

Ayonga Hereid (Yongga A)

POSTDOCTORAL FELLOW · Robotics · Optimization · Control
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Research Interests

Robotics	Exoskeleton and human-assistive devices; Bipedal robots and humanoids
Control & Dynamics	Modeling and optimal control design of hybrid dynamical systems
Optimization	Advanced trajectory optimization of complex systems
Machine Learning	Applications of machine learning algorithms to robust feedback controls

Education

2017	Postdoctoral Fellow	<i>University of Michigan, Ann Arbor</i>
	• Advisor: Prof. Jessy W. Grizzle	
2016	Ph.D. in Mechanical Engineering	<i>Georgia Institute of Technology</i>
	• Advisor: Prof. Aaron D. Ames	
	• Thesis: "Dynamic Humanoid Locomotion: Hybrid Zero Dynamics Based Gait Optimization via Direct Collocation Methods"	
	• GPA: 4.0/4.0	
2010	M.S. in Mechanical Engineering	<i>Zhejiang University, China</i>
2007	B.S. in Mechanical Engineering	<i>Zhejiang University, China</i>

Academic Experience

2017 -	Postdoctoral Researcher	<i>University of Michigan</i>
	• Realize robust and autonomous walking of lower-limb exoskeleton without the use of crutches.	
	• Develop computationally-tractable optimal and robust control for bipedal robot and exoskeleton.	
	• Mentor graduate students with various research projects and coursework.	
2015 - 2016	Graduate Research Assistant	<i>Georgia Institute of Technology</i>
	• Developed FROST, an open source project for fast optimization and simulation of robotic systems.	
	• Experimentally realized sustainable human-like multi-contact walking on a 3D humanoid—DURUS.	
	• Implemented online gait optimization algorithms for an underactuated planar biped.	
2012 - 2015	Graduate Research Assistant	<i>Texas A&M University</i>
	• Demonstrated energy-efficient motion planning for DURUS at 2015 DARPA Robotic Challenges (DRC).	
	• Developed robust control algorithms for sustainable dynamic walking on various biped platforms.	
2010 - 2011	Research Engineer	<i>Zhejiang University</i>
	• Designed multiple DSP+FPGA based embedded systems for digital instrumentation systems.	
	• Conducted performance tests and troubleshooting of a high precision IMU data acquisition unit.	
2007 - 2010	Graduate Research Assistant	<i>Zhejiang University</i>
	• Developed a new high-speed networked instrumentation bus (NIB) communication protocol.	
	• Designed a multi-agent digital diagnosis and testing instrument for distributed systems.	

Honors & Awards

International

2016	Best Conference Paper Award Finalist , ICRA' 2016	Stockholm, Sweden
2014	DENSO Best Student Paper Award , HSCC' 2014	Berlin, Germany

Domestic

2011	Graduate Student Scholarship , Texas A&M University	College Station, Texas
2008	Hua-Ye Scholarship , Zhejiang University	Hangzhou, China
2007	Graduate Student Fellowship , Zhejiang University	Hangzhou, China
2006	Guang-Hua Scholarship , Zhejiang University	Hangzhou, China
2005	Departmental Outstanding Fellow Award , Zhejiang University	Hangzhou, China
2005	Second Place in Undergraduate Robots Design Challenge	Hangzhou, China
2003	Government Fellowship of Zhejiang Province	Hangzhou, China
2002-2006	Excellent Undergraduate Student Award , Zhejiang University (Four Consecutive Academic Years from 2002-2006)	Hangzhou, China

Teaching Experience

01/2017-	Research Mentor <i>Dynamic Legged Locomotion Lab</i> <ul style="list-style-type: none">Mentor and supervise two PhD students with their research and course work.	University of Michigan, Ann Arbor
SPRING 17	Co-Instructor <i>EE5355: Algorithmic Techniques for Scalable Computing</i> <ul style="list-style-type: none">Mentored and supervised a group of five graduate students with their course project.	University of Minnesota
SPRING 16	Guest Lecturer <i>ECE6552: Nonlinear Systems</i> <ul style="list-style-type: none">Prepared and delivered one lecture regarding nonlinear optimization.	Georgia Institute of Technology
SPRING 16	Graduate Teaching Practicum <i>ME2002: Dynamics of Rigid Bodies</i> <ul style="list-style-type: none">Delivered 3 lectures under the supervision of Prof. Harvey Lipkin.Prepared and graded in-class quiz problems.	Georgia Institute of Technology
SPRING 12	Teaching Assistant <i>MEEN368: Solid Mechanics in Mechanical Design</i>	Texas A&M University
FALL 11	Teaching Assistant <i>MEEN363: Dynamics and Vibrations</i>	Texas A&M University

