Varun Satyadev Shetty

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Website | *Google Scholar* | *GitHub* | *Linkedin*

Overview

- I'm interested in reinforcement learning (RL), machine learning (ML), biomechanics and rehabilitation robotics in general. Much of my research is about understanding human-machine interaction and combining the understanding of machine learning, human biomechanics and robotics to control robotic assistive devices. The goal of my research is to advance robotic assistive devices for human locomotion and rehabilitation by developing control algorithms that can facilitate the deployment of these devices in practical, real-world scenarios beyond the confines of the laboratory.

Education

Sept'24 – Present **PhD Robotics**, University of Michigan, Ann Arbor.

Sept'19 – Apr'21 **Master of Science in Robotics**, University of Michigan, Ann Arbor.

Aug'15 – May'19 **Bachelor of Technology in Mechanical Engineering**, Dwarkadas J. Sanghvi College of Engineering, University of Mumbai.

Research Experiences

May'23 – Sept'24 **Research Scholar**, University of Michigan, Ann Arbor, Neurobionics Lab.

- **Topic:** Reinforcement Learning based generalized control tuning approach agnostic of joint, activity and robotic assistive device.
- The goal of this study is to show the possibility of using offline RL with online fine-tuning for control of robotic assistive devices and to take the first steps towards creating a truly generalizable control tuning algorithm which is agnostic of joints, assistive devices and activities.
- **Topic:** Real-time activity classification for Variable Stiffness Orthosis and Prosthetic Ankle.
- The goal of this study is to develope real-time activity classifier using on-board sensor information for Variable Stiffness Orthosis and Variable-Stiffness Ankle-Foot prosthesis.

Aug'22 – Apr'23 **Research Assistant**, North Carolina State University.
Topic: Implementing model-free control strategies for robotic assistive devices and bipedal robots.

- Implemented control strategies for robotic assistive devices by understanding human biomechanics.
- Used physics based simulators (MuJoCo) to perform model free control for bipedal robots.

May'21 – July'22 **Research Engineer**, University of Michigan, Ann Arbor, Neurobionics Lab.
Topic: Developing user preference-learning based controller for lower limb robotic assistive devices.
Collaboration between (Google) X, Georgia Institute of Technology and Neurobionics Lab

- Worked on developing a sample efficient preference based control algorithm and designed the control communication system for the experiment.

May'20 – Apr'21 **Student Researcher**, University of Michigan, Ann Arbor, Neurobionics Lab.
Topic: A data driven approach to design and control new generation of wearable assistive technologies.
Advisor - Elliott J Rouse

- Worked on improving the control of robotic assistive devices by developing and implementing machine learning based approaches trained on rich biomechanical datasets.
- Developed machine learning models for predicting user's preferred prosthesis ankle stiffness for a quasi-passive prosthesis (Variable-Stiffness Ankle-Foot (VSPA) prosthesis).

Nov'19 – Apr'20 **Student Researcher**, University of Michigan, Ann Arbor.
Topic: Eye-surgery instrument localization.
Advisor - Lauro Ojeda

- Worked on developing algorithms for localizing surgical instrument (for eye) using Aruco stickers.

Recent Publications

Ongoing Research — **Reinforcement Learning Based Generalized Control Tuning Approach Agnostic of Joint, Activity and Robotic Assistive Device**, **Varun S. Shetty**, Ung Hee Lee, Sehoon Ha, Elliott J. Rouse, *Research In-Progress* | project explanation link.

BioRob 2024 — **Preferred Ankle Stiffness of a Variable-Stiffness Prosthesis Across Varying Activities**, Nicholas J. Pett, Nundini D. Rawal, **Varun S. Shetty**, Elliott J. Rouse, *Biomedical Robotics and Biomechatronics (BioRob) 2024*| link.

Science Robotics 2023 — **User Preference Optimization for Control of Ankle Exoskeletons using Sample Efficient Active Learning**, Ung Hee Lee, **Varun S. Shetty**, Patrick W. Franks, Jie Tan, Georgios Evangelopoulos, Sehoon Ha, Elliott J. Rouse, *Science Robotics 2023* | link.

RAL + ICRA 2022 — **A Data Driven Approach for Predicting Preferred Ankle Stiffness of a Quasi-Passive Prosthesis**, **Varun S. Shetty**, Ung Hee Lee, Kimberly A Ingraham, Elliott J. Rouse, *IEEE Robotics and Automation Letters 2022* | link.

Grants, Talks, Patents, Posters

NSF Grant (In Progress) — **NSF FRR: An Open-Source Generalizable Control Framework Agnostic of Hardware, Task, Joint and User for Lower-Limb Robotic Prostheses and Exoskeletons**, Actively contributed to the composition and development of this grant proposal.

Dynamic Walking 2022 (Talk) — **Preference-In-The-Loop Optimization: Sample Efficient Active Learning for Control of Ankle Exoskeleton**, **Varun S. Shetty**, Ung Hee Lee, *Dynamic Walking, 2022* | link.

US Patent 2022 — **Predicting User Preference With AI To Control A New Generation Of Robotic Assistive Technologies**, Elliott J. Rouse, Ung Hee Lee, **Varun S. Shetty** | link.

IEEE BioRob 2020 (Late - Breaking Abstract, Poster) — **A data driven approach for predicting preferred ankle stiffness**, **Varun S Shetty**, Ung Hee Lee, Elliott J Rouse, *IEEE RAS – EMBS International Conference on Biomedical Robotics and Biomechatronics*, 2020 | poster link.

Selected Projects

Mar'21 – Apr'21 — **Computer Vision Assisted Pick and Place Robot Arm**, | Python, ROS, | Report.

- Implemented software for a 5 DoF kinematic arm robot, conducted experiments, and participated in a class-wide competition.
- Key points of the implementation consists of PID control, camera calibration, block detection, forward and inverse kinematics and motion planner.

Jan'21 – Feb'21 — **Occupancy-Grid SLAM for Ground Robot**, | C++, LCM, | Report.

- Developed a mini-bot that could independently navigate and explore an unknown environment.
- Key points of this project consists of implementing motion controller algorithm, Simultaneous Localization and Mapping method and using the A-star path planning algorithm on the robot.

Jan'20 – Mar'20 — **Lane Line Detection and Vehicle Position Estimation**, | Python, | Report | GitHub.

- Implemented an algorithm for effectively detecting lane lines and vehicle position estimation on the roads which can be used for self-driving cars for following a lane.
- Implemented techniques such as distortion correction, perspective transform, region masking and polynomial fitting for detecting lane lines and vehicle position estimation in a realistic environment.

May'20 – Aug'20 — **Behavioral Cloning**, | Python, Unity Simulator.

- Created my own dataset for mapping the entire simulator track in Unity Simulator and developed a Deep Convolutional Neural Network architecture to drive a car around the track.

Scholastic Achievements

2021 — **Engineering Innovation Award**, 2021 Engineering Research Symposium, University of Michigan.

2015 – 2019 — Top 3% in the class of 2019 Mechanical Engineering from Dwarkadas J. Sanghvi College of Engineering.

Technical Skills

Languages — Python, Matlab, C, C++, Julia.

Libraries — TensorFlow, PyTorch, ROS, MuJoCo, OpenAI gym, OpenCV, Keras, Scikit-Learn.