Dhruvi Joshi

4th Year Undergraduate | **Mechanical Engineering** | **IIT Bombay**

dhruvijoshi@iitb.ac.in dhruvij2003@gmail.com (+91) 9082834573

Research Interests

My research interests centre around the field of **Robotics**, **Controls** and **Dynamics**, emphasising applications in bio-inspired robotics, aerial robotics, soft robotics and surgical robotics.

Education

Indian Institute of Technology, Bombay *2021-2026*

B.Tech. | **M.Tech.** in the Department of Mechanical Engineering *CPI: 9.02 / 10.00* | *GPA: 3.81/4*

- Recipient of the **Institute Academic Price** (Scholarship of **Rs.3000**) - Excellence in Academic Performance
- Ranked **1st** in the Batch of 2026 - Dual Degree in Mechanical Engineering
- Pursuing a minor in the Department of Systems and Controls Engineering

Scholastic Achievements

- Achieved **10**/**10** SPI in 8th semester (*'25*) | Awarded with the **branch change** (top 7% students) (*'22*)
- Secured **50,000 INR** seed funding, emerged as **7**/ **30** teams for addressing constraints in healthcare ('23)
- Part of **winning** contingency at Formula Bharat: **Overall Winners**, **Best Controls**, **3rd** - **Design Event**('24)
- Achieved **99.56** percentile in **Joint Entrance Examination(JEE) Mains** amongst **1.2** million *('21)*
- Secured the top position nationwide, attaining a score of **98**/**100** in French on the ICSE exam *('19)*
- Ranked among the top **5** percentile in **JEE Advanced** amongst **0.14** million students *('21)*

Research Experience

Aerial Drone Manipulators

(June'23 - Present)

Guide: Professor Vivek Sangwan *Master's Thesis* | *INDUS Lab*

*Design and **control** of an autonomous multi-rotor aerial vehicle with a **linked manipulator** for force application*

- Achieved $<$ **2%** steady-state error and $<$ **5s** settling time using **PID** tuning for hover and helical trajectories
- Utilizing **feedback linearization** for trajectory generation in contact mode in 2D for improved force control
- Conducted **contact** experiments with a single, **unactuated** link with a torsional spring, maintaining force and position using set point control
- Improved force control by **23.67%** using an experimental curve-fit model against theoretical calculations
- Integrated the **VICON** cameras using them to receive data on the location and orientation in an indoor environment and set up wireless communication with the drone via **XBee**
- Formulated a **nonlinear dynamical model** for a two-link manipulator with a precision error of $\mathcal{O}(10^{-7})$
- Manufactured a **load cell set-up** for accurate measurement of thrust by a **motor-propeller system**

Flexible Inverted Pendulum on a Rotary Hub

(*Jan '25 - Present*)

Guide: Professor Prasanna Gandhi *Research Project* | *Suman Mashruwala Lab*

*Coauthoring' Multiple Equilibria of a Flexible Inverted Pendulum on a Rotary Hub' - **Journal of Mechatronics***

- Studied the **Assumed Modes Method** to model the flexible dynamics of the system and performed **static equilibrium analysis** to characterize its behavior under varying parameters
- Analyzed the variation of number of **equilibrium states** of the system under buckling loads for different angles
- Determined the critical values of parameters for **bifurcation** numerically for varying beam length, and tip mass
- Observed **0.3**° error in the critical hub angle estimation and $\approx$ **1cm** displacement error in experiments, arising due to the increased stiffness of the simulated system owing to the reduction in its modes

6DoF Delta Cranial Exoskeleton | University of Minnesota *(June'24 - Aug'24)*

Guide: Professor Suhasa Kodandaramaiah *Summer Intern | BSBRL Lab, University of Minnesota*

Awarded a Letter of Recommendation | Upgrading a delta robot from 3DoF for neuroscience experiments

- Developed and implemented the inverse kinematics for the **delta robot** integrated with a custom goniometer
- Upgraded the system's code on **LabView** to include transformations across multiple frames of reference - mouse head, force sensor, and delta robot platform
- Incremented the **PID–impedance control** framework for velocity regulation, using live motion feedback
- Enhanced the Jacobian matrix to incorporate coupled dynamics for enabling natural movement of the head
- Conducted hardware integration for **2** additional motors and sensors, tuning them for position control
- Designed and manufactured a hardware upgrade to integrate **2** additional motors for the, ensuring a common intersection of all axes of rotation at the mouse's head, enabling naturalistic movement of the neck

Estimating Wrist Torque from EMG Signals | Report *(Jan'25 - Apr'25)*

Guide: Professor Darshan Shah *Course Project: Joint Biomechanics*

- Built an EMG acquisition setup to measure Flexor Carpi Radialis activity during wrist flexion under loads
- Applied biomechanics principles (muscle PCSA, moment arms, specific tension) to estimate muscle torque
- Validated EMG-derived torque against load-based torque calculations, achieving close agreement with expected biomechanical contributions.

