Chinmay Shah

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EDUCATION

North Carolina State University ***Aug 2019 – Dec 2021***
MS(Thesis) in Mechanical Engineering *(GPA 4.0/4.0)*

Vishwakarma Institute of Technology (VIT) ***Aug 2014 – May 2018***
B.Tech. in Mechanical Engineering *(GPA 9.12/10.0)*

PUBLICATIONS

- **C. Shah**, A. Fleming, V. Nalam, M. Liu and H. H. Huang, “EMG-driven Musculoskeletal model for volitional control of a robotic ankle prosthesis” presented at International Conference on Intelligent Robots and Systems(IROS), Kyoto, 2022
- S. Upadhye, **C. Shah**, M. Liu, G. Buckner, and H. H. Huang, "A Powered Prosthetic Ankle Designed for Task Variability - A Concept Validation," presented at the International Conference on Intelligent Robots and Systems(IROS), Prague, 2021.

RESEARCH / WORK EXPERIENCE

Institute of Human Machine and Cognition (IHMC) ***Aug 2023 – Present***
Robotics Control Systems Engineer

- Contributed to the development of EVA, an augmentative lower-limb exoskeleton designed to assist in carrying heavy loads and manual material handling, thereby reducing physical exertion.
- Designed a ground reaction force estimator utilizing the principle of angular momentum conservation in a linear inverted pendulum model, to enhance the performance of the gravity compensation controller.
- Currently exploring optimal control techniques and learning-based approaches inspired by legged robots to improve the exoskeleton's assistance in practical scenarios.

DEKA Research and Development ***Jan 2022 – Aug 2023***
Robotics Software Engineer

- Contributed to the development of the path planning stack for FEDEX’s autonomous delivery robot (ROXO).
- Incorporated a reachability and distance-to-occupancy-based cost layer into the optimization of the Model Predictive Controller (MPC) to avoid planning paths through narrow spaces, hallways, or obstacles.
- Collaborated in refactoring the MPC, improving its real-time operating speed by 30%.
- Assisted in developing a higher-level Behavior Planner which was a global planner and responsible for dictating the bot’s behavior in different scenarios, such as operating on sidewalks/roads, intersections etc.
- Designed a robust dynamic collision check library with a hierarchical architecture to identify potential collisions between the robot's trajectories and machine learning-based predictions of dynamic obstacles, resulting in a 16% reduction in collisions.
- Implemented and evaluated various path planning algorithms, including A*, grassfire, and RRT, enabling the robot to plan optimal paths in a dynamic environment while avoiding obstacles.
- Developed a controller for a capacitive deionization-based water filtration system used in a home-care hemodialysis machine for blood transfusion. The efficient system reduced the maintenance costs by 50% and improved the life of the filters by 30%.

Neuromuscular Rehabilitation Engineering Lab ***Mar 2020 – Dec 2021***
Research Assistant

- Assisted with the development of a novel variable stiffness robotic ankle prosthesis.
- Developed controllers that would enhance the quality of life of transtibial amputees by restoring their lower limb function and allowing them to walk on level ground, climb stairs and perform other daily activities.

Research Projects at the NREL Lab
EMG-driven Musculoskeletal model-based control for a robotic ankle prosthesis (Master’s Thesis)

- Conceptualized and designed a multi-muscle EMG driven musculoskeletal model-based controller to allow the user to control a robotic ankle prosthesis at will.

- Developed and implemented a non-linear optimization to optimize the model parameters. Evaluated model performance via offline simulations achieving a prediction accuracy over 85%.
- Conducted biomechanics analysis using inverse dynamics and kinematics to validate the model and evaluate the robot's performance in real-time.
- The controller enabled the user to operate the device at will, enabling them to react to changes in the environment and adjust their ankle angle at will while performing various tasks.

Reinforcement Learning Based Gait Assistance using Hip Exoskeleton

- Assisted with the Development of gait assistance algorithms for a proprietary hip exoskeleton using Least Squares Policy Iteration.
- The algorithms would reduce human exertion during walking without sacrificing efficiency.

Finite State Machine for a Robotic ankle prosthesis

- Implemented a Finite state control algorithm for a robotic ankle prosthesis to enable the user to walk on level ground and stair climbing.
- Utilized the different force and angle sensors within the device to identify different states/gait phases and developed a robust controller capable of efficiently transitioning between them.

Design of a Robotic Ankle Prosthesis for task variability

- Assisted with the design and development of a novel ankle prosthesis containing an adjustable elastic element allowing for task variability.
- The adjustable elastic element allowed the user to modify the device's passive stiffness and range of motion, optimizing its performance across different tasks.

TECHNICAL EXPERTISE

Courses: Linear and Non-Linear Control Theory, Optimization, Robotics (Planning and perception), Dynamics, Design of Experiments, Embedded Systems, FEA, Design Validation.

Software: ROS, OpenCV, GIT, MATLAB, TwinCAT 3.1 (EtherCAT), SolidWorks, VICON, OpenSIM

Programming Languages: C, C++, Python, Java

Certifications: Deep Learning, Machine Learning

PROJECTS

The CopyCat Robot ***Aug 2023 – Dec 2023***

- Designed a copycat pipeline for a 6-DOF robotic manipulator, enabling it to identify and replicate simple hand-drawn shapes on a sheet of paper.
- Developed a computer vision algorithm using OpenCV to identify hand-drawn shapes and formulated an inverse kinematics solver with motion planning to replicate the identified shape on a piece of paper.

Non-Linear Controller for 2-DOF robotic manipulators ***Aug 2020 – Dec 2020***

- Developed Adaptive and Robust methodology non-linear controllers for a 2DOF robotic manipulator.
- Simulated and evaluated the position tracking performance of the controllers in the presence of external disturbance using Simulink.

Rapid Waste Composting Machine ***May 2017 – Dec 2018***

- Engineered a small-scale, modular composting machine equipped with a mechatronic system for temperature and moisture control.
- The machine converted organic waste to compost within 72 hours, a significant improvement over traditional methods that can take 2-4 months.
- Received the 2nd place prize at Aakruti 2018, a Dassault Systems Design Innovation Competition with 1250 teams from all over India and got the opportunity to present the idea at SolidWorks World 2019, Dallas TX.

LEADERSHIP ROLES

Team Endurance Racing – Team Captain of BAJA SAE Student Team ***Mar 2016 – Mar 2018***

- Led a team of 25 to design and manufacture a custom off-road vehicle for BAJA SAE competition.
- Engineered a custom powertrain system consisting of a Continuously Variable Transmission, 2-stage compound gearbox, composite driveshaft, and constant velocity joints, reducing the weight of the vehicle by 15kgs (20%).
- Achieved 2nd place in acceleration out of 140 teams from all over India.