Anvitha Sudakar   Curriculum Vitae

CONTACT INFORMATION	C-703, Hostel 10 Indian Institute of Technology - Bombay Powai, Mumbai 400 076, India	*Phone:* (+91) 8828290494 *E-mail:* anvitha_s@iitb.ac.in *GitHub:* anvitha-s

RESEARCH INTERESTS

Soft Matter, Mechanobiology, Dynamics, Applied Mathematics

EDUCATION

Indian Institute of Technology - Bombay, Mumbai, India   July 2015 - Present
Bachelor of Technology with Honours in Mechanical Engineering   CPI : **8.88/10.0**

National Public School Rajajinagar, Bangalore, India   2006 - 2015
All India Senior School Certificate Examination 2015 (C.B.S.E.)   **96.6%**
All India Secondary School Examination 2013 (C.B.S.E.)   CGPA : **10.0/10.0**

ACHIEVEMENTS

- Recipient of the **Undergraduate Research Award** in 2017 for modeling dynamics of multi-body impact
- Awarded the **Institute Technical Special Mention** in 2016 for noteworthy contribution to technical affairs at the Institute
- **Runner-up** at the international **Robosub** competition conducted by **AUVSI** and the **US Office of Naval Research** in 2016 and **Winner** at the **NIOT - SAVe** competition conducted by the **National Institute of Ocean Technology** in 2016
- Scholar of the **International Student Internship Program** at **Princeton University** in the Summer of 2018

ACADEMIC HONORS

- Awarded the **Kishore Vaigyanik Protsahan Yojana (KVPY) Fellowship Award** by the Indian Government and attended Vijyoshi, the National Science Camp 2014
- Recipient of **NTS (National Talent Search) Scholarship** since 2011 and participant of the Scholar Nurturance Camp at National Institute of Technology, Suratkal in 2012
- Represented the state of Karnataka in the **Indian National Mathematical Olympiad (INMO)** in 2014 and the **Indian National Olympiad in Informatics (INOI)** in 2013 and 2014

PUBLICATIONS

"Dynamic network modeling of the multi-scale mechanics of respiration", Anvitha Sudakar, Nathanael Ji, and Sujit S. Datta, *in preparation for submission to Journal of Fluid Mechanics*

RESEARCH EXPERIENCE

Multi-scale mechanics of respiration   June 2018 - August 2018
Research Internship   *Chemical and Biological Engineering, Princeton University*
Advisor: Prof. Sujit S. Datta

- Developed a statistical model of the lungs as a branched network represented as a 23-generation binary tree with variation in structural and biomechanical parameters, and opening threshold pressure of branches
- Parameterized the reopening rate of each collapsed branch using branch geometry, tissue stiffness, and mucus surface tension and viscosity
- Modeled the pressure - volume relation of the lung during inhalation by including the effects of deformations of individual airway branches, flow of the viscous mucus lining and coupling between different connected airway branches
- Determined the nature of dependence of size of *avalanches* (airway branches opening together) on the breathing rate and airway compliance
- Developed a quantitative connection between altered lung mechanics, caused during respiratory disorders, and the spatiotemporal features of lung opening by studying the competition between breathing rate and opening rate of the airway (presentation)

Dynamics of Morphogenesis   August 2018 - ongoing
Undergraduate Thesis   *Department of Mechanical Engineering, IIT Bombay*
Advisor: *Prof. Mandar M. Inamdar*

- Exploring the dynamics of morphogenesis as a coupled system of surface deformation and the underlying chemical diffusion of growth factors (presentation)
- Implemented growth to a target shape on surfaces of different rheology, determined by fixed growth factors and currently working on providing feedback of change in surface topology to growth factor concentrations
- Simulating the surface deformation as an energy minimization problem in Surface Evolver by creating a Python wrapper integrated with FEniCS which solves the diffusion PDEs

Modeling the dynamics of Multi-Body Impact   May 2017 - October 2017
Undergraduate Research Project   *Department of Mechanical Engineering, IIT Bombay*
Advisor: *Prof. Salil Kulkarni*

