

Shaswat Garg

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SKILLS

Programming Languages: Python, MATLAB, C++

Others: Linux, ROS1, ROS2, Gazebo, RViz, MoveIt, RoboAnalyzer, PyTorch, TensorFlow, Keras, Eigen, Simulink, SolidWorks, ANSYS, Arduino UNO, Confluence, Linear

EXPERIENCE

Graduate Research Assistant

Jun. 2023 – Present

Cooperative & Adaptive Mechatronic Systems Lab

Supervisor: *Prof. Farrokh Janabi-Sharifi and Prof. Baris Fidan*

- MSc Thesis title - Vision-based Path Planning and Control of Aerial Manipulator using Safe Reinforcement Learning.
- Developing a realistic OpenAI gym environment using Gazebo and PX4-Autopilot in ROS2 Foxy.
- Benchmarking of off-policy reinforcement learning algorithms for path planning in UAV using lidar. (submitted in *ICUAS 2024* as first author)

Robotics Software Intern

Jun. 2023 – Oct. 2023

Orangewood Labs

Supervisor: *Dhanush Bakthavatchalam*

- Developed a LLM based tool (RoboGPT) to reduce the programming time for new use cases by 50%. Added audio and textual awareness into the system using Langchain and chatGPT APIs.
- Added object detection module using zero-shot detection and YOLO in the RoboGPT pipeline.
- Integrated MoveIt and Gazebo simulations in software testing pipeline to reduce deployment time from 1 week to 2 days.
- Integrated constraints and environment pointcloud as Ocotomap (created using RTAB-Map) in MoveIt to check robot-world collision during motion planning.

MITACS Globalink Research Intern

May 2022 – Aug. 2022

Robotics, Mechatronics and Automation Laboratory (RMAL), TMU

Supervisor: *Prof. Farrokh Janabi-Sharifi and Prof. Masoud Goharimanesh*

- Conducted Literature Survey on learning based control of continuum robots and investigated the drawbacks of existing methods for autonomous planning of soft robots.
- Implemented different reinforcement learning methods like DDPG, TD3, SoftQ, SAC, NAF and constraint based Safety Layer from scratch using PyTorch library.
- Proposed a constraint based Safe Reinforcement Learning methodology using Soft Actor Critic and Covariance Matrix Adaptation as base to promote efficient exploration of state and action space while ensuring safety of the robot. (submitted in *Engineering Applications of Artificial Intelligence* as first author)
- Algorithm was able to keep the robot within constraints 70% of the training time and reduced the motion planning error by 20% (to 1-2 mm).
- Trained RL algorithms on custom Open AI Gym environment using a static model based on the classical Cosserat-rod and Cosserat-string models.

Research Intern

Aug. 2021 – Apr. 2022

Mechatronics Laboratory, IIT Delhi

Supervisor: *Prof. S.K. Saha and Prof. S.P. Singh*

- Conducted a survey on dynamic modelling of railway models of different Degree of Freedoms (DOFs) and investigated the hunting stability problem for knife edge rails and conical wheels using Jacobian method in MATLAB.
- Developed an user friendly simulation tool – Railhunt to study the hunting stability of a railway vehicle using App-designer toolbox on MATLAB. (accepted in *Railways 2022* as first author) [[paper](#)]
- Studied the effects of dissimilar properties among rail components due to uneven wear and loading on hunting critical speed for a 17 DOF rail model developed using the DeNOC method. (accepted in *Journal of rail and rapid transit (JRRT)* as first student author) [[paper](#)]

Chassis Engineering Intern

Dec. 2020 – Jul. 2021

HyperX Energy (IIT Delhi Funded Startup)

Mentor: *Raman Sharma (Co-Founder and CEO)*

- Tasked to design and analyze a light weight Trellis Frame for Prototype II against different conditions like maximum acceleration, maximum braking etc. using Solidworks and ANSYS.
- Developed a Simulink Model on MATLAB to validate the simulation results and mathematical calculations on different terrains.

PROJECTS

Optimization of Double Wishbone Suspension Geometry for Off-road Vehicles

Apr. 2021 – Jan. 2022

Supervisor: *Prof. Vikas Rastogi and Prof. Atul Kumar Agrawal*

- Worked on designing suspension system for off-road vehicles using Genetic Algorithm by optimizing the caster, kingpin, toe and camber angles to reduce design time by 3 months.
- Used Bayesian learning technique, particularly Gaussian Regression with a Mattern 3/2 Kernel in MATLAB to predict the design properties of a given double wishbone system.
- Created a custom dataset on 120 datapoints using LOTUS suspension software to train the ML model. (published in *ICMAE 2022* as first author) [[paper](#)] [[code](#)]

Inverse Kinematics of Continuum Robot using Invertible Neural Networks

Jan. 2022 – Mar. 2022

Supervisor: *Prof. Vikas Rastogi*

- Investigated different kinematic models of continuum robots like PCC, Cosserat Continuum Model etc. and reviewed the complexity of performing inverse kinematics using different methods.
- Implemented different machine learning and neural network models like RBF network, ELM, KNNR etc. from scratch using Tensorflow.
- Developed an Invertible Neural Network for the inverse kinematic modelling of single section tendon driven continuum robot reducing the RMSE from 1.17 to 0.0058 mm.
- Validated the model using a virtual path planning problem and achieved a mean relative error of 2%.(accepted in *Comp Auto 2022* as first author) [[paper](#)] [[code](#)]

Motion Planning of a Non-Holonomic Robot using various Path Planning Algorithms

Apr. 2021 – May. 2021

Supervisor: *Not Applicable (Self)*

- Implemented Search Based (Heuristic and Incremental) and Sampling Based (Multi Query and Single Query) motion planning algorithms like Dynamic A*, PRM, RRT* for a non-holonomic and point robot in a 2D obstacle environment using Python.
- Applied concepts of Object-oriented programming and Priority Queue to write clean and well documented codes. [[code](#)]

LEADERSHIP

DelTech BAJA

Sep. 2019 – Jun. 2023

Vice Captain

DTU

- Leading Asia's oldest Baja Team of 35+ students with a goal to manufacture an All Terrain Vehicle.
- Led a sub-team of 7+ members responsible for designing and analyzing Roll Cage.
- Initiated several new projects like the design and manufacturing of a new 4WD concept for 2023, integrating new simulation and design methods to optimize the weight and performance of the vehicle.

EDUCATION

University of Waterloo, Canada

Jan. 2024 – Present

- MAsc in Mechanical and Mechatronics Engineering (specialization in Robotics)

Delhi Technological University, India

Aug. 2019 – Aug. 2023

- BTech in Mechanical Engineering