

Varun Satyadev Shetty

Overview

- I'm interested in reinforcement learning (RL), machine learning (ML), computer vision, optimization, and rehabilitation robotics in general. Much of my research is about understanding human-machine interaction and combining the understanding of human biomechanics and robotics to build and control assistive devices such as robotic exoskeletons and prosthesis. 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'22 – Present **PhD in Mechanical Engineering**, North Carolina State University.
- Sept'19 – Apr'21 **Master of Science in Robotics**, University of Michigan, Ann Arbor
GPA: 3.55/4.0.
- Aug'15 – May'19 **Bachelor of Technology in Mechanical Engineering**, Dwarkadas J. Sanghvi College of Engineering, University of Mumbai
GPA: 9.09/10.0.

Research Experiences

- May'23 – Present **Research Intern**, 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 develop real-time activity classifier using on-board sensor information for Variable Stiffness Orthosis and Variable-Stiffness Ankle-Foot prosthesis.
- May'21 – July'22 **Research Engineer**, University of Michigan, Ann Arbor, Neurobionics Lab.
Topic: Developing user preference-learning based controller for lower limb robotic prosthesis.
Collaboration between (Google) X 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 a 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*.**

Science Robotics 2023(under review)	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, <i>Science Robotics</i> 2023.
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, <i>IEEE Robotics and Automation Letters</i> 2022 link .

Talks, Patents, Posters

Dynamic Walking 2022 (Talk)	Preference-In-The-Loop Optimization: Sample Efficient Active Learning for Control of Ankle Exoskeleton , Varun S. Shetty , Ung Hee Lee, <i>Dynamic Walking</i> , 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, <i>IEEE RAS – EMBS International Conference on Biomedical Robotics and Biomechatronics</i> , 2020 poster link .

Selected Projects

Mar'21 – Apr'21	Computer Vision Assisted Pick and Place Robot Arm , Python, ROS, Report . <ul style="list-style-type: none"> Implemented software for the 5 DoF kinematic arm robot, conducted experiments, and participated in a competition conducted among the students taking the course ROB 550. The 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 . <ul style="list-style-type: none"> Developed a mini robot that could independently navigate and explore an unknown environment. The key points of this project consists of tuning the robot, implementing motion controller algorithm, implementing Simultaneous Localization and Mapping (SLAM) 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 . <ul style="list-style-type: none"> 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 advanced computer vision techniques such as camera calibration, distortion correction, Sobel algorithm, perspective transform, region masking and polynomial fitting techniques for detecting lane lines and vehicle position estimation in a realistic environment.
May'20 – Aug'20	Behavioral Cloning , Python, Unity Simulator. <ul style="list-style-type: none"> 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, University of Mumbai, India.

Technical Skills

Languages	Python, Matlab, C, C++, Julia.
Libraries	TensorFlow, PyTorch, ROS, MuJoCo, OpenAI gym, OpenCV, Keras, Scikit-Learn.

Relevant Coursework

PhD	Foundations of Artificial Intelligence, Mechatronics Design, Neural Networks.
Masters	Self Driving Cars Perception & Control, Digital Control System, Embedded Control, Computer Vision, Computational Data Science & ML, Algorithmic Robotics, Robotic Systems Lab.
Bachelors	Engineering Mechanics, Structured Programming Approach, Industrial Electronics, Mechatronics, CAD/CAM/CAE, Machine Design, Applied Mathematics-I, II, III, IV{Probability Theory, Laplace Transforms, Fourier Series, Linear Differential Equations, Application of Differential Equations, Derivatives, Complex Integration, Double Integrals, Matrices, Numerical Methods}.