Mishal Thapa, Ph.D.

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Current research and future ambition

I am an experienced researcher at the Remote Sensing Center at UA, where I lead key projects in aerospace engineering, focusing on composite structures and aerodynamics for airborne snow/ice-sounding radars. I am also associated with the Stochastic Mechanics and Optimization Laboratory, where I develop novel algorithms and advise graduate students on uncertainty quantification, optimization, machine/deep learning, etc.
Driven by an inquisitive and rigorous approach to computational mathematics, my long-term goal is to contribute to the paradigm shift from a deterministic to a probabilistic design approach to obtain cost-efficient and reliable engineering designs.

Academic/Research Interests

Uncertainty Quantification, Stochastic Optimization, Machine/Deep Learning, Composite Structures (both computational and experimental), Wind energy (aerodynamics and structures), Finite Element Analysis, Aerodynamic Analysis, Structural Analysis, Thermo-mechanical Analysis, Computational Fluid Dynamics Simulation, Surrogate Modeling, Sensitivity Analysis, Reliability Analysis, Data-Driven Modeling, Multi-fidelity modeling, Digital Signal Processing for Synthetic Aperture Radars.

Professional Experience

01/2021 – Present — **Senior Research Personnel/ Assistant Research Professional**, Remote Sensing Center, The University of Alabama

01/2020 – 12/2020 — **Post-doctoral Research Associate**, The University of Arizona
Research Title: *Uncertainty Quantification and Design Optimization under Uncertainty of Composite Wind Turbines.* Advisor: *Dr. Samy Missoum*

08/2019 – 12/2019 — **Post-doctoral Research Associate**, The University of Alabama

01/2015 – 08/2019 — **Graduate Teaching/Research Assistant**, The University of Alabama

11/2012 – 07/2014 — **Design and Research Engineer**, Design Empire Pvt. Ltd, Nepal

(Please refer to last two pages for more details regarding professional experience)

Education

01/2015 – 08/2019 — **Ph. D., Aerospace Engineering and Mechanics, The University of Alabama, (GPA: 4.0/4.0)**
Dissertation Title: *Efficient Algorithms for Uncertainty Quantification using Polynomial Chaos Expansion and its Applications to Composite Structures.*
Advisor: *Dr. Sameer B. Mulani*

01/2015 – 12/2017 — **M.S., Aerospace Engineering and Mechanics, The University of Alabama, (GPA: 4.0/4.0)**
Research Topics: *Uncertainty Quantification, Optimization, Composite Structures*
Advisor: *Dr. Sameer B. Mulani*

Education (continued)

10/2008 – 06/2012 **B. Eng., Aeronautical Engineering, NUAA, China, (GPA: 4.1/5.0)**
Thesis Title Topics: *Conceptual Design and Analysis of Morphing Wing Aircraft.*
Advisor: *Dr. Feng Xu*

Skills and Abilities

Programming/ Packages	**MATLAB, Python/PyTorch, MATHEMATICA**, C++, FORTRAN, Latex, GitHub, Linux (Basic)
Engineering/ CAE Software	**MSC NASTRAN/PATRAN, ANSYS (Mechanical and Fluent)/APDL, XFOIL, SolidWorks, CATIA, ABAQUS,** Microsoft Office, AutoCAD.
Languages	English (fluent); Hindi (fluent); Chinese (medium); Nepali (native).
Interpersonal skills	Able to work independently or in a diverse team; Excellent leadership skills; Excellent work ethic; Highly motivated and inquisitive researcher.

Awards and Achievements

2018-2019	Graduate Council Fellowship, The University of Alabama.
2019	Graduate Student Conference Travel Funding
2010-2011	Full Attendance Award
2009-2010	Second Prize Scholarship of Undergraduate International Students Scholarship
	Honor of Excellent Performance
2008-2009	Second Prize Scholarship of Undergraduate International Students Scholarship
2008	Top 5 in the State, High School Examination
	Excellence in Math Award (Topper), High School Examination