Professional Experience

Grant Proposal

2017	Assisted Prof. Grizzle in preparation of an individual NSF grant.
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Program Committee

2017-2018	Robotics: Science and Systems Conference (RSS)
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Professional Experience (Continued)

Peer Reviewer

- 2018 International Journal of Robotics Research (IJRR)
- 2018 IEEE Transactions on Mechatronics (Mechatronics)
- 2018 Applied Sciences
- 2016-2017 IEEE Transactions on Automatic Control (TAC)
- 2015-2018 IEEE International Conference on Robotics and Automation (ICRA)
- 2016,2018 IEEE Robotics and Automation Letters (RA-L)
- 2017 IEEE Control Systems Letters (L-CSS)
- 2016 IEEE Conference on Decision and Control (CDC)
- 2017 American Control Conference (ACC)
- 2013 ACM International Conference on Hybrid Systems: Computation and Control (HSCC)
- 2016 International Workshop on the Algorithmic Foundations of Robotics (WAFR)
- 2016 Robotics: Science and Systems Conference (RSS)
- 2016 ASME Dynamic Systems and Control Conference (DSCC)

Other Service

- 2017 Judges for Engineering Graduate Symposium, University of Michigan

Publications

Open-Source Code

- [S1] A. Hereid and AMBER Lab, *Frost: Fast robot optimization and simulation toolkit*, AMBER Lab, Feb. 2017, <https://ayonga.github.io/frost-dev>.

Journal Publications

- [J1] Y. Chen, A. Hereid, H. Peng, and J. Grizzle, "Synthesis of safe controller via supervised learning for truck lateral control," in *Submitted to IEEE Transaction of Control System Technology*.
- [J2] O. Harib, A. Hereid, A. Agrawal, T. Gurriet, S. Finet, G. Boeris, A. Duburcq, E. Mungai, M. Masselin, A. D. Ames, K. Sreenath, and J. W. Grizzle, "Feedback control of an exoskeleton for paraplegics: Toward robustly stable hands-free dynamic walking," in *Conditionally Accepted to IEEE Control Systems Magazine*.
- [J3] A. Hereid, C. M. Hubicki, E. A. Cousineau, and A. D. Ames, "Dynamic humanoid locomotion: A scalable formulation for hzd gait optimization," in *To appear in IEEE Transactions on Robotics*.
- [J4] A. Agrawal, O. Harib, A. Hereid, S. Finet, M. Masselin, L. Praly, A. D. Ames, K. Sreenath, and J. W. Grizzle, "First Steps Towards Translating HZD Control of Bipedal Robots to Decentralized Control of Exoskeletons," in *IEEE Access*, vol. 5, pp. 9919–9934. DOI: 10.1109/ACCESS.2017.2690407.
- [J5] H. Zhao, A. Hereid, W.-l. Ma, and A. D. Ames, "Multi-contact bipedal robotic locomotion," in *Robotica*, vol. 35, no. 5, pp. 1072–1106. DOI: 10.1017/S0263574715000995.
- [J6] N. T. Dantam, D. M. Lofaro, A. Hereid, P. Y. Oh, A. D. Ames, and M. Stilman, "The ach library: A new framework for real-time communication," in *IEEE Robotics Automation Magazine*, vol. 22, no. 1, pp. 76–85. DOI: 10.1109/MRA.2014.2356937.

