

Radha Lahoti *Curriculum Vitae*



Dual degree (B. Tech. + M. Tech.) • Mechanical Engineering, IIT Bombay

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RESEARCH INTERESTS

My research interests are primarily dedicated to the fields of Multi-body Dynamics and Control, Mechanical Design, Biomechanics, Robotics & Automation, and their applications to Bio-inspired & Biomedical Robots and Aerial Vehicles

EDUCATION

Indian Institute of Technology Bombay

[17-'22] (ongoing)

- **Dual Degree (B. Tech. + M. Tech.):** Mechanical Engineering | GPA: **9.46/10**
 - ◊ **Specialization:** Computer-Aided-Design and Automation Engineering
- **Minor degree:** Aerospace Engineering

ACADEMIC ACHIEVEMENTS

- **Ranked 1st** amongst dual-degree students across 3 specializations in the Dept. of Mechanical Engineering [21]
- Amongst **10 nationwide** recipients of the prestigious **Student Innovation Grant** awarded by **IISc Bangalore** [21]
- Awarded the **Institute Academic Prize** for academic merit; achieved **perfect 10.0 SPI** in 7th semester [20-'21]
- Secured an **All India Rank 386** in **JEE Advanced** among 0.16 million & **1024** in **JEE Main** among 1.2 million [17]

MASTER'S THESIS PROJECT

DESIGN, ANALYSIS & FABRICATION OF A BAT-LIKE BIOMIMETIC WING

[Jul'21-present]

Guides: Prof. Prasanna Gandhi (Mechanical Engineering, IITB) & Prof. Abhijit Gogulapati (Aerospace Engineering, IITB)

The project is aimed at designing a robotic wing possessing morphing ability like a batwing to achieve highly manoeuvrable flight

- Gained insight into flight of bats & wing morphing, researched the scientific attempts to mimic their capabilities
- Developed a preliminary model for the wing and theoretically analysed and simulated the forward and inverse kinematics in MATLAB utilizing **euler angle** and **quaternion** parametrization for representing spatial rotations
- Studying **unsteady aerodynamics** for dynamic formulation and exploring **tensegrity** based actuation & control
- **Fabricating** a prototype and performing **wind tunnel testing** to validate analytical results and refine the design

INTERNATIONAL RESEARCH INTERNSHIP

Purdue Undergraduate Research Experience

[Jun-Aug'20]

CONTROLLER DESIGN & TUNING FOR THREE-WAY-CATALYTIC CONVERTER

Guide: Prof. Gregory Shaver (School of Mechanical Engineering, Purdue University)

Developed a PID controller utilizing the models of feed-gas and Three-Way-Catalyst (TWC) to robustly control the oxygen storage level of the catalyst at a desired set point, for efficient automobile exhaust emission control in the run for clean energy

- Studied the working of a Three-Way-Catalytic converter and fractional oxidation state based emission control
- Obtained a linearized **state-space** TWC plant model and designed a **Routh-Hurwitz stable PID** controller
- Reduced the **steady state error** from an initial value of 21% to **5.68%** by tuning the controller gains using **Ziegler Nichols technique** on the non-linear plant, and to **8.05%** using **Lead Lag design technique** on the linearized plant

RESEARCH PROJECTS

MECHANISM DESIGN & CONTROL OF A STAIR CLIMBING MOBILITY BOT

[Sep-Dec'20]

Guides: Prof. Ramesh Singh & Prof. Prasanna Gandhi (Mechanical Engineering, IIT Bombay)

Designed a Stair Climbing Bot to help people with reduced mobility and/or ease carrying heavy loads up a fleet of stairs

- Redesigned a **rocker-bogie** mechanism to compensate for the deviations of the seat from horizontal orientation
- Implemented closed-loop control using a **Tiva** microcontroller, to control the servo for self-leveling; configured **accelerometer of smartphone** using Phyphox app & performed **real time web scraping** to sense base inclination
- Performed **static simulations** on CAD to optimize the geometry & material, estimated required motor torques
- Presented the project in **Virtual Research Symposium '21** co-organized by IIT Bombay and **NTU Singapore**

WIND FARM LAYOUT OPTIMIZATION

[Jan-Apr'21]

Guide: Prof. Abhijit Gogulapati (Department of Aerospace Engineering, IIT Bombay)

Optimized the positioning of 'n' wind turbines in a variable area wind farm to maximize the Annual Energy Production