Professional Experience

Augle.AI | Report *(Dec'24 - Feb'25)*

Intern | Vision-Guided Welding Robot

Developed an algorithm for a robotic system integrating camera vision with motion control to automate welding

- Developed a simulation framework to visualise a **camera-laser plane** set up, visualizing the robot's field of view and weld path, enabling the robot to simultaneously follow trajectories on diverse **2D** geometries
- Designed a robust controller maintaining **constant velocity** along path, ensuring consistent weld quality

IIT Bombay Racing *(Apr'23 - Feb'24)*

Design Engineer | Vehicle Dynamics and Electronic Differential *Professor Sandeep Anand*

A cohort of over 70 multidisciplinary students harnessing their expertise to conceptualize and fabricate cutting-edge electric race cars and displaying outstanding performance in various Formula Student Events

- Represented our team in the **FS 2023 Lap Time Simulation** Event organised at Formula Student-UK
- Tuned the **suspension, brake, drivetrain** and **aerodynamic** parameters within permissible limits enhancing the lap time by **4 seconds** on the autocross track and **0.3 seconds** on the skidpad track
- Formulating advanced **testing** methods to propel the **reliability and performance**: executing endurance drives to assess critical parameters like structural integrity, brake line integrity, voltage stability
- Designing special equipment to validate **steady-state and transient** dynamic models like the **tire model, Yaw Moment Diagram** etc, using testing data to design improved suspension points
- Implementing **traction control** algorithm to control wheel spin and **torque vectoring** algorithm to reduce understeer, validating and **tuning** them using track testing

The Humanoid Project *(Mar'22 - Apr'23)*

Core Member | Robot Design and Modelling *Institute Technical Council, IIT Bombay*

A student project to build a humanoid in the library, capable of external object manipulation and navigation

- Utilized **Fusion360** to create models of the humanoid **wheelbase,** and the **two-link manipulator arm**
- Designed a **mechanical gripper** with a thumb with **1 degree of freedom** capable of holding cups

Technical Proficiency

Programming	MATLAB | SimuLink | LabView | C++ | Python | JavaScript | HTML
Softwares	SolidWorks | ANSYS | ArduinoIDE | Gazebo | Adams
Certifications	Aerial Robotics | Graphic Design Theory
Languages	English | French (basics) | Hindi | Gujarati

KEY PROJECTS

Guidance and Control of Fixed Wing UAVs (*Jan'24 - May'24*)

Guide: Professor Shashi Ranjan Kumar *Course Project: Guidance and Control of UAVs*

- Full stack aerial robotics project to design **path planning** and **autopilot** algorithms for fixed wing UAVs
- Built a model to implement **6**-DOF dynamics of Cessna 620 with wind disturbances and actuator saturation
- Implemented rapidly exploring random tree (**RRT**) and **Voronoi** graphs for path planning with obstacle
- Achieved airspeed, altitude, and orientation control with $<$ **3%** error for **20%** disturbance with 50s period

Optimization of Mess for Nutrient Rich food and Wastage | Report *(Jan'24-May'24)*

Guide: Professor Avinash Bhardwaj *Course Project: Industrial Engineering and Operations*

- Achieved **37%** improvement in the nutritional value of mess meals, curating a menu from **130+** food items
- Included constraints to be followed by the mess to come up with 4 meals as per required standards
- Implemented the **Stigler's Diet** problem with modifications to generate a **weekly mess menu** that satisfies daily nutritional requirements, and minimizes cost, leading to a **16%** increase in pricing
- Estimated a **9kg** daily reduction in food wastage by prescribing **preparation quantities** based on **50+** simulations involving taste preferences and randomness factor with real-time data

Automated Industrial Sorting Mechanism | Report *(Aug'24-Dec'24)*

Guide: Professor Salil Kulkarni *Course Project: Machine Design*

- Designed and developed an automated industrial sorting mechanism capable of identifying and segregating parcels by size and color using ultrasonic and RGB sensors, achieving with **95 %** accuracy
- Optimized efficiency by integrating a scalable design that reduced the number of actuators, enabling the system to sort four categories of parcels using a single motor, lowering energy consumption
- Conducted design calculations to determine optimal motor specifications, achieving a conveyor belt speed of **0.36 m/s**, proposing **scalability enhancements** for industrial applications

Early Trend Prediction of Cyclical Infectious Diseases | Github *(Mar'23-Oct'23)*

Technovation Sandbox | Maker Bhavan Foundation *Tinkerer's Laboratory, IIT Bombay*

- Secured Funding for **addressing resource constraints in healthcare**, top **7** out of **30+** teams
- Developing an **accommodating and accessible API** to facilitate **usability** in current healthcare systems
- **Pioneered** the creation of a **stochastic spatio-temporal** simulation framework, proficient in modeling **direct transmission** dynamics of **Influenza** spread in a 2-D compartmentalization based approach
- Implemented the **SIDHARTE V** model, using the **Gillespie algorithm** to simulate disease spread to understand **epidemiological** dynamics, and utilizing machine learning to predict **temporal dependencies**

