatory uncertainties (published)
1. Development of unified surrogate model training and validation framework (published)

Computer Skills

- **Computer Programming:** Modern Fortran, Python, Java, C/C++, Matlab, bash scripting
- **High Performance Computing:** Parallel codes using MPI/OpenMP, Coarray Fortran
- **Platform:** Linux only!
- **Document Preparation:** LaTeX, BibTeX, beamer
- **Version Control:** git, subversion, mercurial
- **Miscellaneous:** shell tools, basic web technologies

Publications

9. K. Boopathy and G. J. Kennedy, "Semi-Intrusive Uncertainty Propagation and Adjoint Sensitivity Analysis Using the Stochastic Galerkin Method", 22nd AIAA Non-Deterministic Approaches Conference at SciTech 2020, Orlando, Florida, Jan 2020. AIAA Paper 2020-xxxx. (Submitted)
8. K. Boopathy and G.J. Kennedy, "Parallel Finite Element Framework for Rotorcraft Multibody Dynamics and Adjoint Sensitivities", AIAA Journal, Vol. 57, No. 8, pp. 3159–3172, 2019, DOI: 10.2514/1.J056585.
7. K. Boopathy and G. J. Kennedy, "Adjoint-based derivative evaluation methods for flexible multibody systems with rotorcraft applications", 55th AIAA Aerospace Sciences Meeting, Grapevine, Texas, Jan 2017. AIAA Paper 2017-1671.
6. G. J. Kennedy and K. Boopathy, "A Scalable Adjoint Method for Coupled Flexible Multibody Dynamics", 57th AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, San Diego, California, Jan 2016. AIAA Paper 2016-1907.
5. K. Boopathy and M.P. Rumpfkeil, "Unified Framework for Training Point Selection and Error Estimation for Surrogate Models", AIAA Journal, Vol. 53, No. 1, pp. 215–234, 2015, DOI: 10.2514/1.J053064.
4. K. Boopathy, M.P. Rumpfkeil and R. M. Kolonay, "Robust Optimization of a Wing Under Structural and Material Uncertainties", 17th AIAA Non-Deterministic Approaches Conference, Kissimmee, Florida, Jan 2015. AIAA Paper 2015-0920.
3. K. Boopathy and M.P. Rumpfkeil, "Robust Optimizations of Structural and Aerodynamic Designs", 15th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference, Atlanta, Georgia, June 2014. AIAA Paper 2014-2595.
2. K. Boopathy and M.P. Rumpfkeil, "A Multivariate Interpolation and Regression Enhanced Kriging Surrogate Model", 21st AIAA Computational Fluid Dynamics Conference, San Diego, California, June 2013. AIAA Paper 2013-2964.
1. K. Boopathy and M.P. Rumpfkeil,"Building Aerodynamic Databases Using Enhanced Kriging Surrogate Models", AIAA Region III Student Conference, Chicago, Illinois, April 2013.

Research Experience

■ **Georgia Institute of Technology** Atlanta, Georgia, United States

⋆ **Research Assistant** Aug 2015 – July 2018

- Project Title: Development of Discrete Adjoint Capability for Rotorcraft Comprehensive Code
- Organization: National Institute of Aerospace, NASA Langley Research Center
- Source: https://github.com/gjkennedy/tacs.git.

- Development of implicit time marching methods for differential-algebraic equations from multibody dynamics
- Adjoint-based sensitivity analysis for optimizing rotorcraft configurations

■ **University of Dayton** Dayton, Ohio, United States

⋆ **Research Assistant** May 2012 – May 2015

- **Surrogate Modeling:** Developed a unified training and error estimation framework for surrogate models, making use of information available from local surrogate models built over sub-domains of the main surrogate model. Developed a Hessian-capable polynomial regression library in Fortran.
- **Optimization Under Uncertainty:** Tailored the enhanced surrogate models for uncertainty analysis and optimization under aleatory and epistemic uncertainties, and applied to structural sizing and aerodynamic shape optimization problems.

■ **Alagappa University** Karaikkudi, Tamilnadu, India

⋆ **Student Researcher** May 2006

- Topic: Anti-bacterial Activity of Traditional Herbs Against Enteric Pathogens
- Funded by the Department of Biotechnology, Govt. of India
- Advisor: Dr. S. Karutha Pandian

- Screened herbs for anti-bacterial activity against enteric pathogens using Kirby-Bauer antibiotic susceptibility test

Teaching Experience

■ **Georgia Institute of Technology** Atlanta, Georgia, United States

⋆ **Teaching Assistant** Aug 2015 – Dec 2015, Aug 2018 – May 2019

- Classes : AE 3145 Structures Laboratory, AE2610 Experimental Methods
- Conducted lab sessions, graded reports

