# Aayush Rath | NA20B003

Indian Institute of Technology, Madras

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## Education

| Program | Institution | %/CGPA | Completion |
| --- | --- | --- | --- |
| B.Tech - **Naval Architecture** | Indian Institute of Technology, Madras | 7.16/10.0 | 2024 |
| Class XII, CBSE | Mother's Public School, Bhubaneshwar | 92.8% | 2020 |
| Class X, CBSE | Delhi Public School, Guwahati | 94.2% | 2018 |

## Skills

- **Analysis and Simulation:** ROS, Gazebo, MATLAB, Simulink, Ansys IDE (Fluent, Thermal, Structural, Topology), MSC Adams, Vicon Workspace, Qualysis, VS code
- **Modelling:** Fusion 360, Autodesk Inventor, AutoCAD, Solidworks
- **Programming languages:** C, C++, Java, Python, HTML

## Work Experience

### Robotics Engineer - Swaayatt Robots Pvt. Ltd.
Aug 2024 - PRESENT

*(CEO: Sanjeev Sharma, Autonomous Driving and ADAS - Bhopal, Madhya Pradesh)*

⟶ Perception & SLAM

- Developed an algorithm for publishing stable local occupancy grid to generate more accurate collision avoidance paths by implementing **Lidar clustering** techniques like **Euclidean cluster and DBSCAN** and **IMM, UKF** and **PHD** filters
- Worked on programs to generate meshed maps of an environment using both Lidar and Image data while performing localization using **point-to-plane iterative close points** and g2o for **graph-optimization**
- Created a generative machine learning based pipeline using the concepts of **GANs** and **NERF** for data augmentation making the data generation process **500% faster** in comparison to manual data augmentation

⟶ Motion Planning & Controls

- Developed and integrated a **Model Predictive Control (MPC)** framework to simulate an autonomous parking planner within the Gazebo environment, incorporating an **inherent PID controller** for simultaneous throttle and brake regulation.
- Conducted extensive research and empirical evaluation of various motion planning algorithms, including **geometric methods**(Bézier and elliptic curves), **sampling-based planners** (RRT, RRT*), **search-based approaches** (Hybrid A*), and **combinatorial motion planning** techniques.

## Research Projects

### Research Internship - Lab de Biomécanique et Mécanique des Chocs
Jun 2023 - Jul 2023

*(Guide: Dr. Raphael Dumas, LBMC, Université Gustave Eiffel, Lyon, France)*

⟶ Gait Analysis of transfemoral amputees

- Developed an algorithm for **motion analysis** on knee amputee gait data from tests conducted on **12 participants**, enhancing rehabilitation methodologies through data-driven insights
- Analyzed ipsilateral and contralateral limb differences using parameters like **power and strut index**, contributing to comprehensive biomechanics analysis to understand the motion characteristics.

⟶ Data Acquisition for Postural Efficiency Evaluation

- Conducted data collection for gait motion experiments employing Treadmetrix and Qualysis systems, ensuring data accuracy, proper calibration and reliability and post-processing using **in-house developed analysis tools**
- Utilized markers for precise limb and muscle motion tracking, leveraging an advanced 18-camera setup, while employing a trackpad to gather comprehensive data on feet location and exerted forces.
- Captured acoustic data from a violin performance and applied a pre-trained machine learning model to evaluate performance efficiency under varying biomechanical postures, encompassing both seated and standing positions.

### B.Tech Project - Indian Institute of Technology, Madras
Jul 2023 - May 2024

*(Guide: Dr. Abhilash Somayajula, Director for Center for Marine Autonomous Systems, DOE, IIT Madras)*

⟶ Collision Avoidance for COLREGS compliant MAVs

- Built a simulation engine for simulating definite manoeuvring tests like constant rudder angle and zig-zag motion based on the **MMG model**(Maneuvering Modelling Group)
- Simulated **Aritficial Potential Field, Velocity Obstacle and Reciprocal VO** algorithms for collision avoidance while ensuring **COLREGS** compliancy.

