

Dr. Navajit Singh Baban

Associate Research Scientist | Division of Engineering, New York University Abu Dhabi (NYUAD)

Research affiliations: [Center for Cyber Security \(CCS-NYUAD\)](#) | [Center for Translational Medical Devices \(CENTMED-NYUAD\)](#)

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PROFESSIONAL APPOINTMENTS

Associate Research Scientist - NYUAD

Abu Dhabi, United Arab Emirates | Division of Engineering: [CCS-NYUAD](#) and [CENTMED-NYUAD](#) **04 Aug 2026 - Present**

Postdoctoral Associate - NYUAD

Abu Dhabi, United Arab Emirates | Division of Engineering: [CCS-NYUAD](#)

01 Sept 2021 - 04 Aug 2026

Graduate Research Assistant – NYUAD

Abu Dhabi, United Arab Emirates | Department of Mechanical Engineering

07 July 2016 - 31 Aug 2021

Planning Manager - Construction Engineering (Mechanical) – Reliance Industries Limited Ltd.

Jamnagar, Gujarat, India

12 Dec 2015 – 30 Mar 2016

Assistant Professor, Mechanical Engineering – Lovely Professional University

Punjab, India

09 Aug 2014 – 30 Nov 2015

EDUCATION

Ph.D., Global Fellow, Mechanical Engineering – NYU, Tandon School of Engineering

2021

GPA: 3.8/4.0 | Adviser: Prof. Yong-Ak (Rafael) Song, NYU/NYUAD

Thesis: *Understanding Micro- and Nanoscale Soft Interfacial Fracture Mechanics through Bioinspired Engineering Models*

M.Tech., Materials Science – Indian Institute of Technology Kanpur (IITK)

2014

CPI: 9.45/10 | Adviser: Prof. Kamak K. Kar, IITK

Thesis: *2D Numerical Simulation of Material Properties of Carbon-Carbon Composites during Carbonization*

B.Tech., Mechanical Engineering – VIT University, Vellore

2012

CGPA: 8.58/10

SELECTED RESEARCH SUPPORT

Research Lead, NSF SaTC Award 2049311 – Secure and Trustworthy Cyberphysical Microfluidic Systems

May 2021 – Apr 2025

Total award: USD 542,431 | Principal Investigator: Prof. Ramesh Karri | Led research, mentoring, publications, and multidisciplinary coordination. [\[Award record\]](#)

Co-PI, NYU-IIT Kanpur Seed Grant – Unconventional Physically Unclonable Functions for Microfluidics and Supply-Chain Fingerprinting

Apr 2024 – Mar 2025

Award: USD 20,000 (NYU) | Coordinated a tripartite NYU-NYUAD-IIT Kanpur collaboration.

Awardee, NYUAD Postdoctoral Collaborative Research Grant – Material-Level Trojan Countermeasures for Microfluidic Biochips

July 2023

Award: USD 5,000 | Supported an NYU New York collaboration associated with the Viscoelastic BioTrojans study.

INTELLECTUAL PROPERTY AND RELATED TRANSLATION

Baban, N. S.; Karri, R.; Chakrabarty, K.; Sanjairaj, V.; Song, Y.-A. “System, Method and Computer-Accessible Medium Facilitating Biochip Fingerprints for Authentication.” International patent application PCT/US2024/051942; filed 18 Oct 2024; published as WO 2025/085728 A1 on 24 Apr 2025. [\[WIPO record\]](#)

Aitmukhanbetov, N.; Song, Y.; **Baban, N. S.**; Sahin, I. “Minimally Invasive Microneedle-Based Glaucoma Implant.” U.S. Provisional Application No. 64/008,558; filed 17 Mar 2026.

RESEARCH INTERESTS

Nature-Inspired Nonlinear Mechanics: Biomimetic fracture of lizard-tail autotomy; interfacial fracture in microinterlocked soft layers; bioinspired tissue adhesives; and plant-stem, lemon-peel, and kirigami mechanics.

Bioengineering: MechanoBioCAD for mechanobiological studies; modular spheroid culture under continuous perfusion; *C. elegans* dispensing and biophysical phenotyping; organ-/alveoli-on-chip mechanics; and translational microfluidic devices for flow regulation, adhesion, and pressure sensing.

