Deepak Raina

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Employment

Johns Hopkins University, Maryland, USA Jan 2024 – Present
Post-doctoral Fellow
Malone Center for Engineering in Healthcare
Advisors: Dr. Axel Krieger and Dr. Muyinatu Bell

Purdue University, Indiana, USA July 2023 – Dec 2023
Post-doctoral Fellow
Collaborative Robotics Lab
Advisors: Dr. Richard M. Voyles

Purdue University, Indiana, USA Jan 2022 – June 2023
Visiting Doctoral Fellow
Collaborative Robotics Lab
Advisors: Dr. Richard M. Voyles

TCS Research and Innovation Lab, Delhi, India Dec 2017 – July 2019
Researcher
Smart Machines Group
Advisors: Dr. Swagat Kumar and Rajesh Sinha

Tata Automation Limited, Pune, India June 2016 – July 2016
Intern
Robotics Division

Education

Indian Institute of Technology Delhi July 2019 – Jan 2024
Ph.D. in Mechanical Engineering *GPA: 9/10*
Research area: Robotics, AI and Computer Vision for healthcare applications
Advisor: Prof. Subir K. Saha

Indian Institute of Technology Jodhpur July 2015 – June 2017
Master of Technology in Mechanical Engineering *GPA: 9.24/10*
Research area: Robot dynamics and control for space applications
Advisor: Prof. Suril V. Shah

Maharishi Markandeshwar University Ambala June 2011 – May 2015
Bachelor of Technology in Mechanical Engineering *GPA: 9/10*

Fellowships

- **Malone Postdoctoral Fellowship** 2024
  Among 2 students to be selected across the globe for postdoctoral position at Johns Hopkins University Malone Center for Engineering in Healthcare. Link
- **Overseas Visiting Doctoral Fellowship** 2022
  Among 25 Ph.D. students to be selected across the country to conduct doctoral research for 1.5 years at Purdue University, USA, sponsored by the Science and Engineering Research Board (SERB) of India. Link
- **Prime Minister's Research Fellowship** 2019
  Among 10 students to be selected across the country in Mechanical Engineering, awarded by the Ministry of Education (MoE) to exceptional doctoral candidates in the country. Link
- **Indira Gandhi Merit Scholarship** 2011
  Awarded by Directorate of Higher Education (DoHE) for securing 7^{th} rank in 12^{th} state board exams.

Awards and Honors

- **PMRF Academic Excellence Award** 2023
  Acknowledged for exceptional performance among all PMRF fellows and invited to present my research at the annual PMRF convention.
- **DST - AWSAR Award** 2023
  Awarded to my doctoral research story, distinguished as nation's top 100 scientific research stories.
- **IEEE RAS Travel Award** 2023
  Awarded for supporting my travel to ICRA 2023 in London, UK
- **Purdue University Dean's Travel Award** 2023
  Awarded for supporting my travel to ISMR 2023 in Georgia, USA
- **Runner-up International Robot Design Competition Award** 2021
  Awarded to our Telerobotic Ultrasound system at ICSR 2021 Robot Design Competition for the COVID-19 innovative response.
- **IIT Delhi Director's Honorarium** 2021
  Awarded by Director of IIT Delhi for my efforts in establishing the Technology Innovation Hub (TIH) on Collaborative robotics (Cobotics) at IIT Delhi.
- **Dassault Systèmes Design Award** 2014
  Awarded 2^{nd} prize in the design of human-powered vehicle competition organized by ASME at IIT Delhi.
- **Letter of Appreciation** 2011
  Awarded by Union Minister of India, Mr. Anurag Thakur, for excellent performance in 12^{th} state board exams

Publications

I have (first/co)-authored 3/1 journal articles, 9/1 conference papers, 1/0 book chapters and 3/1 conference workshop abstracts, and I am an inventor on 1/1 granted/filed patents. The list of publications is also available on my Google Scholar profile.

