CHUNCHU ZHU

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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 Novel Foot Slip", Transactions on Mechatronics (Submitted)
- 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

- C3 G. Sreenivasan, **C. Zhu**, J. Yi, "Biomechanical Analysis of Human Knee Stiffness and Response to Exoskeleton Assistive Torques during Quiet Stance", *Model. Est. Control Conf., 2023*(Submitted)
- 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*(Submitted)
- 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*

- **Knee Exoskeleton-Enhanced Balance Control**
  We presented an integrated wearable sensing and exoskeleton-enabled fall prevention system that provides real-time slip detection and assistive torque control for balance recovery under unexpected foot slip. The results of multiple subject experiments demonstrate that incorporating knee exoskeletons as a balance recovery method for human walking is a reliable and robust approach to mitigate or prevent slip-induced falls.
- **Learning Based Exoskeleton Control**
  We presented a comprehensive framework for real-time activity detection, lower-limb posture estimation, and exoskeleton controller design to assist industrial workers who perform non-periodic awkward gaits. Our integrated system, which includes wearable sensing and assistive exoskeletons, demonstrates promising results in improving subjects' balance, reducing muscle activation, and providing assistance during various industrial tasks such as walking, squatting, and kneeling.

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

· **A Dactyl-Integrated Sensor Design for Measuring Lake Waves**
This work presented a cost-effective approach to designing a wave force sensor for amphibious crab-like robots using thin film pressure sensors and soft materials, and demonstrates its capability to detect waves. The comparison with camera-based wave speed estimation using wavelet-based optical flow velocimetry (wOFV) provides valuable insights for future development of such sensors.

· **Stable Hexapod Locomotion through a Variable Flowing Stream**
We generated stable gaits for a hexapod robot using Central Pattern Generator (CPG) and conducted impedance control on the robor under stream and uneven terrain conditions.

· **Geotechnical Modeling for CRAB-Like Robot Locomotion on Granular Medias**
This work involved designing and implementing a hexapod robot model in Webots simulator, developing a tripod gait controller, designing experiments to derive the leg-terrain interaction model based on Resistive Force Theory, and proposing methods to reduce overlapping stance time and minimize sinkage.

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 through the design, manufacturing, and assembly processes while also optimizing motor design using static stress analysis, and worked on the design and control of a Permanent-Magnet Synchronous Motor.
Thesis topic: System Identification for Dynamic Legged Robot

University of Notre Dame, College of Engineering June 2018 - Aug 2018
Advisor: Prof. Patrick Wensing *South Bend, IN*

· **International Summer Undergraduate Research Experience (iSURE)**
We developed and implemented a speed and height controller for a simulated single leg jumping robot in Webots, accomplished embedded control of the hopping leg robot, read and analyzed data through EtherCAT communication.

Notre Dame-SUSTech Summer Research Program 2016 - 2017
Advisor: Professor Kevin Yiming Rong and Professor Bill Goodwine

· **The Commercial Aircraft Corporation of Shanghai** *June 2017 - Aug 2017*
We designed the mechanical structure of a 5 DoF robot arm for aerospace wing panel riveting, and simulated the design in SolidWorks and Adams for the static and dynamic analysis. An algorithm for the perpendicular calibration of the robot arm was also developed.

· **Timken: Large Wind Bearing Online Monitoring System** *June 2016 - Aug 2016*
We investigated the causes of bearing failure and developing effective monitoring systems to prevent such failures. By conducting ultrasonic tests and analyzing the results using FFT, we were able to identify potential failures and develop a MATLAB-based online monitoring system for wind bearings.

TEACHING EXPERIENCE

Dynamic System and Control June 2022 - August 2022
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*

- Comprehensive experiments in fluid dynamics, acoustics, heat transfer, power systems, and dynamic mechanical systems.
- Responsible for preparation of test procedure, data analysis, and presentation of results and conclusions of two labs: Inverted Pendulum and Airfoil.

SKILLS

Programming	Proficient: MATLAB, Python; Intermediate: C/C++, Java
Technical Tools	TensorFlow, Scikit, PyTorch, Git, Linux, LATEX, Solidworks, 3D-printing, etc
Language	Mandarin, English

HONORS AND AWARDS

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

OTHERS

Presentations and Posters

- 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 Engineernig Practice, IFAC;
- Journal of Mechanisms and Robotics, ASME;