MEMS Design & Security: Cyber-physical security of microfluidic biochips; structural attacks and defenses; material-level countermeasures and BioTrojans; Biochip-PUF/Bio-FP authentication; carbon-quantum-dot fingerprints; and secure digital microfluidics and droplet routing.

RESEARCH PROJECTS AND PUBLICATION OUTCOMES

Nature-Inspired Nonlinear Mechanics:

- **Interfacial fracture in microinterlocked soft layers** — Research Lead: Led cohesive-zone finite-element modeling of crack arrest, secondary cracking, and energy dissipation in human-skin-inspired soft interfaces. Outputs: *Physical Review E* (2020); *MicroTAS* (2019).
- **Biomimetic fracture model of lizard-tail autotomy** — Research Lead: Led multiscale imaging, experiments, and modeling to reveal hierarchical fracture and wet-adhesion mechanisms and translate them into tissue adhesives and switchable soft-

robotic interfaces. Outputs: *Science* cover (2022); *Bioinspiration & Biomimetics* (2022); *Clinical and Translational Medicine* (2022); *The ScienceBreaker* (2022); MicroTAS (2018).

- **Plant-stem, lemon-peel, and kirigami mechanics** — Lead Mechanics Contributor: Led mechanics-based modeling and characterization of bending, puncture, fracture, and energy dissipation in hierarchical biological and architected structures. Output: Springer book chapter (2018); ongoing lemon-peel and kirigami studies.

Bioengineering:

- **MechanoBioCAD and *C. elegans* microdevices** — Lead Computational Contributor: Led finite-element design, error quantification, optimization, and force inference for micropillar mechanobiology, together with the engineering analysis of a pressure-pulse-actuated 3D-printed worm-dispensing tip. Outputs: *Lab on a Chip* (2025); Academic Press book chapter (2021); MicroTAS (2018).
- **Spheroid perfusion, organ/lung-on-chip systems, and translational medical devices** — Lead Mechanics and Modeling Contributor: Led controlled-pressure testing, microflow and nutrient-transport modeling, and fluid–structure analysis for perfused 3D cultures and pulmonary platforms. Current work extends these capabilities to passive flow regulation, tissue–implant adhesion, and pressure sensing in microneedle-based glaucoma implants. Output: *APL Bioengineering* (2025); ongoing organoid-, alveoli-on-chip, and implant development.

MEMS Design & Security:

- **Structural attacks and defenses for flow-based microfluidic biochips** — Research Lead: Led geometry-based attack modeling, approximately 96% deep-learning anomaly detection, and fluorescence watermarking against functional tampering and intellectual-property theft. Output: *IEEE Transactions on Biomedical Circuits and Systems* (2022).
- **Material-level countermeasures and viscoelastic BioTrojans** — Research Lead: Led dynamic material watermarking, greater than 99% machine-learning detection of curing-ratio attacks, and viscoelastic microvalve attack-and-defense models. Outputs: *Lab on a Chip* cover article (2023); *Scientific Reports* (2024).
- **Biochip-PUF, Bio-FP, and carbon-quantum-dot-based authentication** — Research Lead: Led physically unclonable device and material fingerprints, fluorescent stickers, and QR identifiers using multimodal image and spectral authentication, achieving 99.9% classification accuracy. Outputs: *Green Chemistry* (2023); IEEE ITC (2023); IEEE BioCAS (2023); ACNS (2024); IEEE ATS (2024); patent publication WO 2025/085728 A1.
- **Attacks and countermeasures for digital microfluidic biochips** — Research Lead: Led studies of wettability and plasma attacks, OCT-based anomaly detection, calibrated droplet-shape routing, and optical and hash-based runtime safeguards. Outputs: SPACE (2024); *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* (2025); IEEE BioCAS (2025).
- **Secure additive manufacturing and cyber-physical security of biochips** — Research Lead: Led analysis of structural, material, STL/G-code, firmware, and 3D-bioprinting attack surfaces; integrated device-to-supply-chain threats into a translational security roadmap and international BioHack3D challenges conducted from 2023 to 2025. Output: *Biomicrofluidics* perspective (2025).