Peer-Reviewed Conference Publications

- [C1] T. Gurriet, S. Finet, G. Boeris, A. Hereid, O. Harib, M. Masselin, J. Grizzle, and A. D. Ames, “Towards restoring locomotion for paraplegics: Realizing dynamically stable walking on exoskeletons,” in *Accepted to 2018 IEEE International Conference on Robotics and Automation (ICRA)*, IEEE, May 2018.
- [C2] S. Kolathaya, J. Reher, A. Hereid, and A. D. Ames, “Input to state stabilizing control lyapunov functions for robust bipedal robotic locomotion,” in *Submitted to American Control Conference, AACC*, Mar. 2018.
- [C3] A. Hereid and A. D. Ames, “FROST: Fast Robot Optimization and Simulation Toolkit,” in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, IEEE/RSJ, Vancouver, Canada, Sep. 2017.
- [C4] A. Hereid, E. A. Cousineau, C. M. Hubicki, and A. D. Ames, “3D Dynamic Walking With Underactuated Humanoid Robots: A Direct Collocation Framework for Optimizing Hybrid Zero Dynamics,” in *2016 IEEE International Conference on Robotics and Automation (ICRA)*, IEEE, Stockholm, Sweden, May 2016, pp. 1447–1454. DOI: 10.1109/ICRA.2016.7487279. **Best Paper Award Finalists**
- [C5] A. Hereid, S. Kolathaya, and A. D. Ames, “Online Hybrid Zero Dynamics Optimal Gait Generation Using Legendre Pseudospectral Optimization,” in *55th IEEE Conference on Decision and Control (CDC)*, IEEE, Las Vegas, NV, USA, Dec. 2016, pp. 6173–6179. DOI: 10.1109/CDC.2016.7799218.
- [C6] C. M. Hubicki, A. Hereid, M. X. Grey, A. L. Thomaz, and A. D. Ames, “Work Those Arms: Toward Dynamic and Stable Humanoid Walking that Optimizes Full-Body Motion,” in *IEEE International Conference on Robotics and Automation (ICRA)*, IEEE, Stockholm, Sweden, May 2016, pp. 1552–1559. DOI: 10.1109/ICRA.2016.7487293.
- [C7] S. Kolathaya, A. Hereid, and A. D. Ames, “Time dependent control lyapunov functions and hybrid zero dynamics for stable robotic locomotion,” in *American Control Conference (ACC)*, AACC, Boston, MA, USA, Jul. 2016, pp. 3916–3921. DOI: 10.1109/ACC.2016.7525524.
- [C8] W.-I. Ma, A. Hereid, C. M. Hubicki, and A. D. Ames, “Efficient HZD Gait Generation for Three-Dimensional Underactuated Humanoid Running,” in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, IEEE/RSJ, Daejeon, South Korea, Oct. 2016, pp. 5819–5825. DOI: 10.1109/IROS.2016.7759856.
- [C9] Q. Nguyen, A. Hereid, K. Sreenath, J. W. Grizzle, and A. D. Ames, “3d dynamic walking on stepping stones with control barrier functions,” in *55th IEEE Conference on Decision and Control (CDC)*, IEEE, Las Vegas, NV, Dec. 2016, pp. 827–834. DOI: 10.1109/CDC.2016.7798370.
- [C10] J. P. Reher, E. A. Cousineau, A. Hereid, C. M. Hubicki, and A. D. Ames, “Realizing Dynamic and Efficient Bipedal Locomotion on the Humanoid Robot DURUS,” in *IEEE International Conference on Robotics and Automation (ICRA)*, IEEE, Stockholm, Sweden, May 2016. DOI: 10.1109/ICRA.2016.7487325.
- [C11] J. P. Reher, A. Hereid, S. Kolathaya, C. M. Hubicki, and A. D. Ames, “Algorithmic Foundations of Realizing Multi-Contact Locomotion on the Humanoid Robot DURUS,” in *The International Workshop on the Algorithmic Foundations of Robotics (WAFR)*, San Francisco, Dec. 2016.
- [C12] H. Zhao, A. Hereid, E. Ambrose, and A. D. Ames, “3D Multi-Contact Gait Design for Prostheses: Hybrid System Models, Virtual Constraints and Two-Step Direct Collocation,” in *55th IEEE Conference on Decision and Control (CDC)*, IEEE, Las Vegas, USA, Dec. 2016, pp. 3668–3674. DOI: 10.1109/CDC.2016.7798821.
- [C13] A. Hereid, C. Hubicki, E. A. Cousineau, J. W. Hurst, and A. D. Ames, “Hybrid zero dynamics based multiple shooting optimization with applications to robotic walking,” in *2015 IEEE International Conference on Robotics and Automation (ICRA)*, Seattle, WA, USA, May 2015, pp. 5734–5740. DOI: 10.1109/ICRA.2015.7140002.