- **Journals**

[J4] **Raina, D**., Balakuntala, M. V., Kim, B. W., Wachs, J., & Voyles, R. (2024). Coaching a Robotic Sonographer: Learning Robotic Ultrasound with Sparse Expert's Feedback. *IEEE Transactions on Medical Robotics and Bionics (**TMRB**).*

[J3] **Raina, D.**, Chandrashekhara, S. H., Voyles, R., Wachs, J., & Saha, S. K. (2023). Deep Learning Model for Enhancing Quality Assessment of Ultrasound Images using Multi-scale and Higher-order Processing. *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control (**TUFFC**).*

[J2] Chandrashekhara, S. H., Rangarajan, K., Agrawal, A., Thulkar, S., Gamanagatti, S., **Raina, D.**, Saha, S. K., & Arora, C. (2022). Tele-robotic ultrasound: An initial feasibility study. *World Journal of Methodology.*

[J1] **Raina, D.**, Gora, S., Maheshwari, D., & Shah, S. V. (2021). Impact Modeling and Reactionless Control for Post-Capturing and Manoeuvring of Orbiting Objects using a Multi-arm Space Robot. *Acta Astronautica.*

- **Conferences**

[C10] **Raina, D**., Chandrashekhara, S. H., Voyles, R., Wachs, J., & Saha, S. K. (2023). Robotic Sonographer: Autonomous Robotic Ultrasound using Domain Expertise in Bayesian Optimization. In *IEEE International Conference on Robotics and Automation (**ICRA**).*

[C9] **Raina, D.**, Chandrashekhara, S. H., Voyles, R., Wachs, J., & Saha, S. K. (2023). Deep Kernel and Image Quality Estimators for Optimizing Robotic Ultrasound Controller using Bayesian Optimization. In *IEEE International Symposium on Medical Robotics (**ISMR**).*

[C8] **Raina, D.**, Ntentia, D., Chandrashekhara, S. H., Voyles, R., & Saha, S. K. (2023). Expert-Agnostic Ultrasound Image Quality Assessment using Deep Variational Clustering. In *IEEE International Conference on Robotics and Automation (**ICRA**).*

[C7] **Raina, D.**, Mathur, A. R., Voyles, R., Wachs, J., Chandrashekhara, S. H., & Saha, S. K. (2023). RUSOpt: Robotic UltraSound Probe Normalization with Bayesian Optimization for In-plane and Out-plane Scanning. In *International Conference on Automation Science and Engineering (**CASE**).*

[C6] Balakuntala, M. V., **Raina, D**., Voyles, R., & Wachs, J. (2023). Learning Robotic Ultrasound through Coaching. In *Hamlyn Symposium on Medical Robotics (**HSMR**).*

[C5] **Raina, D.**, Zhao, Z., Voyles, R., Wachs, J., Saha, S. K., & Chandrashekhara, S. H. (2024). UltraGelBot: Autonomous Gel Dispenser for Robotic Ultrasound. In *Hamlyn Symposium on Medical Robotics (**HSMR**).*

[C4] **Raina, D.**, Verma, K., Chandrashekhara, S. H., & Saha, S. K. (2022). Slim U-Net: Efficient Anatomical Feature Preserving U-net Architecture for Ultrasound Image Segmentation. In *ACM International Conference on Biomedical and Bioinformatics Engineering (ICBBE).*

[C3] **Raina, D.**, Singh, H., Saha, S. K., Arora, C., Agarwal, A., Chandrashekhara, S. H., Rangarajan, K., & Nandi, S. (2021). Comprehensive Telerobotic Ultrasound System for Abdominal Imaging: Development and in-vivo Feasibility Study. In *IEEE International Symposium on Medical Robotics (**ISMR**).*

[C2] **Raina, D.**, Mithun, P., Shah, S. V., & Kumar, S. (2019). A Novel Image-based Path Planning Algorithm for Eye-in-Hand Visual Servoing of a Redundant Manipulator in a Human-Centered Environment. In *IEEE International Conference on Robot and Human Interactive Communication (**RO-MAN**).*

[C1] **Raina, D.**, & Shah, S. V. (2017). Impact Modeling and Estimation for Multi-Arm Space Robot while Capturing Tumbling Orbiting Objects. In *ACM Proceedings of Advances in Robotics (AIR).*

