Huihua Zhao | Curriculum Vitae

Mechanical Engineering | Georgia Institute of Technology
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Qualifications

• Trajectory design and optimization • Adaptive control for autonomous systems • Dynamical modeling and analysis of robotic systems • Embedded system software development using MATLAB (7 years), C++ (4 years) and ROS (2 years) • Machine learning for intention recognition • Rich robotic system integration and hardware implementation experiences (sensing, motion control, PCB design and mechatronic system design) with 8 robots

Education

Ph.D. in Mechanical Engineering (Robotics)	Georgia Institute of Technology (GaTech), USA	exp 2016.08
M.S. in Mechanical Engineering (Robotics)	Texas A & M University (TAMU), USA	2015.03
B.S. in Mechanical Engineering (Automation)	Univ. of Sci. & Tech. of China (USTC), China	2010.07

Skills

Proficient with: C/C++, Matlab, Linux, Mathematica, Git, LaTeX
Experienced in: ROS, LabView, Python, Machine learning, IPOPT, CANOpen, IMUs, SolidWorks, Eagle

Experience

1) **Research Assistant: 3D Powered Prosthetic Walking Implementation (GaTech)**...2016.2–current

Skills: C++, ROS, Matlab, Eagle, Linux; 3D asymmetric humanoid robot modeling; Trajectory optimization using IPOPT; System integration including motion control and sensing.

- 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.
- Co-designed a 3D prosthetic device AMPRO 3 with complaint joints for better comfortability and energy consumption;
- Achieved stable compliant prosthetic walking outdoors, featured in PBS.

2) **Research Assistant: Translating Robotic Locomotion to Prostheses Walking (TAMU & GaTech)**

Ph.D. Thesis: From Bipedal Locomotion to Prosthetic Walking: A Hybrid System and Nonlinear Control Approach...2014.5–2015.6

Skills: C++, ROS, Python, Matlab, Eagle, CANOpen, IMUs, ELMO, Linux; Embedded system programming; Humanoid Robots modeling and analysis; Trajectory optimization and motion control; PCB design; System integration.

- 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;
- Co-designed and built two self-contained powered transfemoral prosthetic devices: AMPRO1 & 2;
- Decreased energy requirement ($5W$/step) and improved tracking performance (10%) by implementing nonlinear controllers.

3) **Control Engineer: Endurance Competition at DRC Finals 2015 (GaTech)**.....2015.5–2015.6

Skills: Matlab, C++, IPOPT, IMUs; 3D humanoid robot modeling; Nonlinear trajectory optimization; Hardware implementation

- Realized energy efficient (10 times better than ASIMO), human-like multi-contact gaits on the humanoid robot DURUS;
- Contributed to the SRI-AMBER team with winning the endurance test at the DRC final.

4) **Research Assistant: Intent Recognition with Machine Learning (TAMU)**.....2015.3–2015.5

Skills: C++, ROS, Matlab; Machine learning; Hardware Implementation.

- Collected various type of human locomotion data using IMUs for neural network model training;
- Implemented neural network machine learning technique to achieve automatic and natural prosthetic motion transitions.

5) **Research Assistant: Human-Inspired Multi-Contact Locomotion (TAMU)**.....2013.5–2014.2

Skills: LabView, Matlab, FPGA; Embedded system programming; Nonlinear control and optimization; Hardware implementation

- Formulated a theory to formally prove stability of a multi-domain optimization for achieving multi-contact robotic walking;
- Realized human-like multi-contact robotic locomotion on AMBER2, featured on Discovery Channel, Gizmag and Engadget.

6) **Research Assistant: Robotic Motion Primitives Design and Control (TAMU)**.....2011.8–2013.5

Skills: Matlab, Mathematical; Processing motion capture data; Modeling bipedal robots; Nonlinear trajectory optimization and control design for various motion types.

- Implemented and automated a novel algorithm to process camera-captured human locomotion data with improved efficiency;
- Achieved formally stable human-like robotic locomotion for various motion types: standing, walking, stair climbing and running.

