Adamya Singh Dhaker

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### Education

| National University of Singapore   | Singapore                |
|--|--------------------------|
| Master of Engineering in Mechanical Engineering; GPA: 4.5/5                              | Jan. 2023 – April 2025   |
| Supervisors: Prof. Cecilia Laschi, Prof. Gianmarco Mengaldo                              |                          |
| Master's thesis: Underwater Modelling of Soft Robots                                     |                          |
| Nanyang Technological University   | Singapore                |
| Bachelor of Engineering in Aerospace Engineering (Honours with Distinction; GPA: 4.31/5) | Aug. $2018 - May \ 2022$ |
| Minor: Applied Physics   |                          |
| Honours Thesis Supervisor: Dr. Chow Wai Tuck   |                          |
| Bachelor's Honours thesis: Rib-turbulated Cooling of Jet Turbine Blades                  |                          |
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### Fellowships/ Academic Appointments

ETH Robotics Student Fellow, Soft Robotics Laboratory, ETH Zurich Department of Mechanical and Process Engineering (D-MAVT)

Visiting Student, MOX Laboratory, Politecnico di Milano Department of Mathematics

Zurich, Switzerland 1 Jul. 2024 - 31 Aug. 2024

Milan, Italy 1 Sep. 2023 - 5 Oct. 2023

### Publications/Conference Presentations/Conference Workshops/Posters (\*: equal contribution)

- Dhaker AS, Michelis MY, Mekkattu M, Nazeer MS, Sun Y, Mengaldo G, Laschi C, Katzschmann RK, "How can Computational and Numerical Modelling Enable the Next Generation of Soft Robots", IEEE/RSJ International Conference on Intelligent Robots and Systems 2025 Workshop: Proposal submitted
- Dhaker AS<sup>\*</sup>, Sun Y<sup>\*</sup>, Bucelli M, Zullo L, Regazzoni F, Dede' L, Laschi C, Mengaldo G, "Octopus arm movements unveiled: a computational modeling approach to muscle activation-driven biomechanics" (Journal manuscript under submission to Nature)
- Zhang Y, Dhaker AS, Wei H, Li Y, Li Y, Arumugam S, Xie Z, Muralidharan M, New TH, Mengaldo G, Laschi C, "An Octopus-Inspired Robot Arm for Reaching Movements" (Journal manuscript under preparation)
- Dhaker AS<sup>\*</sup>, Sun Y<sup>\*</sup>, Regazzoni F, Dede' L, Mengaldo G, Laschi C, "Translating Biology to Robotics Through Multiphysics Modelling", 7th IEEE-RAS International Conference on Soft Robotics (RoboSoft) 2024 Late-Breaking Results
- Dhaker AS<sup>\*</sup>, Sun Y<sup>\*</sup>, Mengaldo G, Laschi C, Beccai L., "Embodied Exploration through Muscular Hydrostats", 7th IEEE-RAS International Conference on Soft Robotics (RoboSoft) 2024 Workshop
- Dhaker AS<sup>\*</sup>, Sun Y<sup>\*</sup>, Regazzoni F, Dede' L, Mengaldo G, Laschi C, "Computational Modelling of the Octopus Arm", 4th International Conference on Embodied Intelligence (conference presentation)
- <u>Dhaker AS</u><sup>\*</sup>, Sun Y<sup>\*</sup>, Regazzoni F, Dede' L, Mengaldo G, Laschi C, "Translating Biology to Engineering Through Multiphysics Computational Mechanics" 16th World Congress on Computational Mechanics and 4th Pan American Congress on Computational Mechanics- Mini Symposia (presentation and poster)
- Zhang Y, Li Y, <u>Dhaker AS</u>, Qin Z, Xin W, Xie Z, Laschi C, "Octopus-inspired Tensegrity Arm Capable of Efficient Reaching Motion", Physically and Computationally Intelligent Behaviour in Robots, Gordon Research Conference 2024 (poster)
- Say, S., Dhaker, A.S., and Chow, W. T. (November 25, 2024). "V-spline design for enhanced performance in turbine blade internal cooling." ASME. J. Eng. Gas Turbines Power. June 2025; 147(6): 061008. https://doi.org/10.1115/1.4066828
- YS Say, Y Yu, AS Dhaker, WT Chow, "Enhanced Internal Cooling Performance with Protruded Rib Turbulators in Turbine Blade Cooling", AIAA SCITECH FORUM 2023, 0111 (conference paper)
- Golastaneh AF, Mengaldo G, Laschi C, Jonathan LME, Dhaker AS, Saran C, "Quasi-static continuum model of octopus arm configuration underwater", 5th IEEE-RAS International Conference on Soft Robotics (RoboSoft) 2022 Workshop: Soft Robotics Modeling: What Are We Missing? (workshop paper)
- Dhaker AS, Say SY, Chow WT, "Interaction of Heat Transfer and Structural Creep Performance in Rib Turbulated Design for Internal Cooling of Turbine Blades", AIAA Propulsion and Energy Forum (AIAA P&E), 2021 (conference paper)., cited by https://doi. org/10.2514/6.2023-0111
- Beh MW, Dhaker AS, Chow WT, "Impact Analysis of Lightweight Drones on Business Jet Fan Blades", AIAA Propulsion and Energy Forum (AIAA P&E), 2021 (conference paper)., cited by https://doi.org/10.1016/j.cja.2023.02.01 and https://doi.org/10.1007/978-981-19-0707-4-57