- **Workshops**

[W3] **Raina, D.**, Nandi, S., Saha, S. K., Arora, C., Rangarajan, K., & Chandrashekhara, S. H. (2020). Telerobotic Ultrasound: Towards Safer, Precise and Remote Diagnosis of COVID-19 Patients. In *Workshop on Autonomous System in Medicine, IEEE International Conference on Intelligent Robots and Systems (**IROS**).*

[W2] Singhal, A., Kumar, A., Thukral, S., **Raina, D.**, & Kumar, S. (2020). Chitrakar: Robotic System for Drawing Jordan Curve of Facial Portrait. In *Workshop on Creativity and Robotics, International Conference on Social Robotics (**ICSR**).*

[W1] **Raina, D.**, Gora, S., & Shah, S. V. (2020). Reactionless Control and Target Manoeuvring of Orbiting Object in Post-Capture Phase using a Multi-arm Space Robot. In *Workshop on Space Robotics, IEEE International Conference on Robotics and Automation (**ICRA**).*

- **Book Chapters**

[B1] **Raina, D.**, Gora, S., & Shah, S. V. (2019). Modeling and Estimation of Closed-Loop Impact for Multi-arm Space Robot While Capturing a Tumbling Orbiting Object. In *Machines, Mechanism and Robotics, Lecture Notes in Mechanical Engineering.* Springer.

- **Patents**

[P2] **Raina, D.**, Zhao, Z., Voyles, R., Wachs, J., Saha, S. K., & Chandrashekhara, S. H. (2024). Modular Robotic Ultrasound Probe Gripper with Autonomous Gel Dispenser.
U.S. Patent No. 63/620,115, Filed: Jan 11, 2024

[P1] Singhal, A., Kahdilkar, H., Raju, V., **Raina, D.**, Prasad, V. S., Thukral, S., & Sinha, R. (2020). System and method for autonomous multi-bin parcel loading system.
IN Patent No. 527907, App No. 202021005053; Filed: Feb 05, 2020, **Granted**: Mar 15, 2024
US Patent No. US2021/0253376A1, Filed: Feb 04, 2021, Published: Aug 19, 2021
EP Patent No. 3862939A1, Filed: Feb 04, 2021, Published: Aug 11, 2021

- **Theses**

[Th2] Robotic Sonographer: Robot Learning Ultrasound Procedure Skills from Domain Expertise, **Doctoral thesis**, Department of Mechanical Engineering, IIT Delhi

[Th1] Impact Modeling and Estimation for Multi-Arm Space Robot while Capturing Tumbling Orbiting Objects, **Masters thesis**, Department of Mechanical Engineering, IIT Jodhpur

Research Funding

- **Malone Fellowship (2024-2026)**
  Title: Robotic ultrasound-guided diagnosis and interventions for trauma
  Agency: Johns Hopkins Malone Center for Engineering in Healthcare
  Amount: USD 1,44,000
  Role: Writing research proposal and contributing to past/ongoing research
- **Purdue University Indianapolis-West Lafayette Campus Merger Program (2023-2025)**
  Title: Bidirectional coaching for co-robotic assistance with invasive and non-invasive medical procedures.
  Agency: Purdue University
  Amount: USD 50,000
  Role: Writing research proposal, coordinating with PIs, and planning the preliminary approach
- **SERB-Overseas Visiting Doctoral Fellowship (2022-2023)**
  Title: Learning complex medical procedures through expert's demonstrations
  Agency: Science and Engineering Research Board of India
  Amount: INR 31,67,800
  Role: Writing research proposal and contributing to past/ongoing research
- **Technology Innovation Hub (2019-2024)**
  Title: Collaborative Robotics at IIT Delhi
  Agency: Department of Science and Technology
  Amount: INR 1,15,00,00,000
  Role: Student lead for institute data curation, writing research proposal, preparing presentations
- **Prime Minster Research Fellowship (2019-2023)**
  Title: Learning complex manipulation skills from expert's demonstrations
  Agency: Department of Science and Technology
  Amount: INR 43,40,000
  Role: Writing Research proposal, Contributing to research and development

Teaching Experience

- Designed and graded questions for homework assignments and quizzes.
- Conducted weekly office hours and attended classes to assist students during in-class doubts.

