MUKUNDAN CHARIAR

998-708-3908 | mukundan.chariar@gmail.com | linkedin.com/in/mukundan-chariar1
github.com/mukundan-chariar1 | mukundan-chariar1.github.io

EDUCATION

Carnegie Mellon University *Pittsburgh, PA*
Master of Science in Mechanical Engineering *May 2025*
- GPA: 3.69/4.00
- Focus: Computer Vision and Machine Learning
- Courses: Biomechanics of Human Movement, Computer Vision for Engineers, Introduction to Deep Learning, Numerical Methods in Engineering, Robot Dynamics and Analysis, Optimal Control and Reinforcement Learning, Introduction to Robot Learning, Intermediate Deep Learning for Engineers, Linux and Open Source.

Manipal Institute of Technology *Manipal, India*
Bachelor of Technology in Mechatronics *June 2023*
- GPA: 9.14/10.00
- Industrial IOT Systems Minor: Database Management Systems, Information Security in Industrial Automation, Internetworking for Industries, Principles of Cryptography.
- Technical Electives: Machine Vision and Image Processing, Micro Electro Mechanical Systems, Machine Learning.

RESEARCH INTERESTS

- Robot Locomotion and Control - Bipedal walking, trajectory-free motion, reinforcement learning for uneven terrain.
- Human Motion Analysis and Biomechanics - Joint kinematics modeling, physical therapy evaluation, inverse reinforcement learning from movement data.
- Multimodal Sensor Fusion - Integration of uncalibrated IMU and video data for pose estimation and error detection.
- Learning-Based Control - Policy optimization, reward design, imitation learning (GAIL, IRL), model-based and model-free control.
- 3D Computer Vision and Reconstruction - Neural Radiance Fields (NeRF), structure-from-motion, statistical mesh fitting.
- Embodied AI and Simulation - Sim-to-real learning, proprioceptive sensing, MuJoCo-based policy training.
- Human-Robot Interaction - Movement quality feedback, interpretable behavior in learned motor policies.

SKILLS

Programming Languages: Python, Julia, Java, C, C++, Embedded C, Assembly, SQL, MATLAB.
Libraries: PyTorch, NumPy, SMPL/SMPL-X, MuJoCo, OpenCV, Open3D, JAX, Pandas, OpenMP.
Tools: MuJoCo MPC, Fusion 360, MakerBot Print, MATLAB Simulink, Git, COLMAP, Weights & Biases.

PROJECTS

CppMjStep: Efficient Differentiable Simulation with MuJoCo and PyTorch *May 2025 - July 2025*
Independent:Open-Source Package *Pittsburgh, PA*
- Achieved >2× faster differentiable rollouts on large models and batch sizes by moving the op to C++ and enabling multithreading; repo includes benchmark plots for sensor and no-sensor cases.
- Added optional multithreaded differentiation to parallelize the backward pass, improving throughput on large batches.
- Supported batch simulation and multi-step rollouts, facilitating large-scale RL/control research and complex model training.
- Used MuJoCo's built-in differentiation routines for efficient gradients, and propagated sensor data with negligible extra cost.
- Released as an open-source library on GitHub; delivered a pip-installable PyTorch extension with batched, multi-step trajectory support and documented usage examples.

Learning Human Locomotion Reward Functions using Inverse Reinforcement Learning *January 2025 - May 2025*
Carnegie Mellon University: Course Project *Pittsburgh, PA*
- Developed a Bidirectional GAN framework to infer reward functions for human locomotion from PPO-generated running trajectories.
- Integrated a VAE-GAN architecture to stabilize discriminator training and extract state-based reward signals for reinforcement learning agents.
- Diagnosed vanishing gradient and discriminator overpowering issues; analyzed failure cases through reward visualization and policy behavior.
- Implemented a GAIL-based trajectory-level discriminator, improving episode length and reward signal quality in humanoid running tasks.