- [C14] A. Hereid, S. Kolathaya, M. S. Jones, J. Van Why, J. W. Hurst, and A. D. Ames, “Dynamic Multi-domain Bipedal Walking with ATRIAS Through SLIP Based Human-inspired Control,” in *17th International Conference on Hybrid Systems: Computation and Control (HSCC’14)*, Berlin, Germany: ACM, Apr. 2014, pp. 263–272. DOI: 10.1145/2562059.2562143. **Best Student Paper Award**
- [C15] A. Hereid, M. J. Powell, and A. D. Ames, “Embedding of SLIP dynamics on underactuated bipedal robots through multi-objective quadratic program based control,” in *2014 IEEE 53rd Annual Conference on Decision and Control (CDC)*, IEEE, Los Angeles, CA, USA, Dec. 2014, pp. 2950–2957. DOI: 10.1109/CDC.2014.7039843.
- [C16] K. Song, C. Li, L. Ye, B. Chen, and A. Hereid, “Signal integrity optimization of MLVDS based multi-master instrument bus,” in *2014 IEEE International Symposium on Electromagnetic Compatibility (EMC)*, Aug. 2014, pp. 433–437. DOI: 10.1109/IEMC.2014.6899011.
- [C17] N. Dantam, A. Hereid, A. Ames, and M. Stilman, “Correct software synthesis for stable speed-controlled robotic walking,” in *Proceedings of the 2013 Robotics: Science and Systems Conference IX (RSS)*, Berlin, Germany, Jun. 2013, pp. 24–28. DOI: 10.15607/RSS.2013.IX.040.
- [C18] M. J. Powell, A. Hereid, and A. D. Ames, “Speed regulation in 3d robotic walking through motion transitions between human-inspired partial hybrid zero dynamics,” in *2013 IEEE International Conference on Robotics and Automation (ICRA)*, IEEE, Karlsruhe, Germany, May 2013, pp. 4803–4810. DOI: 10.1109/ICRA.2013.6631262.

Workshop Abstracts

- [W1] A. Hereid, “Dynamic multi-contact humanoid locomotion via unified virtual constraints and direct collocation based optimization,” in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, IEEE, 2016.

Invited Presentation

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| 07/2017 | Invited Talk
<i>FROST and Its Applications to Exoskeleton</i> | Wandercraft, Paris, France |
| 02/2017 | Seminar Presentation
<i>Optimal Gait Synthesis for Dynamic Legged Locomotion</i> | University of Minnesota, Twin Cities |
| 01/2017 | Legged Robotics Meeting
<i>Optimal Gait Synthesis for Dynamic Legged Locomotion</i> | University of Michigan, Ann Arbor |
| 10/2016 | IROS Workshop Presentation
<i>Dynamic Multi-Contact Humanoid Locomotion via Unified Virtual Constraints and Direct Collocation based Optimization.</i> | Daejeon, South Korea |

Live Demonstration

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| 06/2015 | DARPA Robot Challenges Finals
<i>Robot Endurance Test</i> | Pomona, CA |
| | <ul style="list-style-type: none"> • Demonstrated the most efficient humanoid walking with SRI’s DURUS. • Competed against Sandia National Lab’ STEPPR humanoid. | |
| 09/2015 | RoboBusiness 2015
<i>SRI International</i> | San Jose, CA |
| | <ul style="list-style-type: none"> • Invited demonstration of energy-efficient dynamic locomotion. | |

Media Coverage (selected)

- [M1] The Michigan Engineer News Center
Getting people moving - Walking exoskeletons could mobilize disabled patients, Online, Sep. 2017, [Online]. Available: <https://news.engin.umich.edu/2017/09/getting-people-moving-walking-exoskeletons-could-mobilize-disabled-patients/>.
- [M2] IEEE Spectrum
DURUS Brings Human-Like Gait (and Fancy Shoes) to Hyper-Efficient Robots, Online, Jul. 2016, [Online]. Available: <http://spectrum.ieee.org/automaton/robotics/humanoids/durus-brings-humanlike-gait-and-fancy-shoes-to-hyperefficient-robots>.
- [M3] AMBER Lab
DURUS: Walks Like a Human, Youtube, Jul. 2016, [Online]. Available: <https://www.youtube.com/watch?v=1fC7b2LjVW4&feature=youtu.be>.
- [M4] The Washington Post
This robot takes power walking to a new level, Online, Jul. 2016, [Online]. Available: <https://www.washingtonpost.com/news/innovations/wp/2016/07/13/this-robot-takes-power-walking-to-a-new-level/>.
- [M5] WSB-TV2, Atlanta
The Robot Uprising Has Began, Television, May 2016, [Online]. Available: <http://www.wsbtv.com/news/2-investigates/the-robot-uprising-has-begun/287553746>.
- [M6] IEEE Spectrum
DURUS: SRI's Ultra Efficient Walking Humanoid Robot, Online, Jun. 2015, [Online]. Available: <http://spectrum.ieee.org/automaton/robotics/humanoids/durus-sri-ultra-efficient-humanoid-robot>.

References

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