■ **University of Dayton** Dayton, Ohio, United States

⋆ Conducted two lectures in graduate CFD class Jan 2014

⋆ **Teaching Assistant** Aug 2013 – Dec 2013

- Class : MEE 308 Fluid Mechanics, EGR 202 Thermodynamics
- Instructor : Dr. Andrew Henrick
- Substituted lectures, conducted help sessions, graded assignments and exams, prepared test questions

Non-Refereed Publications & Presentations

8. K. Boopathy, "Adjoint-Based Derivative Evaluation Methods for Flexible Multibody Systems", AE Seminar Series, Georgia Institute of Technology, Atlanta, Georgia, Nov 2016.
7. K. Boopathy and M.P. Rumpfkeil, "Design Optimization Under Uncertainty Using Surrogate Models", Brother Joseph W. Stander Symposium, University of Dayton, Dayton, Ohio, April 2014.
6. K. Boopathy, "Uncertainty Quantification and Optimization Under Uncertainty Using Surrogate Models", Master's Thesis, University of Dayton, Dayton, Ohio, March 2014.
5. K. Boopathy and M.P. Rumpfkeil, "Practices for Deterministic and Stochastic Design Optimization", Oral Presentation, 39^{th} AIAA Dayton – Cincinnati Aerospace Sciences Symposium, Dayton, Ohio, March 2014.
4. K. Boopathy and M.P. Rumpfkeil, "Surrogate models and their applications in aerospace engineering", Oral Presentation, Brother Joseph W. Stander Symposium, University of Dayton, Dayton, Ohio, April 2013.
3. K. Boopathy and M.P. Rumpfkeil, "A Multivariate Interpolation and Regression Enhanced Kriging Surrogate Model", Oral Presentation, 38^{th} AIAA Dayton – Cincinnati Aerospace Sciences Symposium, Dayton, Ohio, March 2013.
2. K. Boopathy, K. Doyle, E. Getter and V.M. Kotha, "Estimation of Aerodynamic Forces on Wright Flyer II Pedestal – Wright Image Group", Innovation Center Capstone Design Symposium, University of Dayton, Dayton, Ohio, April 2012.
1. K. Boopathy, B. Shepherd, D. Garcher, J. Andras, K. Connolly, L. Jespersen and S. Dobbertin, "A Humanitarian Response Unmanned Aircraft System (HR-UAS)", University of Dayton, Dayton, Ohio, Nov 2011.

Work Experience

■ **Hindustan Aeronautics Limited** Koraput, Orissa, India

⋆ **Intern** Jun 2010

- Studied the functioning of jet engines, fitting of compressor and turbine blades on discs, testing their weight balance, locating flaws in blades
- Authored a technical report on "Components and Functions of Jet Engine"

■ **University of Dayton** Dayton, Ohio, United States

⋆ **Admissions Assistant** May 2012 – Aug 2013

- Creating applications, Banner data entry, assisting students

■ **Indus Valley Consultants Inc.** Dayton, Ohio, United States

⋆ **Systems Analyst** July 2014 – May 2015

- Object-oriented programming and bash scripting

Awards & Achievements

■ **University of Dayton** 2011–2013

- Graduate Student Summer Fellowship Awardee May – Aug 2013
- II place for Technical paper, Master's category, AIAA Region III student Conference, Illinois Institute of Technology, Chicago [link] Apr 2013
- Academic Scholarship holder Aug 2011 – May 2014

■ **SRM University** 2008–2011

- Gold medalist for University Rank I in Aerospace Engineering
- Consecutive recipient of merit scholarship offered to top 3 students in the department
- Winner of event 'Aerocypher' during Chakravyuha-Technical Festival of the School of Mechanical Engineering

■ **Other Organizations**

- Candidate for government sponsored research programme, "Vacation Training Programme on Bio-Resources" at Alagappa University May 2006
- "Award of Academic Excellence" from the Academic Council of Principals of Matric. Schools, Coimbatore & Nilgiris, India Jun 2006
- Winner in several state & district level chess tournaments 2001-2006

Certifications

■ **Diploma in Information Technology** 2003

Tamilnadu Computer Development Education Centre Palani, Tamilnadu, India

■ **Diploma in Computer Applications** 2003

Tamilnadu Computer Development Education Centre Palani, Tamilnadu, India

Leadership

■ **SRM Aerospace Engineers' Association** SRM University, Chennai, India

⋆ **Joint Secretary** Dec 2009 – Jul 2011

- Assisted in organizing seminars by experts from Indian Space Research Organisation, DRDO and IIT Madras
- Organized technical events and workshops for the benefit of student members
- Created and maintained a database of all the members, carried out paper works and provided technical support during events