Robust Bipedal Locomotion on Uneven Terrain *January 2025 - May 2025*
Carnegie Mellon University: Course Project *Pittsburgh, PA*
- Trained a 12-DOF bipedal robot in MuJoCo using Proximal Policy Optimization to walk on rough terrain without explicit trajectory planning.

• Designed clock-based reward functions and policy input features using proprioception and motor currents for stable gait generation.
• Benchmarked learned policies against a receding-horizon iLQR controller with trajectory tracking, highlighting robustness gaps in model-based control.
• Created custom uneven terrains and staircase environments in simulation to evaluate locomotion stability and generalization across conditions.

Physical-Therapy Assessment with Uncalibrated Cameras and Inertial Sensors *August 2023 - December 2024*
Carnegie Mellon University: Research Project *Pittsburgh, PA*
• Designed an auto-calibration pipeline to fuse uncalibrated multi-view video and IMU data, enabling markerless 3D pose estimation using a multi-stage SMPL mesh fitting framework.
• Engineered joint kinematics features (e.g., range of motion, angular deviation) from noisy sensor data for use in classification models of exercise correctness.
• Trained and evaluated machine learning models for movement error detection, achieving up to 60.0% F1 score, comparable to inter-clinician agreement.
• Developed a heuristic-based classifier leveraging joint angle statistics to identify physical therapy form errors with high recall (93.2%) under data-limited conditions.

Neural-Symbolic Visual Question Answering with Transformer Models *January 2024 - May 2024*
Carnegie Mellon University: Course Project *Pittsburgh, PA*
• Implemented and modified the MDETR model for Visual Question Answering on the CLEVR dataset, achieving 70.5% test accuracy with custom attention-head configuration.
• Conducted architectural ablations by increasing transformer attention heads and replacing RoBERTa with ALBERT to evaluate effects on multimodal alignment and reasoning.
• Diagnosed segmentation and detection failure modes, and proposed design improvements for textual grounding and visual reasoning.
• Overcame compatibility issues with legacy frameworks (NS-VQA, Mask R-CNN) by adapting model pipelines for modern PyTorch and CUDA toolchains.

3D Scene Reconstruction with Structure-from-Motion and Neural Radiance Fields *August 2023 - December 2023*
Carnegie Mellon University: Course Project *Pittsburgh, PA*
• Developed a hybrid 3D reconstruction pipeline integrating Structure-from-Motion (SfM) and Neural Radiance Fields (NeRF) for generating dense, photorealistic 3D models from 2D images.
• Implemented camera pose estimation, triangulation, and bundle adjustment to create sparse point clouds and enhanced them using volume rendering via NeRF.
• Improved model accuracy by upsampling input imagery, resulting in significantly denser and smoother reconstructions across object categories.
• Evaluated system performance on diverse real-world objects (e.g., dinosaur, fox, robot) and demonstrated novel-view synthesis using NeRF-based rendering.

Machine Learning for Squat Analysis and Correction *January 2023 - June 2023*
Manipal Institute of Technology: Research Project *Manipal, India*
• Collected a custom dataset of squat exercises from volunteer participants; extracted body joint coordinates using MediaPipe-based pose estimation.
• Applied photogrammetry techniques to reconstruct 3D joint positions from 2D keypoints.
• Generated synthetic squat movement data using interpolation techniques to model additional motion patterns.
• Designed and trained a neural network to classify squat form correctness, achieving 94.0% classification accuracy.

Bio Inspired Designs *May 2022 - December 2022*
Manipal Institute of Technology: Research Project *Manipal, India*
• Engineered six unique bio-inspired internal structures (e.g., rhombic dodecahedron, hexagram) using Fusion 360, based on natural load-bearing systems like honeycombs and bird bone analogs.
• Conducted comprehensive mechanical testing via UTM and simulation-based analysis to assess energy absorption, stress-strain behavior, and structural efficiency.
• Reduced material consumption by up to 65% while retaining 70–90% of solid block load-bearing capacity, enabling lightweight, cost-efficient designs for structural and impact-resistant applications.
• Identified promising applications in aerospace, automotive, and construction industries, leveraging properties such as intrinsic cooling, impact dampening, and modular manufacturability.