Code	Title	Students	Institute	Term
MFET442	Programming Robots with ROS	18	Purdue	Spring 2023
MCP100	Engineering Visualization	≈60	IIT Delhi	Spring 2020, Fall 2021
MCQ301	Seminar Course	31	IIT Delhi	Fall 2020
MCL211	Design of Machines	30	IIT Delhi	Fall 2019
ME311	Dynamics of Machines and Mechanisms	35	IIT Jodhpur	Fall 2016, Spring 2017
ME222	Kinematics of Machines and Mechanisms	36	IIT Jodhpur	Spring 2016

Administrative Experience

- **Students Team Lead** Dec 2019 - 2022
  I-Hub Foundation for Cobotics (IHFC) at IIT Delhi
  - Lead editor of bi-annual newsletters and organized monthly seminars.
  - Promoting hub activities in social media.
- **Vice President** Mar 2014 - 2015
  SAE INDIA Collegiate Club at MMEC Mullana
  - Organized and oversaw activities bringing together automobile enthusiasts, popularizing automobile engineering.
  - Initiated participation of college in various automotive competitions organized by SAE, ASME etc.
- **Team Captain** Sep 2014 - Feb 2015
  ASME-Human Powered Vehicle Challenge (HPVC) Team
  - Led a team of 15 students having 5 departmental heads for designing and fabricating a racing tricycle.
  - Managed budget of USD 2000, allocating it to material procurement, transport, and others.

Mentoring Experience

- Mentored **8 undergraduate and 1 graduate student from 4 different nations** in the area of Robotics, AI, and Medical imaging analysis.
- Helped them create short-term and long-term project goals, conducted weekly individual meetings, and facilitated training to operate hardware and software tools.

Name	**Education**	**Affiliation**	**Duration**	**Next Position**
Pranhav Sundararajan	Undergrad	Johns Hopkins	Jan - Apr 2024	Intern at STR, USA
Byung Wook Kim	Undergrad	Purdue University	Jan - Dec 2023	MS at Columbia University
Abhishek R. Mathur	Undergrad	IIT Goa	Dec - Feb 2023	MS at Carnegie-Mellon Univ.
Ziming Zhao	Undergrad	Purdue University	May - July 2022	MS at Purdue University
Dimitrios Ntentia	Undergrad	Berea College	May - July 2022	PhD at Cornell University
Kashish Verma	Undergrad	NIT Hamirpur	Jun - Oct 2022	MS at TU Denmark
Varad Vaidya	Undergrad	VNIT Nagpur	Jan - Aug 2021	M.Tech at IISc Bangalore
Ashin Anandkrishnan	Undergrad	PSG Coimbatore	Jan - May 2021	MS at TU Germany
Sunil Gora	Masters	IIT Jodhpur	Jan - May 2017	PhD at IIT Kanpur

Professional Activities

- **Invited Talks**
  - *Advancing robotic ultrasound scanning through modeling of domain-expertise*
    Malone Center for Engineering in Healthcare, Johns Hopkins University, USA; Apr 4, 2024
  - *AI in Robotics*
    Muzaffarpur Institute of Technology, Bihar, India; Sep 3, 2020
- **Reviewing Services**
  - **Journals**
    International Journal of Robotics Research (IJRR)
    IEEE Robotics and Automation Letters (RAL)
    IEEE Transactions on Medical Robotics and Bionics (TMRB)
    Springer Journal of Intelligent and Robotic Systems (JINT)
    Elsevier Acta Astronautica
  - **Conferences**
    IEEE International Conference on Robotics and Automation (ICRA)
    IEEE International Conference on Intelligent Robots and Systems (IROS)
    IEEE International Conference on Automation Science and Engineering (CASE)
    IEEE International Conference on Robot and Human Interactive Communication (ROMAN)
- **Media Presence**
  - IIT Delhi, AIIMS New Delhi and Addverb Co-develop Telerobotic Ultrasound System During COVID Times: NDTV, Hindu, Dainik Jagran, News18, IIT Delhi newsletter, Times of India
  - **Live TV shows:** NewsX - Medically Speaking, India Science - Panel discussion
  - Chitrakar: A system that can transform images of human faces into drawings: TechXplore, AtomsTalk