- Tested **Probabilistic Road Maps** on a scaled-down model autonomous marine vehicle with a Raspberry Pi and implemented a PID controller for rudder and propeller commands

## DESIGN OF VEHICLE DYNAMICS MODULE - FORMULA STUDENT                MAY 2021 - JAN 2024
*(Guide: Dr. Satyanarayanan Seshadri, Energy and Emissions Laboratory, IIT Madras)*

⟶VEHICLE MODELLING
- Devised and implemented a highly effective launch control algorithm with a focus on optimizing slip ratio, yielding a **23% reduction** in the **0-100 km/h acceleration time** of 4 seconds and a top speed of **150 kmph**
- Designed and implemented a **Lap time simulation tool**, facilitating critical design decisions for dynamical and aerodynamical parameters and validating overall powertrain performance.
- Constructed an advanced **Four-wheel car model** that excels in constant radius turns, identifying and optimizing key parameters to achieve neutral steer.

⟶STEERING SYSTEM DESIGN
- **Filtered & analyzed tire data** to find the tire's limit and obtained the conditions for **maximum lateral force**
- Calculated the **ideal Ackermann setup** to make turns and maximise lateral force considering mechanical constraints.
- Switched to a bevel gear system instead of a universal joint for **ergonomic comfort of the driver**.

⟶BRAKE ROTOR DESIGN
- Estimated the thermal and mechanical loads present on the brake rotor for a given track layout
- Performed FEA static structural simulations to design a rotor with a satisfactory safety factor
- Obtained the wall heat transfer coefficient of the rotor at various velocities using ANSYS Fluent
- Generated the temperature profile of the rotor over the course of one lap, using MATLAB

## AERODYNAMICS AND CFD - FORMULA STUDENT                MAY 2021 - JAN 2024
*(Guide: Dr. Satyanarayanan Seshadri, Energy and Emissions Laboratory, IIT Madras)*

⟶AUTOMATIC DRAG REDUCTION SYSTEM
- Designed a **6-bar** mechanism for the actuation of the DRS using a single servo motor
- Generated an algorithm to automate the DRS actuation on track and simulated it via **Simulink**
- Obtained a dynamic **drag** reduction of **40%** allowing reduction in laptime of 0.2 seconds every lap

⟶POWERED AERODYNAMIC PACKAGE
- Introduced fan towards the end of the diffuser to **accelerate airflow** and **increase downforce** on the undertray
- Used system impedance curve with fan performance curve to find **optimal fan** while within **geometric constraints**
- Optimised **fan location** across the undertray to **obtain maximum mass-flow rate** using iterative **CFD** Simulations
- Modified **diffuser geometry** to **prevent formation of vortices** and thus **maximizing performance gain**
- Increased **downforce generated** by the undertray by **upto 5kg** and resulting in an even dirstribution of downforce

⟶AERODYNAMICS PACKAGE VALIDATION
- Fabricated a neural network for validating the aerodynamic simulation results using the previous year's test data
- Employed shock potentiometers for dynamic load data collection, enhancing vehicle performance analysis.
- Prepared a **Convulation Neural Network** to predict the load from the shocks' deflection with an **RMSE** of 3%

⟶DESIGN OF FRONT WING
- Designed a 100% carbon fibre multi-element front wing to improve aerodynamic downforce by 30%.
- Composed a cost-effective front wing by removing 6 aerofoils without comprising on optimal performance
- Implemented angled-in (5°) endplates, drastically reducing lateral load transfer to a 1%, enhancing stability.
- Gained a 440 N downforce substantially reducing the vehicle's track time in lap simulations by 3.1 seconds

## THERMAL MANAGEMENT SYSTEM DESIGN - FORMULA STUDENT                MAR 2022 - PRESENT
*(Guide: Dr. Satyanarayanan Seshadri, Energy and Emissions Laboratory, IIT Madras)*