Control of a Needle Valve using PID Controller *March 2022 - April 2022*
Manipal Institute of Technology: Mini Project *Manipal, India*
• Used Matlab and Simulink along with their libraries to create a simulation of a needle valve being controlled, using a PID controller

Development of a Mini 3 Wheeler Rover *March 2022 - April 2022*
Manipal Institute of Technology: Mini Project *Manipal, India*
• Mapped user interface inputs to control signals for a 3-wheeled rover using Python.

Development of a Home IoT system *March 2022 - April 2022*
Manipal Institute of Technology: Mini Project *Manipal, India*

• Used an ESP32 along with various sensors to create a Mini Home IoT system.
• Developed a mobile interface using Blink IoT for home automation.

EXPERIENCE

24-703 Numerical Methods in Engineering — *Carnegie Mellon University, Pittsburgh, PA*
Course Assistant — *January 2025 - May 2025*
• Conducted office hours and recitations with a group of course assistants, proctored and graded exams, graded homeworks, supported students to improve the quality of submissions for a class of 30 students.

24-678 ST: Computer Vision for Engineers — *Carnegie Mellon University, Pittsburgh, PA*
Course Assistant — *August 2024 - December 2024*
• Held office hours, proctored and graded quizzes, graded homework, provided detailed feedback for students on improving the quality of submissions for a class of 60 students as part of a group of course assistants.

Rex Engineering and Metal Works — *Thane, India*
Floor Intern — *June 2022 - July 2022*
• Studied operations on CNC machines, helped inspect completed jobs, created models, generated g-codes for jobs using Fusion 360, AutoCAD and MasterCam Mill 9.
• Fabricated a CNC milled tray under supervision of senior engineers.

LEADERSHIP

Vice President — *June 2021 - September 2022*
Managing Committee member 2020-21 — *June 2020 - June 2021*
Institution of Engineers, Mechatronics Students' Chapter, Manipal — *Manipal, India*
• Led a student chapter of 120+ members, fostering initiatives in technical education, community outreach, and interdisciplinary collaboration.
• Managed an executive board of 8 members; organized weekly meetings to track progress on events, projects, and club objectives.
• Coordinated inter-club collaborations, planned recruitment drives, and oversaw budgeting and resource allocation for events and technical projects.
• Organized and mentored student-led technical initiatives, including mini-projects, workshops, and community-oriented programs.

Programme Coordinator 2021-2022 — *June 2021 - June 2022*
MTE Student Peer Programme — *Manipal, India*
• Served as a liaison between students and faculty as part of a department-supervised academic support initiative.
• Facilitated regular feedback sessions to communicate student concerns and suggestions to faculty.
• Provided input on curriculum structure and course delivery to improve academic outcomes and student experience.
• Assisted in organizing peer academic support activities and contributed to fostering a collaborative learning environment.

Managing Committee member 2020-21 — *June 2020 - June 2021*
Working Committee member 2019-20 — *September 2019- June 2020*
Leaders Of Tomorrow — *Manipal, India*
• Volunteered in the Logistics and Operations Department, contributing to the planning and execution of events such as Manipal Model United Nations (MUN).
• Coordinated event logistics, managed venue and resource planning, and supported real-time operations during large-scale student-led initiatives.
• Promoted to the Managing Committee for demonstrated leadership and reliability in operations and team coordination.

PUBLICATIONS

• M. Chariar, S. Rao, A. Irani, S. Suresh and C. S. Asha, "AI Trainer: Autoencoder Based Approach for Squat Analysis and Correction," in *IEEE Access*, vol. 11, pp. 107135-107149, 2023, doi: 10.1109/ACCESS.2023.3316009.