# Peer Reviewing Duties and Academic Society Memberships

- Reviewer for IEEE-RAS International Conference on Soft Robotics (RoboSoft), 2024-present
- Graduate Student Member, Institution of Electrical and Electronic Engineers (IEEE), 2023-present
- Student Member, American Institute of Aeronautics and Astronautics (AIAA), 2021-present

### **Research Experience**

### **Energy-Minimization Based FSI for Biohybrid Robots**

PI: ETH Zurich: Prof. Robert Katzschmann

- Designed and proposed novel energy-minimization-based fluid-structure interaction scheme to integrate into the Soft Robotics Lab's finite-element simulation code for biohybrid robots
- Conducted extensive literature review and analysis to propose fluid-solid coupling which optimizes accuracy and speed
- Formulated constrained optimization algorithm to solve soft body FSI problems. Further establishing a mathematical framework for energy-based coupling at fluid-solid interface
- Developing 3-D, fully coupled soft-body FSI code for the proposed mathematical scheme from the ground-up using fixed Cartesian grid and tetrahedral elements. Devising a method to detect intersection volumes of tetrahedra in 3-D grid cells

#### Modelling Octopus Arm Biomechanics and Electrophysiology September 2023 - Present PIs: MOX: Profs. Luca Dede', Francesco Regazzoni; NUS: Cecilia Laschi, Gianmarco Mengaldo Milan & Singapore

- Developed full-complexity multiphysics model of octopus arm using finite-element programming in C++ by augmenting MOX's  $life^{X}$  cardiac simulation code. The model aimed at creating a digital twin of the octopus arm.
- Achieved biologically accurate simulations of well-studied octopus arm motions such as reaching and bending by implementing and activating muscle fibers. Validated arm kinematics from simulation and biophysical faithfulness of muscle architecture details with experimentally available data
- Creating a numerical cellular-tissue level electrophysiological model of octopus to simulate calcium-driven muscle contraction in longitudinal and transverse muscle fibers
- Leading the numerical investigation into octopus arm biomechanics and linkage between calcium dynamics, muscle activation, and arm deformation

#### Underwater Modelling for Octopus-Inspired Tensegrity Robot Arm August 2023 – Present PIs: NUS: Prof. Cecilia Laschi, Prof. Gianmarco Mengaldo; NTU: Prof. Daniel New

• Contributed to the fabrication of octopus-inspired tensegrity-based soft robotic arm and its test setup

- Performing high-fidelity motion reconstruction and numerical modeling of the arm in ANSYS, created digital twin in MATLAB Simscape
- Designing and conducting underwater grasping tasks, high-speed imaging, and particle image velocimetry to characterize the flow field of robot arm reaching motion
- Formulating appropriate energy and drag efficiency of reaching motion to establish physically coherent dimensionless number and framework for generalized robot manipulation and grasping efficiency comparison

#### Computer Vision-Enabled Kinematic Reconstruction for Octopus Reaching Jan 2023 – Present PIs: NUS: Prof. Cecilia Laschi, Prof. Gianmarco Mengaldo; IIT: Prof. Letizia Zullo Singapore

- Developed markerless vision algorithm to segment and extract octopus arm contours, bend propagation, and midline during reaching motion (to create dataset for kinematic validation of simulations with experiments)
- Reconstructed key reaching motion kinematics such as bend displacement and bend velocity; verified them with experimental data from real octopuses
- Training deep-learning models to fully automate octopus-arm detection and segmentation
- Future plans include generalizing the algorithm for soft, deformable bodies to create tools for kinematic extraction without the need for an individual camera and test setups

### Design of Novel Cooling Methods for Jet Turbine Blades PI: NTU MAE: Dr. Chow Wai Tuck

- Augmented and improved existing jet-turbine blade cooling techniques by designing new rib-turbulator configurations through CFD and FSI simulations
- Achieved 5% higher engine efficiency and better temperature performance by 100K through conjugated fluid-flow heat-transfer analyses
- Improved turbine blade fatigue life with 20000 cycle increase through maximum creep, principal stresses, and fatigue life analysis using finite-element software
- Verified CFD results via thermocouple-heated test channels and wind tunnels, focusing on Sherwood and Nusselt no.