Academic Honors Fraternities by Invitation

- The Honor Society of Phi Kappa Phi
- Golden Key International Honour Society

Academic Service as a Reviewer for Refereed Journals and Conferences

- Reliability Engineering and System Safety
- AIAA Journal
- Aerospace Science and Technology
- Engineering with Computers
- Journal of Cleaner Production
- Composites and Advanced Materials
- Structural and Multidisciplinary Optimization
- Applied Mathematical Modeling
- Thin-Walled Structures
- Smart Materials and Structures
- Journal of Composites Science
- Materials
- Fluids
- Engineering Analysis with Boundary Elements
- Wing Energy Science
- 2nd International Conference on Numerical Modeling in Engineering 2019
- International Mechanical Engineering Congress & Exposition IMECE 2020 (ASME)

Professional Memberships/ Involvements

- **Technical Committee Member of non-deterministic approaches (NDA) at the American Institute of Aeronautics and Astronautics (A committee of 56 technical experts on NDA/uncertainty quantification selected from all around the world)**
- **NSF-CMMI's Game Changer Academies for Advancing Research Innovation 2024**
- American Institute of Aeronautics and Astronautics **(Professional Member)**
- American Society for Composites
- Judge at The Undergraduate Research and Creative Activity Conference, The University of Alabama, Tuscaloosa, 2019

Refreed Research Publications

Journal Articles

1. S. Gupta, **M. Thapa**, A. Paudel, S. B. Mulani, and R. W. Walters, "Robust design optimization of variable stiffness composites with manufacturing constraints," *Engineering Structures*, **(Under review)**.
2. L. M. Santos, A. Lang, **M. Thapa**, *et al.*, "The root mean square intersect method to identify vortex cores," *Experiments in Fluids*, **(Under review)**.
3. **M. Thapa**, S. Mulani, and V. Goyal, "Stochastic non-linear buckling analysis of variable angle tow composites," *Composite Structures*, **(Manuscript under Preparation)**.
4. **M. Thapa**, S. B. Mulani, A. Paudel, S. Gupta, and R. W. Walters, "Classifier-based adaptive polynomial chaos expansion for high-dimensional uncertainty quantification," *Computer Methods in Applied Mechanics and Engineering*, vol. 422, p. 116 829, 2024.
5. S. Gupta, A. Paudel, **M. Thapa**, S. B. Mulani, and R. W. Walters, "Adaptive sampling-based artificial neural network for surrogate modeling," *Aerospace Science and Technology*, vol. 133, p. 108 109, 2023.
6. A. Paudel, S. Gupta, **M. Thapa**, S. B. Mulani, and R. W. Walters, "Higher-order taylor series expansion with efficient sensitivity estimation for uncertainty analysis," *Aerospace Science and Technology*, vol. 126, p. 107 574, 2022.
7. **M. Thapa** and S. Missoum, "Stochastic optimization of a horizontal-axis composite wind turbine blade," *Structural and Multidisciplinary Optimization*, vol. 65, no. 2, pp. 1–18, 2022.
8. **M. Thapa** and S. Missoum, "Uncertainty quantification and global sensitivity analysis of composite wind turbine blades," *Reliability Engineering and Sytem Safety*, vol. 222, p. 108 354, 2022.
9. **M. Thapa**, A. Paudel, S. B. Mulani, and R. W. Walters, "Uncertainty quantification and global sensitivity analysis for progressive failure of fiber reinforced composites," *Structural and Multidisciplinary Optimization*, vol. 63, no. 1, pp. 245–265, 2020.
10. **M. Thapa**, S. B. Mulani, and R. W. Walters, "Adaptive weighted least-squares polynomial chaos expansion with basis adaptivity and sequential adaptive sampling," *Computer Methods in Applied Mechanics and Engineering*, vol. 360, p. 112 759, 2019.
11. **M. Thapa**, S. B. Mulani, and R. W. Walters, "Stochastic multi-scale modeling of carbon fiber reinforced composite laminates with polynomial chaos expansion," *Composite Structures,*, vol. 2013, pp. 82–97, 2019.
12. J. Bodiuzzaman, **M. Thapa**, S. B. Mulani, and S. Roy, "Repeatable self-healing of thermosetting fiber reinforced polymer composites with thermoplastic healant," *Smart Materials and Structures*, vol. 28, no. 2, p. 025 037, 2018.