- Studied Jensen's Wake effect model and Gradient Descent, Genetic Algorithm (GA), Random Search techniques
- Programmed a GA optimizer in Python, tuned its hyperparameters and benchmarked using multimodal problems

DYNAMIC MODELLING OF AN INVERTED FLEXIBLE PENDULUM IN 3D

[May-Jul'20]

Guide: Prof. Prasanna Gandhi (Department of Mechanical Engineering, IIT Bombay)

- Researched mathematical models to capture the physics of flexible beam deflections- Euler Bernoulli beam, Rigid links torsion springs (Pseudo-Rigid-Body-Model), Assumed Modes Method, Cosserat Rod Theory in a team of 2
- Theoretically analysed the Rigid Links Torsion Springs model using newtonian and lagrangian formulation, taking stiffness, damping & gravity into account; simulated the dynamics in MATLAB for up to 4 discretized links

ESTIMATION OF EARTHQUAKE RADIUS USING ML REGRESSION TECHNIQUES

[Sep-Nov'19]

Guide: Prof. Vinay Kulkarni (Department of Mechanical Engineering, IIT Bombay)

Obtained the relation between Peak Ground Acceleration, Fault distance & Magnitude to estimate the radii of Earthquakes

- Modeled the peak acceleration for a significant 2019 earthquake utilizing ML techniques on 800+ data points
- Extracted and refined data with 6000+ entries, dealt with missing values, and visualized correlations in Python
- Implemented feature engineering, regressed 28 MLR, Ridge, LASSO, Elastic Net, K-fold cross validation, Decision trees & Random forest models; achieved optimal predictions based on test-train RMSE and R² values

DESIGN AND FABRICATION OF 'DRAGOWL' - A FLAPPING WING UAV

[May-Jul'19]

Guide: Prof. Arindrajit Chowdhury (Department of Mechanical Engineering, IIT Bombay)

- Studied the flight of birds and analysed the role of flapping motion in the generation of aerodynamic forces
- Innovated actuation mechanisms for flapping & pitching of the wing; developed the electronic circuit for control
- Led a team of 6, designed CAD (inspired by the bird Condor) & fabricated the ornithopter with wing span of 2.8 m

ACADEMIC PROJECTS & SEMINARS

TEMPERATURE & STRESS ANALYSIS IN LINEAR FRICTION WELDING OF TB9

[Mar-Apr'21]

Guide: Prof. Amber Shrivastava (Department of Mechanical Engineering, IIT Bombay)

- Used Finite Difference Method to formulate the coupled heat & mass transfer, identified boundary conditions
- Simulated in MATLAB to obtain stress, strain temperature fields within 2.4% of the data available from literature

MODELLING OF SPHERICAL JOINTS USING EXPONENTIAL COORDINATES

[Feb-Mar'21]

Seminar | Guide: Prof. Anirban Guha (Department of Mechanical Engineering, IIT Bombay)

- Studied the mathematics of exponential coordinates and their utilization to represent 3D rotations in space
- Surveyed literature on the kinematic and dynamic modelling of spherical joints using exponential coordinates, methods to handle singularities & their advantage over euler angles; delivered a presentation on the findings

KINEMATIC & DYNAMIC ANALYSIS OF R-S-S-R SPATIAL MECHANISM

[Feb-Mar'21]

Guide: Prof. Anirban Guha (Department of Mechanical Engineering, IIT Bombay)

- Theoretically analysed the kinematics - position, velocity and acceleration of 4 bar R-S-S-R spatial mechanism and simulated in MATLAB utilizing Newton-Raphson technique for solving the non-linear system of equations
- Studied the effect of introducing clearance in a joint; formulated the dynamics & verified by simulating in ADAMS

MODELLING HUMAN GAIT TO ESTIMATE ENERGY-CONSUMED-PER-CYCLE

[Oct-Dec'20]

Guide: Prof. Abhijit Gogulapati (Department of Aerospace Engineering, IIT Bombay)

- Modelled the arms & legs as rigid links with mass at CoM, and revolute joints with damping for muscular effects
- Simulated constrained lagrangian dynamic formulation in MATLAB and obtained Energy-Consumed-per-Cycle

INNOVATIVE CUTTING TOOL DESIGN FOR ADVANCED ENGINEERING MATERIALS

Seminar | Guide: Prof. Amber Srivastava (Department of Mechanical Engineering, IIT Bombay)

[Oct-Nov'19]

- Reviewed literature on desirable tool geometry, material properties, coatings required to enhance machining performance of 4 difficult-to-cut advanced engineering materials - Inconel, Duplex, Aluminium & Titanium alloys
- Studied the experimental procedure, tool performance measurement parameters and delivered a presentation