Numerical Analysis of Surface Tension Models in Multiphase Flows PI: Dr. Pao-Hsiung Chiu (Fluid Dynamics Department, IHPC, A\*STAR)

Jan. 2021 – May 2021 Singapore

April 2020 – September 2022

Singapore

Singapore

July 2024 – August 2024 Zurich, Switzerland

- Conducted CFD analysis of surface tension models (Balanced-Force, Continuum-Surface) using MATLAB and Python
- Assisted in writing finite-difference solver code for Navier-Stokes equations and learned different meshing techniques to gain fundamental CFD solver development experience
- Worked towards verifying solver accuracy through benchmark tests, including Rayleigh-Taylor instabilities and Zalesak's problem
- Overall project flow- explored and enhanced existing surface tension models for multiphase flows, gaining experience in solving Navier-Stokes equations for two-phase systems

System Identification and Fluid Dynamical Analysis of UAVs PIs: NTU MAE: Prof. Chan Wai Lee and Dr. Basman Elhadidi

- Designed and built a UAV, performed system identification and CFD analysis for flight testing and viability in MATLAB
- Developed solver to analyze n-th order differential equations for vehicle response in varying degrees of freedom
- Conducted wind-tunnel testing to study the impact of real-world flight characteristics such as angle of attack, roll, and yaw on UAV performance
- Optimized UAV aerodynamics with 25% drag reduction via boundary-layer analysis and numerical flow characterization

#### Synthesis of Nanoparticles to Treat Neurodegenerative Diseases August 2019 – May 2020 PIs: NTU LKC School of Medicine: Prof. Balazs Gulyas, Dr. P. Padmanabhan, Dr.TS. Selvan Singapore

- Devised strategies to de-aggregate amyloid plaques in-vitro for treating Alzheimer's Disease (AD)
- Synthesized functionalized nanoparticles using naturally occurring polyphenols (Quercetin, Resveratrol) and surfactants for intravenous use
- Performed confocal and transmission electron microscopy, Dynamic Light Scattering, and UV-Vis absorbance spectroscopy to assess particle size, structure, and absorption properties
- Verified anti-amyloidogenic properties and cytotoxicity of nanoparticles via MTT and ThT cell-culture assays

# Technical Competitions/Challenges

#### Propulsion Systems Team Member for Singapore Space Challenge July 2019 - Dec 2019 Advisor (NTU MAE): Prof. Sunil Chandrakant Joshi Singapore

- Participated in the Singapore Space Challenge 2019 in a 4-member team to design a cubesat for space debris removal, adhering to financial and design constraints
- Proposed a novel satellite de-orbiter concept, performing CFD and trajectory simulations in STK software
- Designed and optimized a propulsion system using iodine-xenon thrusters to balance power consumption and cost-effectiveness
- Delivered a well-received final report and satellite design, praised by faculty and industry professionals

#### Team Leader for Glider Design Competition, School of MAE, NTU Aug 2018 – Dec 2018 Advisor (NTU MAE): Prof. Prof. Chan Wai Lee Singapore

- Led 7-member team to design and construct carbon-fiber and balsa glider in 4 months.
- Performed fluid dynamics simulations and CAD of wing and nose cone to optimize aerodynamics after field testing
- Achieved 4th place out of 20 teams, earning commendation for design and material optimization based on weight

# Mentorship

Mentored seven bachelor thesis students and interns during my master's degree on topics ranging from FEM/CFD simulation, computer vision, and biomechanical modeling.

# Technical Skills

Languages: Python, C++, MATLAB

Software: Paraview, ANSYS, OpenFOAM, Git, MS Office, SolidWorks, COMSOL, Arduino, Simulink/Simscape Hardware: Particle Image Velocimetry, Wind/Water Tunnel testing, 3-D Printing, Cell Culture, MTT/ThT Assay, Microscopy and Spectroscopy (TEM, SEM, Confocal)