⟶DRIVETRAIN SYSTEM COOLING DESIGN
- Implemented **fan control** for accumulator **push fans** to ensure even distribution of airflow in each module
- Mapped airflow versus duty cycles and current drawn for push fans using pulse width modulation
- Built a **fan testing setup** with multiple fans connected to study the effect of downstream fans on **airflow distribution**
- Constructed an algorithm mapping **fan rpm** with car speed and cell temperature to ensure **maximmum performance**

## RELEVANT COURSEWORK

- Introduction to Robotics
- Multi-Body Dynamics
- Principles of Guidance of Autonomous Vehicles
- Control of Automotive Systems
- Guidance and Control of Marine Vessels
- Introduction to Motion Planning
- Probability and Statistics
- Dynamics and Control of Rotorcraft
- Marine Robotics
- Marine Autonomous Vehicles

## Positions of Responsibility

**Chassis Lead** - Raftar Formula Racing                                          Mar 2023 - Present
- Directed an engineering vertical for the RFR23 & RFR24 car overseeing overall design and manufacturing
- Enhanced team motivation and effective knowledge sharing, ensuring cohesive subsystem functioning
- Managed integration of CADs from diverse subsystems to create the comprehensive full-car CAD model.
- Organized events and cultivated partnerships with enterprises such as Brakes India, Bosch, Tubes India, etc.

**Aerodynamics System Design Engineer** - Raftar Formula Racing      May 2021 - Mar 2023
- Responsible for design, documentation, assembly and CAD integration of the Aerodynamic package
- Ensured that the Aerodynamics Subsystem adheres to the design timeline decided upon by the team
- Coordinated with the Vehicle Dynamics department to improve driveability by complementing the car performance

**Frames and Composites Manufacturing Engineer** - Raftar Formula Racing   May 2021 - Mar 2023
- Responsible for design and documentation of the entire frame along with the cockpit components
- Ensured that the Frame and Composites Subsystem adheres to the design timeline decided by the team
- Designed a frame based on powertrain requirements and assembled over 600 components within the frame
- Responsible for managing juniors in the team by guiding them and ensuring proper knowledge transfer

## Achievements and Co-Curriculars

**Formula Bharat 2024** - Coimbatore                                                              Jan 2024
- Major Improvement in the vehicle design and performance helped up the **2nd position** in the overall event
- Secured the first place in **Engineering Design Competition** & received the **Best Battery Design Award**

**Formula Bharat 2023** - Coimbatore                                                              Jan 2023
- Obtained a podium-finish backing the third place in the on-site competition in Coimbatore in the EV category
- Secured the first place in Business Planning Presentation & second in Engineering Design Competition

**Pi-EV Concept Challenge** - Online Competition                                          Jul 2022
- Emerged as **Overall Champions** out of over **25** teams from India and abroad, and improved on previous performance
- Winner of the **Engineering Design** Event, **Team Management** Event, **Best Battery** Design and **Best Powertrain**
- Presented and defended the design of **Thermal Systems** module before a panel of **judges** and **industry experts**
- Performed **Failure Models and Effects Analysis** on the entire Powertrain package to ensure **reliability** of design

**Formula Bharat Virtuals 2021 (Electric Class)** - Online Competition        Sep 2021
- Emerged as **Overall Champions** at Formula Bharat Virtuals 2021, the team's 1st ever competition in the electric class
- First team in India to win both the **Best Battery Design** and **Best Powertrain Design** awards in the same year

**Formula Student Electric Vehicle Concept Challenge** - Online Competition   Jul 2021
- Secured a **2nd place** finish Overall in the event conducted by Formula Bharat - Our **first podium** in the electric class
- Placed **2nd** in the **Engineering Design** Event and adjudged as the **2nd** best **Procurement Strategy**

**Techsoc Innovatus Challenge**                                                                    Feb 2021
- Competed as a team of 5 members conducted virtually by TechSoc and secured the **2nd position**
- Developed a novel secure system architecture for storing **Medical Health Records** in cloud storage
- Created a simple **convolutional deep learning neural network** to estimate discrepancies in records

**Tensors Volunteer**                                                                                   Jan 2021
- Mentored more than 30 students to make a rightful college decision after their JEE examination