13. **M. Thapa**, S. B. Mulani, and R. W. Walters, "A new non-intrusive polynomial chaos using higher order sensitivities," *Computer Methods in Applied Mechanics and Engineering*, vol. 328, pp. 594–611, 2018.

Conference Proceedings

1. A. Paudel, **M. Thapa**, S. Gupta, S. Mulani, and R. W. Walters, "Polynomial chaos with modified tikhonov regularization for uncertainty quantification," in *: AIAA SCITECH 2025 Forum* ***(Accepted)***, Jan. 2025.
2. C. Campbell, **M. Thapa**, S. Mulani, and G. S., "Modified gram-charlier method for analytical pdf," in *: AIAA SCITECH 2024 Forum*, Jan. 2024, p. 1024.
3. S. Gupta, A. Paudel, **M. Thapa**, S. Mulani, N. Rowshan, and R. W. Walters, "Stochastic thermal buckling analysis of variable angle tow composites," in *: AIAA SCITECH 2024 Forum*, Jan. 2024, p. 0170.
4. **M. Thapa**, S. Mulani, S. Gupta, and V. Goyal, "Stochastic non-linear buckling analysis of variable angle tow composites," in *: 2024 ASC Technical Conference, US-Japan Joint Symposium, D30 Meeting*, Oct. 2024.
5. **M. Thapa**, W. Zhao, and S. B. Mulani, "Stochastic thermal buckling analysis of variable angle tow composites," in *: ASME Aerospace Structures, Structural Dynamics, and Materials Conference*, vol. 87745, Apr. 2024, V001T01A002.
6. A. Paudel, S. Gupta, **M. Thapa**, S. B. Mulani, and R. W. Walters, "Stochastic buckling of composite cylinder with geometric imperfection and global sensitivity analysis," in *: 2023 AIAA SciTech Forum, National-Harbor, Maryland*, Jan. 2023, p. 1093.
7. N. Rowshan, S. Gupta, A. Paudel, **M. Thapa**, S. B. Mulani, and R. W. Walters, "New method of antithetic sampling for higher dimensionality," in *: 2023 AIAA SciTech Forum, National-Harbor, Maryland*, Jan. 2023, p. 2370.
8. **M. Thapa**, S. B. Mulani, A. Paudel, S. Gupta, and R. W. Walters, "Adaptive sparse polynomial chaos based on a classifier and sequential sampling," in *: 2023 AIAA SciTech Forum, National-Harbor, Maryland, (Accepted)*, Jan. 2023.
9. S. Gupta, A. Paudel, **M. Thapa**, S. B. Mulani, and R. W. Walters, "Adaptive sampling-based artificial neural network for surrogate modeling," in *:AIAA SCITECH 2022 Forum*, 2022, p. 0805.
10. S. Gupta, A. Paudel, **M. Thapa**, S. B. Mulani, and R. W. Walters, "Efficient decoupled approach for robust design optimization," in *:AIAA AVIATION 2021 FORUM*, Aug. 2021, p. 3044.
11. A. Paudel, S. Gupta, **M. Thapa**, S. B. Mulani, and R. W. Walters, "Regularized solution to underdetermined system in polynomial chaos for uncertainty quantification," in *: 4th National Conference on Multidisciplinary, Design, Analysis, and Optimization, Virtual Conference*, Oct. 2021.
12. **M. Thapa**, A. Paudel, S. Gupta, *et al.*, "Aero-structural design and analysis of pylons for a 16-element airborne radar antenna array," in *: 26th International Symposium on Polar Sciences (ISPS2021)*, Sep. 2021.
13. A. Paudel, **M. Thapa**, S. Gupta, S. B. Mulani, and R. W. Walters, "Higher-order taylor series expansion with efficient sensitivity estimation for uncertainty analysis," in *: AIAA AVIATION 2020 FORUM*, 2020, p. 3164.
14. **M. Thapa** and S. Missoum, "Design of composite wind turbine blades under uncertainties," in *:2nd annual Arizona Postdoctoral Research Conference, September 2020.*, Sep. 2020.
15. **M. Thapa** and S. Missoum, "High-dimensional uncertainty quantification and global sensitivity analysis of a composite wind turbine blade," in *:ASC 35th Annual Technical Conference, Virtual Conference: American Society of Composites*, Sep. 2020.
16. **M. Thapa** and S. Missoum, "Stochastic optimization of a horizontal-axis composite wind turbine blade," in *:ASME International Mechanical Engineering Congress and Exposition*, vol. 84669, American Society of Mechanical Engineers, Sep. 2020, V014T14A026.

