Rudrajyoti Das

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Education

Completion	Degree	Institute	GPA/Percent
2025	Dual Degree (B.Tech + M.Tech) in Metallurgical and Materials Engineering	Indian Institute of Technology Kharagpur	9.27/10
2020	AISSCE	Bhavan's Gangabux Kanoria Vidyamandir	95.2 %

Research Internships

Soft Fish using EHD Pumps (Master's Thesis) [Video] — Jun 2024 – Dec 2024

Supervised by Dr. Jun Shintake

- Designed and fabricated soft pneumatic actuators mimicking a fish-tail by **3D printing** and **silicone molding**
- Fabricated **electrohydrodynamic pumps (EHD)** with helical electrodes by **SLA printing**, with a **15ml/s flowrate** and **2.33 kPa pressure** at **6kV**, superior to conventional EHD pumps
- Conducted underwater experiments to characterize swimming speed, thrust force, tail-beat amplitude, resonance frequency and power consumption

Continuum Robotic Manipulator (Bachelor's Thesis) [Video] — Sep 2023 – Dec 2023

Supervised by Dr. Aditya Bandopadhyay

- Developed a **tendon-actuated** continuum robot with two **independent sections** and floating **magnetic** spacer discs .
- Used bowden tube and brake wires for backbone and nylon wires as tendons and stepper motors for actuation
- Performed a kinematic analysis for vision-based control using a **Piecewise Constant Curvature model** (report)

DeePC based Safety Filter (Mitacs GRI) — May 2023 – Aug 2023

Supervised by Dr. Klaske van Heusden

- Studied the effect of regularisation on **Data Enabled Predictive Control (DeePC)** applied to nonlinear systems
- Assisted in the implementation of a novel **Data-Driven Safety Filter (DDSF)** on a **Crazyflie 2.1** with the lighthouse positioning system, and in simulation on a linearized model of the Quadcopter
- Successfully implemented a DeePC based **Data-Driven Safe Trajectory Planner** on a Crazyflie (videos)

3-DoF Robot Arm [Video] — Apr 2022 – Jul 2022

Supervised by Dr. Aditya Bandopadhyay

- Designed, 3D Printed, assembled and programmed a three degree of freedom robot arm made with off-the shelf components and in house manufactured **cycloidal drive gearbox** and a **parallelogram mechanism** (actuator)
- Implemented **PID** joint angle control and current control on an **STM32F103** for the low level control of each joint

Competitions

11th Inter-IIT Tech Meet 2023 — Feb 2023

Robotic Charging Challenge by Jaguar Land Rover

- Secured **second position (silver)** in the problem statement, and helped the contingent secure an **overall gold**
- Designed and controlled a 6-DoF manipulator in simulation based on provided constraints for autonomous charging
- Implemented a **Computed Torque Controller** to track task-space trajectories in simulation using **Simscape** (video)

Inter Hall Hardware Modelling — Feb 2024 - Apr 2024

- Developed self-powered smart shoe that generates power from **piezoelectric plates** using **LTC3588** energy harvester
- Interfaced the shoe with an **MPU6050** accelerometer and **A9G GPS/GSM module** for fall detection and alerts

Achievements

- Awarded the highly selective **WISE 2024 Scholarship** (Working Internships In Science and Engineering) by **DAAD** (German Academic Exchange Service) to carry out a summer internship at TU Darmstadt, Germany
- Selected for the **Mitacs Globalink Research Internship 2023** program to carry out summer internship at the University of British Columbia, Canada
- Holding a **Department Rank 1** among 50 Dual Degree students in the Department of Metallurgical and Materials Engineering with a CGPA of 9.27
- Secured a silver medal in the Robotic Charging event by Jaguar Land Rover in the national level 11th Inter IIT Tech Meet 2023; and helped the institute secure an overall gold
- Captained the Hardware Modelling Team of Nehru Hall of Residence to secure silver in the Inter-Hall Hardware Modelling event
- Achieved a rank of 5856 (out of 11,74,000 students) in the IIT-Joint Entrance Examination Advanced 2020

