Manvir Singh Lamba

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Education

University of California San Diego **Starting Fall 2023**
Master of Science in Mechanical Engineering (Control & Mechatronics) *San Diego, USA*

Thapar Institute of Engineering and Technology (TIET) **2019 – 2023**
Bachelor of Engineering in Mechatronics ***GPA 3.8*** *Punjab, India*
Merit Scholarship holder *during 2020-2022*

ROBEX, Lab-STICC, ENSTA **August,2020**
Master 2 Level Diploma Constraint Programming with Applications to Mobile Robotics *Bretagne, France*

Udacity, USA
Nanodegree in Robotics Software Engineering *August, 2021*

Nanodegree in Deep Reinforcement Learning *July, 2023 - Present*

Publications

- R. Singh, M. S. Lamba, and T. K. Bera, 'Trajectory tracking of 4-DOF robot manipulator: a bond graph approach', International Journal of Mechatronics and Automation, vol. 9, no. 4, pp. 180–191, 2022 Doi: 10.1504/IJMA.2022.130398. (Link)
- Lamba M.S., Singh A. and Ramkumar J.,2021. A Review of Smart Condition Monitoring System for Gearbox. 8th International & 29th All India Manufacturing Technology, Design, and Research Conference (AIMTDR 2021) https://doi.org/10.1007/978-981-19-3866-5_35 (Link)

Research Experience

Mechatronics LAB, TIET **August 2019 – May 2023**
Volunteer Research Assistant

▷ Soft Pneumatic-Controlled, Finger-Inspired Robotic Gripper :

- Designed a soft pneumatic-controlled robotic gripper, drawing inspiration from the biomechanics of the human finger.
- Fabricated the soft actuator finger using FDM 3D Printing with TPU material.
- Designed and fabricated the gripper base with one DoF servo motor-controlled joint for each pneumatic actuator.
- Conducted testing to measure the curvature of the gripper actuator at different pressures.
- Designed and fabricated chamber to test the pressure sensor.
- Developed a Hyperelastic FEA model in ANSYS and redesigned the soft actuators, and obtained a 50% increase in bending angles
- Designed and engineered a custom pneumatic control circuit to efficiently drive the soft robotic gripper.
- Manufactured a specialized test chamber to evaluate the compressor to calibrate the pressure sensor.
- Developed a Python program to measure the diameter of a circular object.

▷ Trajectory tracking of 4-DOF robot manipulator: a bond graph approach:

- Fabricated and assembled a 4-DOF Robotic Manipulator using FDM 3D printing with ABS material.
- Assembled the electronic circuit for all stepper motors, servo motors, motor drivers, and the Arduino control board.
- Formulated the forward kinematic equations of the manipulator using DH parameters.
- Designed a voltage divider circuit to integrate force sensors in the end effector.
- Conducted extensive testing to calculate the contact force required for grasping objects of various materials.
- Conducted a literature review on serial robotic manipulators.

TIET-Tel Aviv University Centre for Food Security (T2CEFS) **August 2022 – May 2023**
Final Year Capstone Project

- Conducted literature review and patent survey to discover shortcomings in existing robotic weed control techniques.
- Designed a mobile differential drive-based robot with a delta manipulator for agricultural fields.
- Formulated the inverse kinematic equations of the delta manipulator and programmed the equations in a Python script.
- With the help of a morphological table and weighted point method, compared the components required to make the robot autonomous.

- Calculated the motor torque requirement for each joint and selected the motor and motor driver accordingly.
- Developed an FEA model of the chassis and delta manipulator and iterated the changes in the CAD model following the engineering design principles, including material selection, affordability, safety, and other factors.
- Fabricated and assembled all components using different machining processes.
- Calculated the motor torque requirement for each joint and selected the dc geared motor and motor driver accordingly.
- Developed ROS-based packages for sensor fusion and teleop control for initial testing purposes in the field.
- Tested the robot and delta manipulator in row crop farms using teleop control, and different weed species data was captured using an INTEL depth camera.
- Developed an unsupervised machine learning model using the K-means method to identify weeds in an agriculture field.