17. **M. Thapa**, A. Paudel, S. B. Mulani, and R. W. Walters, "Global sensitivity analysis for stochastic responses of fiber reinforced composites with polynomial chaos," in *: 2020 AIAA SciTech Forum, Orlando Florida*, Jan. 2020.

18. N. Vishe, J. Bodiuzzaman, **M. Thapa**, S. B. Mulani, and S. Roy, "Healing of mode-i fatigue crack in fiber reinforced composites using thermoplastic healants," in *: 2020 AIAA SciTech Forum, Orlando Florida*, 2020, p. 2104.

19. J. Bodiuzzaman, **M. Thapa**, S. B. Mulani, and S. Roy, "Experimental characterization of shape memory polymer enhanced thermoplastic self-healing carbon/epoxy composites," in *: AIAA Science and Technology Forum and Exposition*, 2019, p. 1112.

20. **M. Thapa**, J. Bodiuzzaman, N. Vishe, S. B. Mulani, and S. Roy, "A comparative numerical and experimental study of mode-i interlaminar fracture of self-healing composites using cohesive zone modeling," in *: ASC 34th Annual Technical Conference, Atlanta, Georgia*, 2019.

21. **M. Thapa**, A. Paudel, S. B. Mulani, and R. W. Walters, "Efficient adaptive sparse polynomial chaos expansion with l1-minimization and sequential sampling," in *: AIAA Science and Technology Forum and Exposition 2019*, 2019, p. 1226.

22. **M. Thapa**, A. Paudel, S. B. Mulani, and R. W. Walters, "Stochastic progressive failure analysis of fiber-reinforced composite laminate," in *: 2019 AIAA Aviation and Aeronautics Forum and Exposition, Dallas, Texas, June 17-21*, 2019, p. 3553.

23. J. Bodiuzzaman, **M. Thapa**, S. B. Mulani, and S. Roy, "Repeatability of non-autonomous self-healing with thermoplastic healing agent in fiber reinforced thermoset composite," in *: ASC 33rd Annual Technical Conference, Seattle, Washington*, Sep. 2018.

24. M. W. Fister, **M. Thapa**, and S. B. Sameer B. Mulani, "Adaptive higher-order integration method and its applications in uncertainty quantification," in *: 2018 AIAA Non-Deterministic Approaches Conference, AIAA Science and Technology Forum and Exposition 2018, Kissimmee, Florida*, Jan. 2018, p. 1408.

25. **M. Thapa**, S. B. Mulani, and R. W. Walters, "Variance-based adaptive sparse polynomial chaos with adaptive sampling," in *: 2018 AIAA Non-Deterministic Approaches Conference, AIAA Science and Technology Forum and Exposition 2018, Kissimmee, Florida*, Jan. 2018, p. 2168.

26. **M. Thapa**, S. B. Mulani, and R. W. Walters, "Multi-scale uncertainty quantification of fiber reinforced composites using polynomial chaos decomposition," in *:American Society for Composites 31st Technical Conference and ASTM Committee D30 Meeting, Williamsburg, Virginia, D.C, 2203*, 2016.

27. **M. Thapa**, S. B. Mulani, and R. W. Walters, "Polynomial chaos decomposition with differentiation operation," in *:17th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference, Washington, D.C.*, 2016, p. 4288.

Books and Chapters

1. **M. Thapa**, J. Bodiuzzaman, S. B. Mulani, and S. Roy, *Development of Intelligent and Predictive Self-Healing Composite Structures Using Dynamic Data-Driven Applications Systems*, In: Handbook of Dynamic Data-Driven Applications Systems, 2nd Edition. Springer, Cham, 2022, vol. 1.

2. **M. Thapa**, S. B. Mulani, and R. W. Walters, *Polynomial Chaos for Uncertainty Quantification: Past, Present, and Future*, In: Uncertainty Quantification: Advances in Research and Applications. Nova Publishers, 2019.