Projects

Eccentric Cycloid Actuator for Robotic Applications [Video] **August 2022**

- Designed and 3D printed an **eccentric cycloid gearbox** with a **17:1 reduction** and **6 Nm output torque**
- Used an **AS5600 magnetic encoder** and an **ACS712 current sensor** for feedback, and implemented **PID position and torque control** (videos)
- Developed an Arduino library to easily send position commands to multiple actuators using an I2C multiplexer

Model Predictive Control on a Quadrotor [Code] **May 2023**

- Developed a simulation environment for a nonlinear Quadcopter model ignoring the complex aerodynamics in Python
- Stabilized the drone about hover using **discrete-time Linear Quadratic Regulator (LQR)** on the linearized model
- Implemented **Model Predictive Control (MPC)** using CVXPY for both stabilization and waypoint tracking, also improved tracking performance by adding an **integrator effect** through an augmented state space approach

Data-Enabled Predictive Control for Cartpole Balancing [Code] **May 2023**

- Implemented a simulation environment for Cartpole and recorded various trajectories for balancing and swing up
- Used **LQR** for balancing, and a **Partial Feedback Linearization** based **Energy Shaping** approach for swing up
- Using **Hankel Matrices** from these trajectories, successfully applied **DeePC** for stabilization of the upright position

Mecanum Wheel Mobile Robot [Picture] **Sep 2024**

- Made a robosoccer bot with 3D-printed Mecanum wheels connected to chassis by stepper motors, and a solenoid kicker
- Sent motion commands (left, right, front, back, rotate) wirelessly using an NRF24L01 to an onboard microcontroller

Soft Fluidic Relaxation Oscillator **Aug 2024**

- Fabricated a soft valve by laser cutting a pattern on a substrate made by casting Ecoflex 00-30, that behaves as a **relaxation oscillator** under a **constant inflow rate**. Frequency can be tuned by tuning flowrate or outflow resistance

Test bench to Characterize Response of SMPs **Feb 2023**

- Designed a test bench using induction heaters, relays, temperature sensors, and a microcontroller to characterize temperature response of various commonly available 3D-printable **Shape Memory Polymers** (SMPs)

Traverse Stage using Compliant Mechanisms **Oct 2023**

- Developed and 3D printed a traverse stage using a compliant mechanism for automated microscopy, that converts large rotational inputs into small translational outputs confined in a plane (**ten times reduction**)

Positions of Responsibility

Kharagpur Robosoccer Students' Group (Head, Embedded Team)

- Designed and fabricated BLDC motor drivers and implemented Hall-sensor based commutation for a three phase inverter in an STM32 microcontroller, and used in-built encoders for PID velocity control
- Designed the chassis and PCBs of small-sized bots, and programmed them for Code-o-Soccer in Kshitij 2024 (video)
- Managed an annual budget of $1500 to work on robotics projects, while leading a team of 20 members
- Collaborated with other teams to conduct the robosoccer event Code-o-Soccer at Kshitij 2024, with 20+ participants

Relevant Coursework

- Advanced Calculus
- Probability and Statistics
- Algorithms
- Linear Algebra
- Transform Calculus
- Convex Optimization
- Physics of Materials
- Phase Transformations
- Atomistic Modelling (DFT/MD)
- Deformation Behaviour of Materials
- Material Characterization

Technical Skills

Languages and Libraries: Python, C, C++, MATLAB, numpy, PyTorch, CVXPY
Software: Fusion 360 (CAD), ABAQUS (FEA), LAMMPS (MD), QuantumEspresso (DFT)
Areas of Expertise: Mechatronics, FDM/SLA Printing, Silicone molding, Laser cutting, MPC, Multibody Dynamics

Extracurricular

- Volunteered as a mentor in the three-week long **Winter School of AI and Robotics** conducted annually by Technology Robotix Society, IIT Kharagpur to make freshers familiar with **AVR programming** and **PID control**
- Team member of the inter-hall field hockey team and represented Nehru Hall of Residence in the inter hall tournament
- Participated in Composit 2023, and gave a technical presentation on Liquid Crystal Elastomers winning the second prize