CHUNCHU ZHU

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PROFILE

Results-driven Robotics Engineer with a strong academic background in Mechanical Engineering and extensive research experience in robotics, automation, and mechatronics. Proficient in developing and implementing innovative solutions for enhancing human-machine interactions and improving industrial processes. Adept at programming and utilizing cutting-edge technologies to design and control robots for various applications.

EDUCATION

Rutgers, The State University of New Jersey *Jan 2022 - Present*
Ph.D. in Mechanical Engineering New Brunswick, NJ

Case Western Reserve University *Jan 2020 - Dec 2021*
M.Sc. in Mechanical Engineering Cleveland, OH

Southern University of Science and Technology *Sept 2015 - June 2019*
B.E. in Mechanical Engineering Shenzhen, China

PUBLICATIONS

Journal Papers

- J2 **C. Zhu**, J. Yi, "Knee Exoskeleton-Enabled Balance Control of Human Walking Gait with Unexpected Foot Slip," *IEEE Robotics and Automation Letters.*
- J1 J. Zhou, Q. Nguyen, S. Kamath, Y. Hacohen, **C. Zhu**, M. J. Fu, and K. A. Daltorio, "Hands to hexapods, wearable user interface design for specifying leg placement for Legged Robots," *Frontiers in Robotics and AI, vol. 9, 2022.*

Conference Papers

- C5 G. Sreenivasan, **C. Zhu**, J. Yi, "Intersection Point-Based Analysis of Neural Balance Control Strategies in Parkinson's Patients during Quiet Stance," *America Control Conference, 2024*, Submitted.
- C.4 **C. Zhu**, S. Maurya, J. Yi, and A. Dutta, "Brain Computer Interface (BCI)-Enhanced Knee Exoskeleton Control for Assisted Sit-to-Stand Movement," *America Control Conference, 2024*, Submitted.
- C3 G. Sreenivasan*, **C. Zhu***, J. Yi, "Knee Stiffness in Assistive Device Control at Quiet Stance: A Preliminary Study," *Model. Est. Control Conf., 2023*
- C2 G. Sreenivasan, **C. Zhu**, J. Yi, "Neural Balance Control of Human Quiet Stance for Construction Workers," *2023 IEEE 19th International Conference on Automation Science and Engineering, Auckland, New Zealand*
- C1 **C. Zhu**, F. Han, J. Yi, "Wearable Sensing and Knee Exoskeleton Control for Awkward Gaits Assistance," *in Proc. IEEE Conf. Automat. Sci. Eng., Mexico City, Mexico, 2022, pp. 2393–2398.*

RESEARCH EXPERIENCE

Robotics, Automation, and Mechatronics (RAM) Lab Jan 2022 - Present
Advisor: Prof. Jingang Yi *Piscataway, NJ*

- **Brain Computer Interface-Enhanced Human Robot interaction**
  Designed a human-exoskeleton interface to facilitate Sit-to-Stand assistance. Proactively integrated cutting-edge machine learning-based Brain-Computer Interface (BCI) technology to establish a seamless communication link between the human brain and robotic knee exoskeleton systems, fostering intuitive and efficient control. Leveraged Python and C++ to successfully implement the system.

· **Knee Exoskeleton-Enhanced Balance Control**
Designed and developed an integrated wearable sensing and exoskeleton-assisted system focused on slip and fall prevention. Successfully implemented real-time slip detection and precise assistive torque control, resulting in effective balance recovery. The system was constructed utilizing multiple Inertial Measurement Units (IMUs) in conjunction with knee exoskeletons. Demonstrated the system's effectiveness in preventing slip-induced falls through extensive experiments on human subjects. This project showcased my exceptional expertise in biomechanics and robotics, contributing to the advancement of wearable technology with a primary goal of enhancing human mobility and safety.

· **Learning-Based Exoskeleton Control**
Designed a comprehensive framework tailored for real-time activity detection, precise lower-limb posture estimation, and exoskeleton controllers to support industrial workers performing non-periodic, awkward gaits. This innovation resulted in noticeable enhancements including improved balance, reduced muscle activation, and task assistance across a range of industrial operations. Demonstrated an exceptional proficiency in harnessing the power of machine learning and robotics, contributing significantly to the advancement of exoskeleton capabilities within industrial environments.

