Huihua Zhao | Resume

Mechanical Engineering | Georgia Institute of Technology
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Qualifications

• Nonlinear trajectory optimization • Adaptive control for autonomous systems • Dynamical modeling of 2D and 3D robots • Nonlinear control design of robotic systems • Embedded system software development using MATLAB (7 years), C++ (4 years) and ROS (2 years) • PCB design with Eagle • Rich hardware implementation experiences with 8 robots • Skilled scientific writer with $10+$ peer-reviewed publications • Conference presentation experience and excellent commutation skills • Leadership experience in multiple projects

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 Travel Award 2015 • 2014 ICCPS Best Paper Award Finalist • 2014 ACC Best Session Paper Award • 2011–2014 Academy Success Center Excellent Tutor Award • 2010 TAMU Graduate Student Scholarship • 2010 USTC Outstanding Graduate • 2007–2009 USTC Outstanding Student Scholarship

Skills

Proficient with: MATLAB, Mathematica, C/C++, Git, Linux, LaTeX
Experienced in: ROS, SolidWorks, Eagle, Python
Basic knowledge of: AutoCAD, LabView, Perl
Expertise: Dynamic system modeling, nonlinear control and optimization, control Lyapunov functions, machine learning, embedded system development, implementation experience with CANOpen, motor control and sensors

Research Experience

1) **Translating Robotic Locomotion to Prostheses Walking (AMBER 1&2 and AMPRO 1, 2&3)**.
Project Leader: dynamical system modeling, optimization and control, hardware implementation *2013.5–current*
Skills learned: Embedded system programming with C/C++ and ROS; 2D and 3D robot modeling with Mathematica and Matlab; Nonlinear optimization and control for robotic systems; Machine Learning for intention detection; PCB board design using Eagle; CANOpen implementation; Hardware experience with robots AMBER 1&2, AMPRO 1, 2 & 3.

- Formulated a theory to formally guarantee stability of a multi-domain optimization problems for achieving stable human-like multi-contact (with heel/toe lift and contact behaviors) robotic walking;
- Realized human-like multi-contact robotic locomotion experimentally on AMBER2, which was featured on Canada Discovery Channel and multiple news sites (Engadget, Gizmag);
- Reduced parameter hand-tuning time significantly for prosthetic control (from 4 hours to 10 minutes) by designing a novel, decentralized nonlinear optimization-based prosthetic controller;
- Verified prosthetic controllers on a physical robot AMBER1 to prove out the controllers prior to human testing;
- Co-designed and built three compact self-contained powered transfemoral prosthetic devices: AMPRO1, 2, & 3;
- Decreased energy requirement ($5W$/step) and improved tracking performance (10%) by implementing nonlinear controllers which achieve stable human-like multi-contact prosthetic walking on the prostheses (with both healthy subject and amputee);
- Implemented neural network machine learning technique to achieve automatic and natural prosthetic motion transitions;
- Enhanced the prosthetic gait design method by considering a compliant, asymmetric 3D amputee-prosthesis model, which is solved via a 2-Step direct collocation optimization using IPOPT.

2) **Endurance Competition with DURUS at the DARPA Robot Challenge Finals 2015**.....
Simulation Expert: 3D humanoid robot modeling, nonlinear optimization *2015.5–2015.6*
Skills learned: 3D robotic dynamical modeling using Mathematica and MATLAB; Nonlinear trajectory optimization using IPOPT; hardware implementation with the robot DURUS.

- Realized energy efficient, human-like multi-contact gaits on the humanoid robot DURUS;
- Contributed to the SRI-AMBER team in winning the endurance test at the DRC final.

3) **Motion Primitives Studies from Human Locomotion Experiments**

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

Skills learned: Processing motion capture data with MATLAB; Modeling bipedal robots using Mathematica; Nonlinear trajectory optimization and control design for various motion types using MATLAB;

- Implemented and automated a novel algorithm to process camera-captured human locomotion data with improved efficiency;
- Achieved formally stable (with theoretical proofs) human-like robotic locomotion for various motion types: standing, walking, stair ascending, descending and running;
- Realized motion-transitions between various motion types using novel optimization problems.

Professional Experience

Journal Reviewer: Mechatronics, Journal of Intelligent and Robotic System, Journal of Control, Automation and Systems, Journal of Optics and Precision Engineering
Conference Reviewer: ACC, ICRA, IROS, HSCC, CDC
Conference Presentations: ACC, ICRA, IROS, CDC, ICCPS, ICORR, DSC
Conference Live-Demonstrations: Dynamic walking on DURUS at the DRC Finals 2015; Demo on HSCC conference 2015; Demo on NASA dual conference keynote lunch speech 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's 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 translating robotic walking to prostheses: a nonlinear optimization based control approach". Autonomous: Special Issue on Assistive and Rehabilitation Robotics, in press, 2016

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, in press, 2016

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