3. **M. Thapa**, J. Bodiuzzaman, S. B. Mulani, and S. Roy, *Intelligent Self-Healing Composite Structure Using Predictive Self-Healing and Dynamic Data-Driven Application System*, In: Handbook of Dynamic Data-Driven Applications Systems. Springer, 2018.

Invited Talks and Presentations

[T1] Efficient Uncertainty Quantification and Stochastic Design Optimization using Spectral Approaches and Machine Learning, Plasma & Reacting Flow Science Department, SANDIA National Laboratory, 08/24/2023 (Online).

[T2] Efficient Uncertainty Quantification and Stochastic Design Optimization of Composite Wind Turbine Blades, Wind Energy Computational Sciences, SANDIA National Laboratory, 03/16/2023 (Online).

[T3] Adaptive Sparse Polynomial Chaos based on a Classifier and Sequential Sampling, AIAA SciTech 2023 Forum, National Harbor, MD, 01/24/2023.

[T4] Stochastic Optimization of a Horizontal-Axis Composite Wind Turbine Blade, IMECE2020-24004, Proceedings of the ASME 2020 International Mechanical Engineering Congress and Exposition IMECE 2020, Oregon, USA, 11/18/2020. (Online).

[T5] Uncertainty Quantification and Stochastic Design Optimization of Composite Wind Turbine Blades, Aerospace and Mechanical Engineering Seminar, University of Arizona, 11/03/2020 (Online).

[T6] High-Dimensional Uncertainty Quantification and Global Sensitivity Analysis of a Composite Wind Turbine Blade, 35th Annual Technical Conference, NYU Tandon School of Engineering, 09/15/2020. (Online).

[T7] Efficient Algorithms for Uncertainty Quantification using Polynomial Chaos Expansion and its Application to Composite Structures, Chemistry & Nanoscience Department, National Renewable Energy Laboratory, 07/22/2019.

[T8] Efficient Adaptive Sparse Polynomial Chaos Expansion with L_1-minimization and Sequential Sampling, AIAA SciTech 2019 Forum, San Diego, California, 01/10/2019.

[T9] Polynomial Chaos Decomposition with Differentiation Operation, 17th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference, Washington, D.C., 06/15/2016.

Research Experience/Inner College Training

01/2020-12/2020	**Postdoctoral Research Associate** (Uncertainty Quantification, Stochastic Optimization, Wind Energy)
01/2018-12/2019	**Research Assistant** (Uncertainty Quantification; Self-Healing Composites Structures)
08/2017-12/2017	**Research Assistant** (Self-Healing Composites Structures)
05/2017-07/2017	**Research Assistant** (Adaptive Sparse Polynomial Chaos Expansion; Adaptive Higher-Order Integration Method and its Applications in Uncertainty Quantification Structural Sizing and Analysis of the UWB Antenna Assemblies for Basler BT-67)
05/2016-07/2016	**Research Assistant** (Polynomial Chaos Decomposition with Differentiation)
11/2012-07/2014	**Researcher** Research and Development of UAV at Design Empire Pvt. Ltd
01/2012-06/2012	**Researcher** Bachelor Graduation Thesis NUAA (Design and Optimization of Morphing Wing Aircraft)
	Researcher The Design and Fabrication of Blended Wing Body Electric-Powered Unmanned Air Vehicle (Part of the team, NUAA)

Teaching/Advising Experience

Teaching

08/2024-12/2024 (Fall)	Guest Lecturer for Graduate level Microwave Course. (Topics Covered: Synthetic Aperture Radar (SAR) digital signal processing with Unfocused SAR, Range Doppler, F-k migration.)
08/2022-12/2022 (Fall)	Guest Lecturer for Graduate level Stochastic Mechanics Course. (Topics covered: Global Sensitivity Analysis, Sparse PCE using regularized l1-minimization- Orthogonal Matching Pursuit, Data-driven arbitrary PCE)
01/2017-05/2017 (Spring)	Instructor (Lab of Mechanics of Materials)
08/2016-12/2016 (Fall)	Instructor (Lab of Mechanics of Materials)
01/2016-05/2016 (Spring)	Teaching Assistant (Mechanics of Materials)
08/2015-12/2015 (Fall)	Teaching Assistant (Statics)
06/2015-07/2015 (Summer)	Teaching Assistant (Dynamics)
01/2015-05/2015 (Spring)	Teaching Assistant (Dynamics)

Advising

I have advised several graduate students jointly with Dr. Sameer B. Mulani at the Stochastic Mechanics and Optimization Laboratory (SMO Lab at UA). The topics covered are uncertainty quantification, stochastic optimization, machine learning, finite element analysis, and computational fluid dynamics simulations.