PUBLICATIONS

Peer-Reviewed Journal Articles

1. Aljayyousi, H.; Sahloul, S.; Orozaliev, A.; **Baban, N. S.**; Van, D.-A.; Al Nuairi, A.; John, P.; Zam, A.; Percipalle, P.; Song, Y.-A. “A Modular and Reconfigurable Microfluidic Device for Culturing Spheroids Under Continuous Perfusion.” *APL Bioengineering* 9(3), 036111 (2025). DOI: 10.1063/5.0262536.
2. **Baban, N. S.**; Stubbs, C. J.; Song, Y.-A. “MechanoBioCAD: A Generalized Semi-Automated Computational Tool for Mechanobiological Studies.” *Lab on a Chip* 25(11), 2632-2643 (2025). DOI: 10.1039/D4LC00843J.
3. **Baban, N. S.***; Bhattacharjee, S.; Song, Y.-A.; Chakrabarty, K.; Karri, R. “Cyber-Physical Security of Biochips: A Perspective.” *Biomicrofluidics* 19(3), 031304 (2025). DOI: 10.1063/5.0252554.
4. Eenhakkattu Mana, A. S.; **Baban, N. S.**; Zhang, M.; Wang, D.; Ma, H.; Ho, T.-Y.; Chakrabarty, K. “Optimization of Droplet Routing in Microfluidic Biochips Using Calibrated Droplet-Shape Morphing.” *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* 44(7), 2683-2696 (2025). DOI: 10.1109/TCAD.2024.3524475.
5. **Baban, N. S.***; Zhou, J.; Elkhoury, K.; Bhattacharjee, S.; Vijayavenkataraman, S.; Gupta, N.; Song, Y.-A.; Chakrabarty, K.; Karri, R. “BioTrojans: Viscoelastic Microvalve-Based Attacks in Flow-Based Microfluidic Biochips and Their Countermeasures.” *Scientific Reports* 14, 19806 (2024). DOI: 10.1038/s41598-024-70703-0.
6. **Baban, N. S.***; Saha, S.; Jancheska, S.; Singh, I.; Khapli, S.; Khobdabayev, M.; Kim, J.; Bhattacharjee, S.; Song, Y.-A.; Chakrabarty, K.; Karri, R. “Material-Level Countermeasures for Securing Microfluidic Biochips.” *Lab on a Chip* 23(19), 4213-4231 (2023). DOI: 10.1039/D3LC00335C. *Selected for the issue cover.*
7. Abdelhameed, M.; Elbeh, M.; **Baban, N. S.**; Pereira, L.; Matula, J.; Song, Y.-A.; Ramadi, K. B. “High-Yield, One-Pot Upcycling of Polyethylene and Polypropylene Waste into Blue-Emissive Carbon Dots.” *Green Chemistry* 25(5), 1925-1937 (2023). DOI: 10.1039/D2GC04177D.
8. **Baban, N. S.***; Saha, S.; Orozaliev, A.; Kim, J.; Bhattacharjee, S.; Song, Y.-A.; Karri, R.; Chakrabarty, K. “Structural Attacks and Defenses for Flow-Based Microfluidic Biochips.” *IEEE Transactions on Biomedical Circuits and Systems* 16(6), 1261-1275 (2022). DOI: 10.1109/TBCAS.2022.3220758.
9. **Baban, N. S.**; Orozaliev, A.; Kirchhof, S.; Stubbs, C. J.; Song, Y.-A. “Biomimetic Fracture Model of Lizard Tail Autotomy.” *Science* 375(6582), 770-774 (2022). DOI: 10.1126/science.abh1614. *Featured on the issue cover and reported by The New York Times, The Independent, and 20+ international media outlets.*

10. **Baban, N. S.**; Orozaliyev, A.; Stubbs, C. J.; Song, Y.-A. “Biomimicking Interfacial Fracture Behavior of Lizard Tail Autotomy with Soft Microinterlocking Structures.” *Bioinspiration & Biomimetics* 17(3), 036002 (2022). DOI: 10.1088/1748-3190/ac4e79.
11. **Baban, N. S.**; Song, Y.-A. “Rational Design of Bioinspired Tissue Adhesives.” *Clinical and Translational Medicine* 12(4), e784 (2022). DOI: 10.1002/ctm2.784. [Perspective].
12. **Baban, N. S.**; Orozaliyev, A.; Stubbs, C. J.; Song, Y.-A. “Understanding Interfacial Fracture Behavior between Microinterlocked Soft Layers Using Physics-Based Cohesive Zone Modeling.” *Physical Review E* 102(1), 012801 (2020). DOI: 10.1103/PhysRevE.102.012801.