ANALYSIS OF THE CHALLENGES FACED BY INDIAN NUCLEAR PROGRAM

[Oct-Nov'19]

Technical Consulting Project | ShARE, IIT Bombay

ShARE is a startup at the crossroad of education and consulting which recruits students to work on industrial consulting projects

- Analysed the trends in the production & utilization of nuclear power in India, and identified the key challenges faced by scientists and policy makers to increase its production through a statistical study; presented a report

TEACHING, MENTORSHIP & ORGANIZATIONAL ROLES

INSTITUTE STUDENT MENTOR | Student Mentorship Program

[Aug'21-present]

- Selected to mentor **12 UG freshmen** and assist them with their academic & extra-curricular endeavours at IITB

TEACHING ASSISTANT | Design of Mechatronic Systems - IITB (offline) & NPTEL (online)

[Jun-Nov'21]

- Designed assignments & exams; clarified conceptual doubts & assisted a batch of **3092** with problem solving
- Helped students with **hardware** circuitry and **microcontroller programming** through hands-on assignments
- Mentored **11** students in their projects, helped them with the practical implementation of theoretical concepts

SENIOR MENTOR | Department Academic Help Sessions Head

[Apr'19-Jul'21]

- Spearheaded a team of 9** to conduct academic help sessions; achieved **300-500%** y-o-y increase in participation
- Mentored **2** students from the **Academic Rehabilitation program**, provided academic & general counsel ['20-'21]
- Mentored **7** second year students, functioned as the first point of contact between students and faculty ['19-'20]

TEACHING ASSISTANT | Linear Algebra

[Mar-May'21]

- Clarified concepts & assisted a batch of **43** in problem solving during **weekly tutorials**; invigilated & graded exams

INSTITUTE DESIGN CONVENER | Sports Council

[Mar'18-Apr'19]

- Innovated **posters & videos** for event publicity; designed sport **T-shirts & jerseys**; sport **mentor** for **20** freshmen
- Organized inter-hostel general championships, IITB's annual sport fest **Aavhan**, Swimathon, Triathlon, Yogathon

RELEVANT COURSES

Mechanical Engineering	Robotics, Design of Mechatronic Systems, Computer Aided Simulation of Machines, Optimization, Machine Design, Vibrations & Structural Dynamics, Finite Element Analysis
Systems & Control	Microprocessors & Automatic Control, Systems Theory, Control of Nonlinear Systems
Aerospace Engineering	Introduction to Flight, Aircraft Design, Aerodynamics, Spaceflight Mechanics
Computer Science	Data Structures and Algorithms, Statistical Machine Learning and Data Mining

TECHNICAL SKILLS

Programming Languages C/C++, Python, Matlab/Octave

Softwares/Platforms Simulink, SolidWorks, ANSYS, AutoCAD, ADAMS, Fusion360, Tiva CCS, Arduino IDE

EXTRA-CURRICULAR ACTIVITIES

Sports	<ul style="list-style-type: none">Captain of the third year UG team, Winners of the Battle of Batches mixed basketball tournament ['20]Captain of the IIT Bombay basketball team achieving 3rd position in the Black Cat Championship ['20]Won Gold in inter-college basketball tournament at Sportsaga, the sports fest of ICT Mumbai ['18]Awarded the Hostel Sports Citation for exceptional contribution to the hostel sport activities ['18]Achieved 4th position at the Inter IIT Basketball tournament as a part of the IIT Bombay team ['17]Qualified Mumbai district level to compete at Maharashtra state level Yoga championship by NYSF ['21]
Dance	<ul style="list-style-type: none">Professionally trained in Indian classical dance Bharatnatyam for 7 years (till madhyama antim)2nd position in Contemporary group dance at Mood Indigo IITB, Asia's largest college cultural fest ['20]3rd position in Classical group dance at Malhar, the cultural fest of St. Xavier's College, Mumbai ['18]
Other	<ul style="list-style-type: none">Delivered a talk on Ornithopters in a seminar series Aerocast organized by Aeromodelling club IITB ['21]Visited JBF Bahrain, a polyester film manufacturing firm, to gain insight into BOPET film fabrication ['18]Engineered an Obstacle Manoeuvring bot, among top 3 teams completing the pick up & place task ['17]Recipient of Overall Performer, Best Student Of The Year, LIC Student Of The Year awards ['12-'15]

REFERENCES

Prof. Abhijit Gogulapati

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