Mechatronics Lab & Control Lab, IIT Patna **January 2022 – July 2022**

Research Intern

- Conducted a literature review on CFD of bio-inspired fishes.
- Performed 2D hydrodynamic analysis of an Anguilliform-inspired robot using ANSYS Fluent.
- Developed a MATLAB model to visualize the joint equations used to control the robot's motion.
- Created UDF scripts to introduce the robot motion in CFD.
- Developed and simulated more than 35 CFD models of a single link, two linked robotic swimmers and a six-linked anguilliform-inspired robot.
- Conducted a comparative study of thrust produced by the robot at various parameters like maximum amplitude, frequency, phase lag and the number of links.

AWaDH, IIT Ropar **May 2021 - July 2021**

R&D Intern

- Selected among first 100 applicants from throughout India.
- Conducted a literature review and patent search for swarming of Robots for Precision Agriculture.
- Designed an MPC controller for autonomous lane-changing rovers.
- Devised algorithms for the swarming of UAVs for disease detection and precision pest control and harvesting rovers.
- Programmed a simulation depicting the movement of the swarm of UAVs and Rovers on MATLAB.
- Tools/Language Used: - MATLAB Multirobot toolbox, Fusion 360, Python, DFMA

Imagineering Laboratory, IIT Kanpur **May 2021- December 2021**

Volunteer Research Assistant

- Studied different Conditional Indicators used in conditional monitoring.
- Surveyed 60+ research manuscripts for different techniques and sensors used for conditional monitoring.
- Highlight the Opportunities and Challenges in monitoring gearbox health.
- Investigated different research papers on the history of industrial robots.
- Presented a paper, "A Review of Smart Condition Monitoring System for Gearboxes," at 8th International & 29th All India Manufacturing Technology, Design, and Research Conference (AIMTDR) – December 2021.

Technical Skills

Tools & Technologies: MATLAB & Simulink, NI Multisim, NI LabView, Simplify 3D, Autodesk EAGLE , ANSYS
CAD Softwares: PTC CREO, Solidworks, Fusion 360, Onshape
Languages: Python,C++, PLC ,Arduino IDE
Frameworks & OS: Robot Operating System (ROS), Gazebo, Linux
Hardware: Force Sensor, Pressure Sensor, Encoder, Camera, Servo Motor, Stepper motor, DC Motor, Solenoid Values, Arduino, Raspberry PI

Projects

Multi Robot P2P Synchronized Navigation using Deep RL | *ROS, Fuzzy Logic* **September 2022 - Present**

- Trained and tested a Reinforcement Learning model on the Gazebo environment.
- Implemented Q learning algorithms on a single tortoise robot.
- Developing an algorithm for multi-robot coordination using two tortoise robots.
- Integrated and tested optical encoder sensors on tortoise robots.
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- Develop a fuzzy logic controller on MATLAB for the robots to maintain a fixed distance and maneuver in a fixed geometry.

Wall Painting Robotic Manipulator | *MATLAB, CREO, ROS* **September 2022 - October 2022**

- Designed a 3-DoF PPR robotic manipulator on CREO Parametric.

- Developed a MATLAB model to solve the kinematics equations of the robot from its DH parameters.
- Implemented Path Planning and Inverse Kinematics of the robot using the moveit library.
- Validated the results using the RoboAnalyzer Platform.

Constraint Programming with application to Mobile Robots | *Python, Tubex Library, SLAM* **May 2020 – July 2020**

- Used Interval Analysis and its implementation in Python or C++ using the Tubex library.
- Applied Constraint Programming and build solvers for problems of localization and SLAM in mobile robots.
- Applied Constraint Programming and built solvers for localization problems and SLAM in mobile robots.