CRAB Lab at Case Western Reserve University Jan 2020 - Dec 2022
Advisor: Prof. Kathryn Daltorio *Cleveland, OH*

· **Wave Force Sensor Design**
Designed and manufactured a cost-effective wave force sensor for amphibious crab-like robots using thin film pressure sensors and soft materials. Demonstrated its capability to detect waves and compared it with camera-based wave speed estimation.

· **Hexapod Locomotion Control**
Generated stable gaits for a hexapod robot using Central Pattern Generator (CPG) and conducted impedance control under stream and uneven terrain conditions.

· **Geotechnical Modeling for Robot Locomotion**
Designed and implemented a hexapod robot model in Webots simulator, developed a tripod gait controller, and derived leg-terrain interaction models based on Resistive Force Theory.

Control & Learning for Robotics and Autonomy (CLEAR) Lab Sept 2018 - Dec 2019
Advisor: Prof. Wei Zhang *Shenzhen, China*

· **Quadruped Design and Control Project**
Contributed to the development of a quadruped robot, optimizing motor design and working on the design and control of Permanent-Magnet Synchronous Motors.

· **System Identification for Dynamic Legged Robot**
Conducted research on system identification methods for dynamic legged robots.

TEACHING EXPERIENCE

Dynamic System and Control June 2022/2023 - August 2022/2023
Instructor *Piscataway, NJ*

· The course addresses dynamic systems, i.e., systems that evolve with time. Typically these systems have inputs and outputs; it is of interest to understand how the input affects the output (or, vice-versa, what inputs should be given to generate a desired output). Lectures are intended to concentrate on systems that can be modeled by Ordinary Differential Equations (ODEs), and that satisfy certain linearity and time-invariance conditions. We will analyze the response of these systems to inputs and initial conditions. It is of particular interest to analyze systems obtained as interconnections (e.g., feedback) of two or more other systems. We will learn how to design (control) systems that ensure desirable properties (e.g., stability, performance) of the interconnection with a given dynamic system.

MAE Senior Lab II Jan 2022 - May 2022
Teaching Assistant *Piscataway, NJ*

· Assisted in comprehensive experiments in fluid dynamics, acoustics, heat transfer, power systems, and dynamic mechanical systems. Responsible for test procedure preparation, data analysis, and presentation of results.

SKILLS

Programming	MATLAB, Python, C/C++, Java
Technical Tools	TensorFlow, Scikit, PyTorch, Git, AutoCAD, Solidworks, Webots, Ros, etc
Algorithms	Robotic modelling and control, haptic algorithm, Machine Learning, path planning, sensor fusion, nonlinear optimization, PID, OpenCV, etc.
Other	Embedded systems, manufacturing methods, data structure, etc

HONORS AND AWARDS

ASME DSCD Best Robotics Student Paper Award	2023
MECC 2023 Finalist for Best Student Paper	2023
Outstanding Graduate of Zhicheng Residential College, SUSTech	2019
First-Class SUSTech Scholarship for Outstanding Students	2018
Third-Class SUSTech Scholarship for Outstanding Student	2015-2017
Outstanding Leadership of Zhicheng Residential College, SUSTech	2016-2018
Outstanding Student Representative of Student Congress, SUSTech	2017

OTHER ACTIVITIES

Presentations and Posters

· 2023 MECC, Lake Tahoe, NV
· 2023 NSF-TIH PI Meeting, Baltimore, MD
· 2022 IEEE-CASE, Mexico City, Mexico
· 2022 IEEE-ICRA, Philadelphia, PA

Reviewer

· IEEE Transactions on Mechatronics
· IEEE Robotics and Automation Letters
· IEEE International Conference on Robotics and Automation
· IEEE Transactions on Neural Systems & Rehabilitation Engineering
· International Journal of Intelligent Robotics and Applications
· Intelligent Transportation Systems
· Control Engineering Practice, IFAC
· Journal of Mechanisms and Robotics, ASME