Peer-Reviewed Conference Papers and Proceedings

1. **Baban, N. S.**; Roy, P. B.; John, P.; Soundararajan, R.; Zam, A.; Bhattacharjee, S.; Song, Y.-A.; Chakrabarty, K.; Karri, R. “Toward Secure Digital Microfluidic Biochips: Optical and Hash-Based Runtime Safeguards.” *IEEE BioCAS*, 457-461 (2025). DOI: 10.1109/BioCAS67066.2025.00104.
2. **Baban, N. S.**; Abdelhameed, M.; Elbeh, M.; Ramadi, K.; Song, Y.-A.; Bhattacharjee, S.; Karri, R.; Chakrabarty, K. “Carbon Quantum Dot Fluorescent Stickers for Biochip Authentication.” *IEEE Asian Test Symposium*, 1-6 (2024). DOI: 10.1109/ATS64447.2024.10915375.
3. **Baban, N. S.**; Roy, P. B.; John, P.; Zam, A.; Bhattacharjee, S.; Song, Y.-A.; Karri, R.; Chakrabarty, K. “Attacks and Countermeasures for Digital Microfluidic Biochips.” *SPACE 2024*, LNCS 15351, 1-5. DOI: 10.1007/978-3-031-80408-3_1.
4. **Baban, N. S.**; Zhou, J.; Bhattacharya, S.; Chatterjee, U.; Bhattacharjee, S.; Sanjairaj, V.; Song, Y.-A.; Mukhopadhyay, D.; Chakrabarty, K.; Karri, R. “Physically Unclonable Fingerprints for Authentication.” *ACNS Workshops 2024*, LNCS 14587, 235-239. DOI: 10.1007/978-3-031-61489-7_21.
5. **Baban, N. S.**; Saha, S.; Jancheska, S.; Zhou, J.; Vijayavenkataraman, S.; Bhattacharjee, S.; Song, Y.-A.; Chakrabarty, K.; Karri, R. “Bio-FP: Biochip Fingerprints for Authentication.” *IEEE BioCAS*, 1-5 (2023). DOI: 10.1109/BioCAS58349.2023.10388991.
6. **Baban, N. S.**; Orozaliyev, A.; Song, Y.-A.; Chatterjee, U.; Bose, S.; Bhattacharjee, S.; Karri, R.; Chakrabarty, K. “Biochip-PUF: Physically Unclonable Function for Microfluidic Biochips.” *IEEE International Test Conference*, 166-175 (2023). DOI: 10.1109/ITC51656.2023.00033.
7. **Baban, N. S.**; Orozaliyev, A.; Stubbs, C. J.; Song, Y.-A. “Bioinspired Micromechanical Interlocking Structures for Enhanced Adherence between Soft Elastomeric Layers.” *MicroTAS*, 1130-1131 (2019).
8. Chaturvedi, N.; **Baban, N. S.**; Sofela, S. O.; Orozaliyev, A.; Giakoumidis, N.; Kim, J.; Gunsalus, K. C.; Song, Y.-A. “A Single Pressure Pulse-Actuated 3D-Printed Microfluidic Tip for High-Throughput Dispensing of C. elegans Worms.” *MicroTAS*, 1557-1559 (2018).
9. **Baban, N. S.**; Orozaliyev, A.; Song, Y.-A. “Mechanistic Approach to Mimic Lizard Tail Autotomy Using Deformable Microstructures as Biological Interlock in Soft Tissue.” *MicroTAS*, 1670-1672 (2018).
10. Hassan, N.; **Baban, N. S.**; Chand, R.; Vijayavenkataraman, S.; Bhattacharjee, S.; Chatterjee, U.; Mukhopadhyay, D.; Song, Y.-A.; Chakrabarty, K.; Karri, R. “MEW-QRC: Physically Unclonable Melt-Electrowritten Quick-Response Codes for Secure Authentication.” *IEEE PAIN*, 1-6 (2026). (Accepted; to be presented at PAIN 2026, Phoenix, AZ).