- Modeled the mechanics of sticking and sliding collision between slightly frictional, nearly elastic discs, occurring in dilute granular flow (report)
- Implemented algorithms for rapid collision detection and built a physics based simulation of a dynamic system having a finite number of discs confined by rigid boundaries.
- Computationally solved the problem of multiple impacts in a non-binary collision by designing a stochastic model to handle simultaneous multiple impacts between discs and this was implemented as the *break* in carrom (first strike of the game)
- Performed the simulation on the *SDL* graphics platform running parallely with the algorithmic implementation of the model in *C++* (link)

Sensor Fusion and Visual Servoing   December 2016 - February 2017
Winter Project   *Systems and Controls Department, IIT Bombay*
Advisor: *Prof. Leena Vachhani*

- Implemented sensor fusion by designing Kalman Filters for state prediction (typically of a mobile robot) using displacement, velocity and acceleration input from heterogeneous sensors operating asynchronously
- Simulated various sensor data viz. linear and angular velocity, linear acceleration, position and orientation to test performance of sensor fusion algorithm on these signals in Gazebo
- Worked on Visual Servoing as a method of distance estimation of specific features in the visual data stream, and as the measurement input for kalman filtering of position data

Motion of Molecular Motor   December 2017 - January 2018
Winter Project   *Department of Civil Engineering, IIT Bombay*
Advisor: Prof. Mandar Inamdar

- Studied the probabilistic motion of molecular motors under the influence of potential fields, governed by Langevin Dynamics
- Simulated the translation of the motor as a Brownian particle under the influence of an extended on-off ratchet of 2 sawtooth periodic potential fields
  (repository with MATLAB code and Python notebook)

KEY PROJECTS   **Autonomous Underwater Vehicle** (AUV), IIT Bombay   December 2015 - July 2017
Institute Technical Team

- Multi-disciplinary project aimed at developing an unmanned Autonomous Underwater Vehicle, *Matsya*, which competes annually in the international **Robosub** competition conducted by **AUVSI** and **US Office of Naval Research** at San Diego, California
- Represented the team in Robosub 2016, and secured **2nd place** amongst **46 international teams**
- Software lead of the winning team at the NIOT - SAVe competition, conducted in Chennai by the National Institute of Ocean Technology in 2016

- **Chief Software Architect** of the team between July 2016 - July 2017, handling the Computer Vision, Navigation, Hardware Communication and Simulator sub-systems of the software stack
  - Worked on image processing for the **autonomous detection and localization** of tasks to be executed at both the competitions
  - Revamped the state machine structure of the vision package, to ensure robustness and improved memory handling capabilities with extensive use of smart pointers and class abstraction
  - Created the visual and inertial model of the vehicle on the robot simulation platform, *Gazebo*, with actuator configurations enhanced to provide individual PWM - motion mapping

COURSE PROJECTS

Mechanics of Euler's Disc   Spring 2018
Guide: Prof. Salil Kulkarni   *Analytical Mechanics*
- Analysed the mechanics of a rolling Euler's disc toy to explain increase in frequency of acoustic signal produced and the prolonged time taken for it to settle down (report)
- Modeled the effect of frictional dissipation on the rigid body motion of the toy to explain its characteristic behaviour
- Simulated this model (link) on MATLAB to emulate the observed behaviour of this toy

Finite difference methods in solving 1-D wave equation   Spring 2018
Guide: Prof. Shivasubramanian Gopalakrishnan   *High Performance Scientific Computing*
- Solved the one dimensional wave equation using the finite difference method and implemented it in *C++*
- Performed a convergence study for 2 problems against known analytical solutions of the equation to determine robustness and accuracy of the procedure for solving linear hyperbolic partial differential equations (report)
- Parallelised code using *MPI* and *OpenCl* and a timing study on CPU computing was conducted to determine the speedup obtained (code)

Design and Fabrication of a foldable helmet   Autumn 2018
Guide: Prof. Parag Tandaiya   *Machine Design*
- Designed a motorcycle helmet with reliable collapsing mechanisms for volume reduction during storage
- Created a telescoping model on *Autodesk Fusion 360* and, used ATOM (Abaqus Topological Optimization Module) for structural optimization and material reduction in the model
- Maunfactured the prototype by 3D printing in ABS, assembled the final helmet and displayed it in the Trade Show with prototype demonstration and poster presentation
- Currently discussing patenting the design with the Industrial Design Centre at IIT Bombay

Dynamics of Avascular Tumour Growth   Autumn 2018
Guide: Prof. Dnyanesh Pawaskar   *Nonlinear Dynamics and Chaos*
Studied the different mathematical models put forward to predict avascular tumour growth and the effect of treatment on the tumour. Proposed potential directions of future research as, preventive treatment by modeling relapse occurence and predictive modeling of tumour growth controlled by smooth muscle or myoepithelium.