2D Geometric Transformation Calculator | *MATLAB* **May 2021 - July 2021**

- Developed a user-friendly MATLAB-based 2D geometric transformation calculator.
- The calculator can perform various combinations of rotation and translation rigid-body transformations on a user-defined polygon.

Autonomous Home Cleaning Robot | *ROS, SLAM* **June 2021 – August 2021**

- Developed URDF files for a differential drive robot equipped with encoder and LIDAR sensors.
- Performed 2D and 3D mapping on the robot using gmapping and RTABMap, respectively.
- Used AMCL and EKF to deploy SLAM.
- Used OpenCV for masking and contour detection via mounted camera to track and follow a tracker.

Design of Drive Mechanism for Feed Force Pump | *Onshape, PTC Creo BMX & MDX* **May - June 2021**

- Modeled the crankshaft of the engine and performed sensitivity, feasibility, and optimization analysis to balance the crankshaft with minimum weight.
- Modeled and assembled a feed pump and performed structural analysis on the pump's air vessel.
- Designed a drive mechanism consisting of a belt and pully, gear reduction, and scotch and yoke mechanism to transfer motion from a HONDA GX160 engine to the feed pump.
- Graphed Velocity and Acceleration of plunger using Creo MDX.

Optimum design of a perfume bottle | *PTC Creo Behavior Modeler Extension, PTC Simulate* **May-June 2021**

- Designed a glass bottle of 200 mm height using revolve tool.
- Performed sensitivity, feasibility and optimization analysis to obtain the interior volume of 550 ml.
- Performed structural analysis on the bottle taking 500kPa interior pressure.
- Performed sensitivity, feasibility and optimization analysis on the thickness of the bottle to obtain FOS of minimum 6.

Certifications

Programming the Internet of Things (IOT) Specialization **Completed**
University of California, Irvine (Coursera) *Link*

A Hands-on Introduction to Engineering Simulations **Completed**
Cornell University (Edx) *Link*

How to Write and Publish a Scientific Paper (Project-Centered Course) **Completed**
École Polytechnique by Coursera *Link*

FDP on Robotics **Completed**
AICTE Training And Learning (ATAL) Academy *Link*

Modern Robotics: Mechanics, Planning, and Control Specialization **In Progress**
Northwestern University by Coursera *Link*

Fundamentals of Digital Image and Video Processing **In Progress**
Northwestern University by Coursera

Neural Networks and Deep Learning **In Progress**
DeepLearning.AI by Coursera

Applied Control Systems 1: autonomous cars: Math + PID + MPC **In Progress**
Udemy

Professional Affiliations

- Member of IEEE Society (Member# 96568754)
- IEEE Robotics and Automation Society (Member# 96568754)
- Robotics Society of India (Membership# S201266)
- Member of Technical Committee on Space Robotics
- Member of Technical Committee on Soft Robotics
- Former Joint Secretary of Thapar Amateurs and Astronomy Society
- Former Executive Board Member of Thapar Mechatronics and Robotics Society

Conferences & Workshops Attended

- 6th Summer School on AI by IIIT, Hyderabad – August 2022
- International Conference on Robotics and Automation (ICRA) – June 2020
- International Conference on Intelligent Robots and Systems (IROS) – October 2020
- Workshop on "Robotics System Design: Fundamentals, Challenges and Applications" IIT Ropar – November 2020

Leadership Volunteer Experience

The Kalgidhar Society -NGO **July 2020 – September 2020**

Student Volunteer *Punjab, India*

- Assisted in organizing a social event, "Walk to Save" - A worldwide challenge to collectively walk 28,000 Km in 28 days to support rural educational projects in 5 Northern states of India.
- Assisted in the registration process and marketing.
- Enhanced participation by creating social media awareness.

Pratigya Abhiyan - NGO **August 2020 – July 2021**

Volunteer Teacher *Punjab, India*

- Taught physics classes to underprivileged high school students
- Created practice test series for physics, chemistry, and biology subjects.