- **Dr. Achyut Paudel (08/2018-12/2022)**
  Ph.D. Dissertation Title: Efficiency Improvements For Uncertainty Quantification And Applications To Composite Structures
  Research topics: Uncertainty Quantification, Finite Element Analysis.
- **Dr. Subham Gupta (08/2019-05/2024)**
  Research topics: Robust Optimization, Machine Learning/Neural Networks, Curvilinear Composites.
- **Nadiya Rowshan (Ph.D. Student, 08/2022-05/2026)**
  Research topics: Sampling Methods, Uncertainty Quantification.

Professional Experience

- **Senior Research Personnel/Assistant Research Professional-Aeronautics and Engineering Mechanics, The Remote Sensing Center, The University of Alabama (01/2021-Present)**
  Major Responsibilities/Outcomes
  - Performed aerodynamic analysis of the **world's largest airborne radar antenna array** structures with 32 pylons
  - Performed structural design and FEA of the world's largest airborne radar antenna array at RSC.
  - **Successfully certified the world's largest airborne composite antennae array attached to the Basler aircraft, meeting aerodynamics and structural requirements under Transport Canada**
  - Developed algorithms for efficient uncertainty quantification, optimization, and machine learning and implemented to engineering design improvement
  - Develop codes for digital signal processing of Synthetic Aperture Radar.
  - Collaborate with faculties from different disciplines on multi-disciplinary projects and write white papers, technical reports, and proposals.
  - Mentor and train graduate and undergraduate students

- **Postdoctoral Research Associate, AME, University of Arizona (01/2020-12/2020)**
  Major Responsibilities/Outcomes
  - Developed a fully parametric composite wind turbine blade finite element model
  - Developed a framework for stochastic optimization of composite wind turbine blades considering the aero-structural aspects
  - Perform research on uncertainty quantification, optimization, global sensitivity analysis
  - Mentor and guide graduate students
  - Identify potential sources for grant funding
  - **Published two journal papers, two conference papers, and one poster based on my one-year post-doc research**
- **Post-doctoral Research Associate/ Graduate Research/Teaching Assistant, AEM, University of Alabama (01/2015-12/2019)**
  Major Responsibilities
  - Performed research on Uncertainty Quantification/Optimization and published several journals, book chapters, and conference papers
  - Carried out design and structural analysis of the UWB-Radar Assembly, Mill Cross Radar (for Antarctica Mission), VHF Duol-Pol Antenna Panel, and Composite Stiffened Panel for the Fuselage Section of an Aircraft
  - Mentored junior members with CAD modeling and FEA analysis
- **Design and Research Engineer, Design Empire Pvt. Ltd, Nepal (11/2012-07/2014)**
  Major Responsibilities
  - Identify the user's requirement for the product to be developed
  - Designed the products using CATIA
  - Carried out structural analysis with NASTRAN/PATRAN
  - Research and development of UAV

Grants/Funding

- **Airborne Ultra-Wideband Radars for Polar Research: A19-0250-003;**
  Budget: $397,309.00; (co-PI 15% share)
  Our team at The University of Alabama (UA) Remote Sensing Center proposed the development of an ultra-wideband (UWB) radar designed with the largest possible composite antenna array for airborne sounding and imaging of ice sheets to the Korean Polar Research Institute (KOPRI). This world's largest airborne radar antenna array was mounted on the wings of the Basler aircraft, was certified in July 2023, and deployed in December 2023 in Antarctica. This radar allows measuring the ice thickness for generating 3-D topography of the ice bed for selected areas and mapping air-snow and snow-ice interfaces to estimate the snow thickness on sea ice.

References

Available on Request