Book Chapters

1. Sofela, S.; Feng, Y.; **Baban, N. S.**; Stubbs, C. J.; Song, Y.-A.; Wang, W. “Biophysical Phenotyping of C. elegans in a Microfluidic Chip for High-Throughput Drug Screening.” *Micro and Nano Systems for Biophysical Studies of Cells and Small Organisms*, Academic Press, 261-293 (2021).
2. Stubbs, C. J.; **Baban, N. S.**; Robertson, D. J.; Alzube, L.; Cook, D. D. “Bending Stress in Plant Stems: Models and Assumptions.” *Plant Biomechanics: From Structure to Function at Multiple Scales*, Springer, 49-77 (2018). DOI: 10.1007/978-3-319-79099-2_3.
3. Pramanik, S.; Cherusseri, J.; **Baban, N. S.**; Sowntharya, L.; Kar, K. K. “Metal Matrix Composites: Theory, Techniques, and Applications.” *Composite Materials: Processing, Applications, Characterizations*, Springer, 369-411 (2017). DOI: 10.1007/978-3-662-49514-8_11.

TEACHING EXPERIENCE

Teaching Assistant – Quantitative Synthetic Biology – New York University Abu Dhabi | Spring 2023

- Delivered class and recitation instruction; designed experimental procedures, laboratory manuals, and evaluation criteria; assessed student work.

Teaching Assistant – Biomechanics – New York University Abu Dhabi | Spring 2020

- Designed laboratory experiments and assessment rubrics; created remote-learning experiment videos and datasets during the COVID transition to online instruction.

Assistant Professor – Mechanical Engineering – Lovely Professional University | Aug-Nov 2015

- Taught core mechanical-engineering courses and supervised final-year capstone projects in mechanical and materials engineering.

PROFESSIONAL SERVICE AND OUTREACH

- **BioHack Challenge Leadership (2022–2025)**: Led the Biochip Security Workshop and Hackathon on diagnostic microfluidics and cyber-physical security, followed by CSAW BioHack3D editions focused on security-critical 3D-printed biochips, material fingerprints and biochip authentication, and AI-assisted authentication of 3D-printed QR codes and melt-electrowritten fingerprints.

- **Cross-Regional Collaboration:** Coordinated the 2024 MENA–India edition with IIT Guwahati and IIT Kharagpur, and the 2025 MENA and US–Canada editions with NYU Tandon, IIT Kharagpur, IIT Guwahati, and IIT Roorkee, building a sustained academic network across MENA, India, and North America.
- **Inclusion, Diversity, Belonging, and Equity (IDBE):** Designed accessible, interdisciplinary programs that connected participants across educational levels, institutions, disciplines, and regions; promoted mentorship, cross-cultural teamwork, inclusive participation, and community-building at the intersection of bioengineering, AI, cybersecurity, and advanced manufacturing.

AWARDS AND HONORS

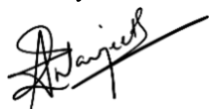
- **Global Ph.D. Fellowship, New York University (2016-2021):** Competitive doctoral fellowship providing full tuition and research support.
- **Travel grants:** New York University Abu Dhabi, MicroTAS 2018 (Kaohsiung, Taiwan); New York University Abu Dhabi, MicroTAS 2019 (Basel, Switzerland); Chemical and Biological Microsystems Society, MicroTAS 2019.

REFERENCES

Name	Professional Relationship and Affiliation	Email
Prof. Yong-Ak (Rafael) Song	Ph.D. adviser, co-PI, and research collaborator; Program Head of Bioengineering, CENTMED-NYUAD director, and Professor of Mechanical Engineering and Bioengineering, NYU Abu Dhabi	ys50@nyu.edu
Prof. Ramesh Karri	Postdoctoral adviser, mentor and principal PI; Electrical and Computer Engineering Department Chair and Professor of ECE, NYU Tandon School of Engineering	rkarri@nyu.edu
Prof. Krishnendu Chakrabarty	Postdoctoral Co-PI, mentor, and collaborator, Biochip Security Project; Fulton Professor of Microelectronics, Arizona State University	krishnendu.chakrabarty@asu.edu

DECLARATION

I certify that the details provided in this curriculum vitae are accurate and have been personally compiled by me.



Dr. Navajit Singh Baban

Place: Abu Dhabi, United Arab Emirates