Experimental Measurement of Critical CTOD   Spring 2018
Guide: Prof. S. K. Maiti   *Fracture Mechanics*
Studied the significance of CTOD (Crack Tip Opening Displacement) in determining crack propagation and its critical values in different modes of fracture and conducted a detailed analysis of the theory behind British Standard 5762 experimental method (report)

Fabrication of Micro-arrays   Autumn 2017
Guide: Prof. Pradeep Dixit   *Manufacturing Processes II*
Studied and implemented the manufacture of micro-arrays using laser cutting and quantified
the effect of laser and machining parameters on the overcut or error in structural characterization of the array feature

Matrix operations and application   Autumn 2015
Course Project
Guide: Prof. Varsha Apte   *Computer Programming and Utilization*
Designed a menu driven program to perform basic operations on matrices with real elements,
solve systems of linear equations, and differentiate matrices with single variable polynomials
as elements. Also solved curl operations on a vector with steps represented in a matrix form

KEY COURSES

Dynamics : Nonlinear Dynamics and Chaos, Analytical Mechanics, Systems Theory
Applied Math : Numerical Analysis, High Performance Scientific Computing, Computational Fluid Dynamics and Heat Transfer
Mechanics of Materials : Solid Mechanics, Strength of Materials, Solid Mechanics Lab, Fracture Mechanics
Miscellaneous : Introduction to Bioscience and Bioengineering, Probabilistic Models
 electives outside core curriculum

TEACHING, MENTORSHIP AND ORGANIZATIONAL EXPERIENCE

Teaching Assistant for the sophomore Mathematics course of **Numerical Analysis** in *Spring 2018* under Prof. Shripad Garge and Prof. Rekha Kulkarni

Chief Software Architect, Team AUV-IITB, 2016-17
- Organised a recruitment test and interviewed over 100 freshman applicants to the team
- Mentored freshman trainees in software subdivision, endowing them with the knowledge and skillset required to work on an autonomous vehicle and closely monitored their growth to become independent contributing members of the team.
- Delivered an introductory talk on designing software stacks for autonomous robots and taught in workshops of *ROS* and *Gazebo*

Organizer of Exhibhitions, Techfest 2015, Asia's largest Science & Technology Festival

TECHNICAL SKILLS

Programming	C++(Advanced), Python, C, MATLAB, Scilab, Octave, Shell Scripting
Tools/Libraries	Surface Evolver, FEniCS, ROS, OpenCV, Gazebo, Git, SDL, Armadillo
Software	Mathematica, ABAQUS, AutoCAD, SolidWorks, Simulink, PSPICE
Publishing	LaTeX

STANDARDIZED TESTS

GRE®	**332**/**340**	Q:169	V:163	AWA:4.5		*October 2018*
TOEFL®	**110**/**120**	R:27	L:30	S:25	W:28	*October 2018*

EXTRA-CURRICULAR ACTIVITIES

- Nonlinear Control and Applications Workshop at IIT-Gandhinagar(January 2018)
- **Chief Editor** (2017-18), Mechanical Engineering Media, IIT Bombay
- Completed a two semester course of Lawn Tennis as a part of NSO(National Sports Organization) in 2016
- Secured 3rd place in the Squash General Championship of the Institute in 2015

REFERENCES

Sujit S Datta, Assistant Professor, Princeton University
Mandar M Inamdar, Associate Professor, Indian Institute of Technology Bombay
Salil S Kulkarni, Professor, Indian Institute of Technology Bombay
Shripad Garge, Assistant Professor, Indian Institute of Technology Bombay