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Varun Satyadev Shetty

Overview

- My core area of research is Reinforcement Learning and Machine Learning based control of robotic assistive devices such as exoskeletons and robotics prostheses. 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'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 / Research Intern**, 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 wearable assistive technologies, such as exoskeletons and robotic prosthesis by developing machine learning and reinforcement 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 (specifically used for eye surgery) using Aruco stickers.

Recent Publications

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, *Science Robotics 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, *IEEE Robotics and Automation Letters 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, 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

June'22 – Present **Reinforcement Learning Based Generalized Control Tuning Approach Agnostic of Joint, Activity and Robotic Assistive Device**, | Python.

- 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 are agnostic of joints, robotic assistive devices and activities.

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

- 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.

- 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.

- 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.

- Created my own dataset for mapping the entire simulator track with the help of three cameras on the car and developed a Deep Convolutional Neural Network architecture to drive a car around a track in the Unity simulator.

Scholastic Achievements

2021 **Engineering Innovation Award**, at the 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.

Others Git, LaTex, SolidWorks.

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, Computer Aided Drawing, 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}.