Pendubot - Control of Underactuated 2 - Link Manipulator | Code (*Aug'24 - Nov'24*)

Guide: Professor Prasanna Gandhi *Course Project: Design of Mechatronic Systems*

- Simulated the dynamics and control of an **underactuated** two - link manipulator with motor at the first link
- Utilised a **PID controller** to swing the pendubot up and then implemented the **LQR controller** to stabilise it
- Developed a hardware prototype of the same that can be optimized to improve **transient** time response

IoT-Enabled Meteorological Monitoring System *(Jan'23 - Apr'23)*

Guide: Professor Sridhar Balasubramanian *Course Project: Mechanical Measurements*

- Developed an affordable weather station, for measuring wind direction, temperature, pressure, humidity
- Employed **NodeMCU-based ESP8266** for wireless data transmission and collected data over **2 days**
- Performed error analysis with an error of $\pm$**1℃**, **DFT & IDFT** on the discrete data for trend prediction
- Presented the device in its working state and its readings to **80+** students and **4+** teaching assistants

Thermo-mechanical Modeling of Material Behavior | Report *(Jan'23 - Apr'23)*

Guide: Professor Krishna Jonnalagadda *Course Project: Solid Mechanics*

- Devised an experimental method to analyze the influence of temperature on **Young's modulus**, ductility, yield, ultimate, and fracture stresses using the **Universal Testing Machine** (UTM) and strain gauges
- Conducted uniaxial-tensile tests on aluminium samples, thus acquiring the trends in variations and their rates, and verified the results (**5% error**) by comparing them with theoretical data

Mentorship and Positions of Responsibility

Institute Student Mentor | **Student Mentorship Program** (*Jun'24 - Present*)
- Selected out of **450+** students as a part of a mentorship team through interviews/peer reviews
- Mentoring **10** first-year students, offering guidance to ensure academic, social, and personal well-being
- Helped assuage **Dual Degree** and **Core Engineering** concerns in **Sophomore -101** for career building

Teaching Assistant | **Design of Mechatronic Systems** *(May'24-Nov'24)*
- Curated weekly assignments and exam for an online **NPTEL course** taken by **250+** students across country
- Assisting a batch of **40+** students with hardware based learning, carrying out quizzes and evaluations

Summer of Science (SOS) Mentor | **Math and Physics Club** *(May'23-Aug'23)*
- Curated personalized reading projects for **5** students, sourced from extensive literature and website articles

Class Representative | **Metallurgical Engineering and Material Sciences** *(Dec'21-Aug'22)*
- Facilitated online communication between **145+** classmates & professors during the COVID-19

Key Courses Undertaken*

Robotics and Controls	Guidance and Control of UAVs | Joint Biomechanics | Design of Mechatronic Systems | Non Linear Dynamics and Chaos | Microprocessors and Control | Signals and Feedback Systems | Differential Geometric Methods in Control
Mechanical Engineering	Solid Mechanics | Fluid Dynamics | Structural Materials | Heat Transfer | Machine Design | Advanced Engineering Dynamics | Design Optimization | Manufacturing Processes | Finite Element Methods
Others	Statistical Machine Learning and Data Mining | Computer Programming | Electrical & Electronic Circuit | Biomedical Microsystems | Methods in Satellite Image Processing

**Full List of Courses can be found in my Transcript*

Extra-Curricular Activities

Technical	• Designed and developed an **RC plane** by optimizing aerodynamic lift and load • Developed a line follower with gripper for the **Jr. Robocon, Pandharpur** • Built a **Smart Trolley, Home Automation** and a **Bluetooth RC car** • Received a Certificate of Excellence in **Dr Homi Bhabha Balvaidyanik** Exam held by the Maharashtra State Government and was selected for the second level • Awarded with **multiple medals** by the **Science Olympiad Foundation(SOF)** in the **International Math Olympiad (IMO)** and the **National Science Olympiad(NSO)**
Social Service	• Volunteered to help **underprivileged communities** in rural areas of **Panchgani** by providing them with **basic amenities**, **setting up a local library** and organizing a fun-filled day at their local school • Volunteered for Multiple **beach cleanups** conducted at Versova beach, Mumbai
Others	• **Intermediate Art Exam** held by Maharashtra • Responsible for executing offline ambience over 550-acre campus at Mood Indigo • Took part in the **VHMUN** sessions of VIBGYOR High and excelled in debate

References

Vivek Sangwan
Assistant Professor
Mechanical Engineering
IIT Bombay
vivek.sangwan@iitb.ac.in
Phone: (+91)-22-25769357

Prasanna S. Gandhi
Professor
Mechanical Engineering
IIT Bombay
gandhi@iitb.ac.in
Phone: (+91)-22-25767519

Suhasa Kodandaramaiah
Associate Professor
Mechanical Engineering
University of Minnesota
suhasabk@umn.edu
Phone: +1-612-626-1307