Huihua Zhao | Resume

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Research Interests

• Dynamical modeling of robotic systems • Nonlinear control design of hybrid systems • Optimal trajectory design using nonlinear optimization problems • Prosthetic system design, modeling and control • Embedded system developing • Hardware implementation of both bipedal robots and lower-limb prosthetic devices.

Education

Ph.D. in Mechanical Engineering	Georgia Institute of Technology - Atlanta, USA	GPA[3.6/4.0], 2016.08
M.S. in Mechanical Engineering	Texas A&M University - College Station, USA	GPA[4.0/4.0], 2015.05
B.S. in Mechanical Engineering	University of Science&Technology of China - China	GPA[3.5/4.0], 2010.07

Awards

• Graduate Conference Fund Award 2015 • Best Paper Award Finalist of ICCPS 2014 • Excellent Tutor Award at Academy Success Center 2011–2014 • Graduate Student Scholarship of TAMU 2010 • Outstanding Graduate of USTC 2010 • Outstanding Student Scholarship of USTC 2007–2009

Research Experience

3D Compliant Low-Limb Prosthesis Modeling and Control for AMPRO3

Project Leader: complaint lower-limb prosthesis modeling and control, embedded system developing 2015.6–current

- Co-designed the 3D transfemoral prosthetic device: AMPRO3 coupled with series elastic actuators (SEA) and complaint parts;
- Modeled the compliant 3D prosthetic locomotion for control design and gait generation using Matlab and Mathematica;
- Designed nonlinear controllers for series elastic actuators using Matlab;
- Developed embedded control system in Beagle Bone Board for the 3D prosthesis using C/C++ and ROS;
- Implemented nonlinear controllers in real-time on the prosthetic device AMPRO3 experimentally.

Robotic Inspired Prosthetic Device Design and Control for AMPRO1&2

Project Leader: prostheses design, modeling, optimization and control, embedded system developing 2013.6–2015.6

- Co-designed and built the 2D transfemoral prosthetic device: AMPRO1 and AMPRO2 using SolidWorks and Eagle;
- Modeled the prosthetic walking as a hybrid bipedal system for control design using Matlab and Mathematica;
- Developed embedded control system in Beagle Bone Board using C/C++ and ROS;
- Achieved stable walking and stair climbing on prostheses AMPRO1 & 2 with both an unimpaired subject and an amputee;
- Realized natural and smooth prosthetic motion transitions using Machine Learning.

Endurance Competition with DURUS at DRC Finals 2015

Simulation Expert: 3D humanoid robot modeling, nonlinear optimization *2015.6.5–2015.6.6*

- Designed controller to achieve both 2D and 3D multi-contact locomotion on DURUS using Matlab and Mathematica;
- Realized dynamical 2D multi-contact locomotion on the physical robot DURUS using Matlab and C++.

Human-Inspired Multi-Contact Locomotion with AMBER2

Project Leader: dynamical system modeling, control design and implementation *2013.5–2014.2*

- Modeled the 2D multi-contact locomotion as a hybrid system using Matlab and Mathematica;
- Designed the controller to achieve multi-contact feature of human locomotion on bipedal walking robot;
- Proposed a theory to prove the stability of the generated multi-contact controller;
- Realized the multi-contact walking on the physical bipedal robot AMBER2 experimentally using LabView and C++.

Motion Primitives Studies from Human Locomotion Experiments

Project Leader: data processing, dynamical system modeling, nonlinear control design *2011.8–2013.5*

- Processed human locomotion data and extracted outputs that characterize human locomotion;
- Modeled robots and designed controllers for achieving different motion primitives: walking, stair climbing and running;
- Designed motion transition controllers for achieving transitions between these motion primitives.

Teaching Experience

Teaching Practicum Assistant for Robotics 6407 (GaTech) **2016.1-2016.5**
• *Coordinated and delivered graduate lectures with professor • Evaluated homeworks and exams*

Academia Tutor for Calculus 101 & 102 (TAMU) **2011-2014**
• *Prepared and deliverd Q&A sessions • Tutored students with homeworks one-on-one*

Teaching Assistant for MEEN 363 & 364 (TAMU) **2010.9-2011.5**
• *Prepared and delivered lectures and tutorials • Graded and assigned projects and exams*

Professional Experience

Journal Reviewer: Journal of Mechatronics, Journal of Intelligent and Robotic System
Conference Reviewer: ACC, ICRA, IROS, HSCC, CDC
Conference Presentation: ACC, ICRA, IROS, CDC, ICCPS, ICORR, DSC
Conference Live-Demonstration: Dynamic walking on Durus at the DRC Finals 2015; Demo on DSC Conference 2014; Demo on NASA dual conference keynote lunch speak 2014; Demo on National Instrument Week 2011

Publications

Thesis

Huihua Zhao. "From Bipedal Locomotion to Prosthetic Walking: A Hybrid System and Nonlinear Control Approach". Ph.D. dissertation, in progress, Georgia Institute of Technology, 2016

Huihua Zhao. "Human-Inspired Motion Primitives and Transitions for Bipedal Robotic Locomotion in Diverse Terrain". Master thesis, Texas A& M University, 2015

Journal Papers

H. Zhao, A. Hereid, W. Ma, and A. D. Ames. "Multi-contact bipedal robotic locomotion". Robotica, 1-35, 2015

H. Zhao, J. Horn, J. Reher, V. Paredes, and A. D. Ames. "First steps toward trans- lating robotic walking to prostheses: a nonlinear optimization based control approach". Autonomous: Special Issue on Assistive and Rehabilitation Robotics, Conditionally accepted 2015

H. Zhao, J. Horn, J. Reher, V. Paredes, and A. D. Ames. "Multi-contact locomotion on transfemoral prostheses via hybrid system models and optimization-based control". Automation Science and Engineering, IEEE Transactions on, Conditionally accepted 2015

H. Zhao, M. Powell, and A. D. Ames. "Human-inspired motion primitives and transitions for bipedal robotic locomotion in diverse terrain". Optimal Control Applications and Methods, 35:730–755, 2013

Selected Conference Papers

H. Zhao, J. Reher, J. Horn, V. Paredes, and A. D. Ames. "Realization of stair ascent and motion transitions on prostheses utilizing optimization-based control and intent recognition". In Rehabilitation Robotics (ICORR), IEEE International Conference on, 2015

H. Zhao and A. D Ames. "Quadratic program based control of fully-actuated transfemoral prosthesis for flat-ground and up-slope locomotion". In IEEE, American Control Conference, 2014. **Best Session Paper Award of ACC**

H. Zhao, S. Kolathaya, and A. D. Ames. "Quadratic programming and impedance control for transfemoral prosthesis". In Robotics and Automation, International Conference on, 2014

H. Zhao, W. Ma, M. B. Zeagler, and A. D. Ames. "Human-inspired multi-contact locomotion with amber2". In Cyber Physics System, ACM/IEEE, International Conference on, 2014. **Best Paper Award Finalist of ICCPS**

N. Aghasadeghi, **H. Zhao**, L. J. Hargrove, A. D. Ames, E. J. Perreault, and T. Bretl. "Learning impedance controller parameters for lower-limb prostheses". In Intelligent Robots and Systems, International Conference on, 2013

H. Zhao, S. Kolathaya, and A. D. Ames. "Bipedal robotic running with partial hybrid zero dynamics and human-inspired optimization". In Intelligent Robots and Systems, International Conference on, 2012

S. Jiang, S. Partrick, **H. Zhao**, and A. D. Ames. "Outputs of human walking for bipedal robotic controller design". In IEEE, 2012 American Control Conference, 2012