# Relevant Coursework (\*: includes lab component)

Major: Advanced Soft Robotics, Mathematics for Engineering Research, Topics in Mechatronics, Data-Driven Engineering and Machine Learning, Fluid Mechanics, Computational and Experimental Fluid Dynamics<sup>\*</sup>, Aeroelasticity, Advanced Aircraft Structures<sup>\*</sup>, Aircraft Design, Aerodynamics, Aircraft Propulsion, Flight Dynamics, Thermodynamics<sup>\*</sup>, Heat Transfer\*, Fluid Dynamics, Aerospace Materials and Manufacturing Processes\*, Aerospace Control Theory\*, Flight Performance\*, Aircraft Electrical Devices\*, Introduction to Data Science and Artificial Intelligence\*, Mechanics of Materials\*, Physics<sup>\*</sup>, Mechanics and Rigid Body Dynamics<sup>\*</sup>, Matrix Algebra

Minor: Optics Vibrations and Waves, Quantum Mechanics I, Relativity and Quantum Physics, Physical Optics, Biophysics **Others:** Human Body Functions and Diseases, Cancer Biology and Therapeutics (Audited)

Jan. 2021 – May 2021

Singapore

# Academic Distinctions

- Selected as one of 8 Robotics Student Fellows for the ETH Robotics Student Fellowship 2024 (out of 162 applicants) through the ETH RobotX program for fully-funded research at ETH Zurich
- Selected for the NTU Undergraduate Research Experience on Campus Programme (URECA) (equivalent of UROP) for three years in a row, an invitational research program for undergraduate students whose academic performance merits scientific research involvement and thrust
- NTU President's Research Scholar 2019/20, 2020/21 and 2021/22, distinction for URECA projects
- Chosen for NTU's Accelerated Bachelor Program, allowing early graduation based on academic excellence
- Qualified IIT JEE Advanced and Mains (Top 1.3%) 2018 out of 1.5 million candidates
- Ranked among the top 5 students at school in Central Board for Secondary Education Examination (10th grade) with a perfect GPA of 10
- Ranked among top 5 students at school (Maharaja Sawai Mansingh Vidyalaya, Jaipur) consistently from 7th to 12th grade
- Scored 95% marks in Science Stream in school in the All-India Senior Certificate Examinations at the end of 12th grade, was again amongst the top 5 students in the stream in school
- Awarded distinction in English based on Grade 12 All-India Senior Secondary Exam performance by the Central Board of Secondary Education for being amongst the top 0.1% scorers in English

# Leadership/Extracurricular Experiences and Awards

| Lead Student Conference Assistant, IEEE RoboSoft 2023 | 3-7 April, 2024 |
|---|-----------------|
| Marina Bay Sands Convention Centre                    | Singapore       |

- Led student assistant team from 3 universities for the 6th IEEE-RAS International Conference on Soft Robotics (RoboSoft), managing event logistics and smooth conference execution
- Coordinated conference operations such as room setups, delegate assistance, and presentations

# **Resident Assistant**

Prince George's Park Residences, NUS

- Selected for a competitive Resident Assistant (RA) role, providing pastoral care for 300+ students and managing student events alongside a team of 10 RAs and faculty mentors
- Organized logistics for student events such as kavaking, dog therapy, and laser tag
- Provided peer support and ensured resident safety and well-being
- Conducted tennis coaching clinics for students residing in the hostel

# Tennis (Player and Coach)

Played at national level and varsity level

- Lead Singles Player for NTU and NUS tennis varsity, securing two silver medals in Singapore University Games and bronze in 2022 for NTU
- Coached 20 students over two years at NTU and currently coaching Yale-NUS College Tennis Team since 2023
- Awarded Certificate of Merit for Outstanding Contributions to University Sports by NTU
- Former National-level player in India, ranked top 3 in the region from grade 6-12, and provincial representative at national tournaments
- Captained the school tennis team from grade 9-12
- Most Promising Player in the Pathways Invitational in grade 9, one of the most recognized invitational tennis tournaments in northern India

# Charitable Work

Personal Endeavours

- Donated food to Mother Teresa's home for kids with physical impairments and severe economic/family challenges
- Taught basic computing and English to over 60 students in rural areas around Jaipur through my high school's initiative for educating underprivileged children
- Taught engineering design using readily available materials to 50 students from underprivileged communities under NTU Mechanical and Aerospace Engineering Club's Special Projects

# Miscellaneous

Personal Endeavours

- Founded "The Chai Company," selling homemade tea as part of an entrepreneurial initiative at NTU.
- Successfully completed two years of National Cadet Corps, C certificate training
- Regular member of school quizzing team, participated in various competitions (Inter school and regional level), including qualification for the national round of the Discover India Quiz, national standard GK quiz in India
- Active in theater and dramatics from grades 4-10, with two scripts selected for local film festivals

### 2008 - Present

June 2023 – July 2024

National University of Singapore

India & Singapore

# 2014 - Present

India & Singapore

2008 – Present

India & Singapore