7) **System Engineer: Model-Based Design and Optimization of a Prosthesis (TAMU)**..2012.2–2012.5

Skills: Matlab, SolidWorks, Mathematica, Genetic Algorithm; Multi-process integration; Optimization in the loop design

- Proposed a model-based optimization method to optimally design a powered prosthesis using Genetic Algorithm;
- Developed a software package to integrate Matlab, Mathematica and SolidWorks for optimization in the loop design.

8) **Research Assistant: Piezoelectric Scanning Mirror Design (USTC)**.....2009.5–2010.6

Skills: LabView, Matlab; Design Piezoelectric Scanners; Hardware design

- Designed a high-order modal piezoelectric scanners for large angle high frequency scan (*Undergraduate Thesis*);
- Improved the scanning range by 13% to 55°.

9) **Software Engineer: Professional Video Instrument Software Design (USTC)**.....2008.10–2009.6

Skills: C++, VC, MFC, Cadence; Hardware testing

- Developed the functions of frequency sweep analysis, peak-to-peak value analysis and total harmonic distortion analysis;
- Realized the functionality of LCD display using C++.

Teaching Experience

Guest Lecturer for Robotics 6407 (GaTech) **2016.1-2016.5**

- *Coordinated and delivered graduate lectures with professor*
- Set and evaluated homeworks and exams

CETL's Faculty Development Workshop (GaTech) **2015.11-2015.11**

- *Participated discussion forums with faculty colleagues to learn teaching skills*
- Understood teaching challenges and learned practical teaching techniques

Academia Tutor for Calculus 101 & 102 (TAMU) **2011.1-2015.5**

- *Prepared and delivered Q&A sessions*
- Tutored students with homeworks one-to-one

Teaching Assistant for MEEN 363 & 364 (TAMU) **2010.9-2011.5**

- *Prepared and delivered undergraduate lectures and tutorials*
- Graded and evaluated homeworks, design projects and exams

Relevant Courses

MEEN651: Control System Design
MEEN655: Design of Nonlinear Control System
MEEN612: Mechanical of Robot Manipulation
MEEN689: Special Topic in Model-Based Design
ECEN609: Adaptive Control
ECEN605: Optimal Control
MEEN652: Multi Control System Design
MATH666: Geometric Control

Professional Experience

Journal Reviewer: Mechatronics, Journal of Intelligent and Robotic System, Journal of Control, Automation and Systems, Journal of Optics and Precision Engineering, IEEE Transactions on Robotics
Conference Reviewer: ACC, ICRA, IROS, HSCC, CDC, MMAR, MSC
Conference Presentations: ACC, ICRA, IROS, CDC, ICCPS, ICORR, DSC
Conference Live-Demonstrations: 5th Anniversary Robotics Caucus Meeting of NRI, DC 2016; Dynamic walking on Durus at the DRC Finals 2015; Demo on DSC Conference 2014; Demo on National Instrument Week 2011

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

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

Posters

H. Zhao, J. Reher, J. Horn, V. Paredes, and A. D. Ames. "Demonstration of locomotion with the powered

prosthesis AMPRO utilizing online optimization-based control". 18th International Conference on Hybrid Systems: Computation and Control, Seattle, 2015

J. Horn, J. Reher, **H. Zhao**, V. Paredes, and A. D. Ames. "Translating Robotic Locomotion to Powered Transfemoral Prosthesis". ASME 2014 Dynamic Systems and Control (DSC) Conference, San Antonio, 2014

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, 1-18, 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, 502-513, 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

Conference Papers

H. Zhao, A. Hereid, E. Ambrose and A. Ames "3D Multi-Contact Gait Design for Prostheses: Hybrid System Models, Virtual Constraints and Two-Step Direct Collocation". In Intelligent Robots and Systems, IEEE International Conference on, 2016

V. Paredes , W. Hong, S. Patrick, **H. Zhao**, A. Ames and P. Hur. "Upslope Walking with Transfemoral Prosthesis using Optimization based Spline Generation". In Decision and Control (CDC), IEEE International Conference on, 2016

H. Zhao, J. Horn, J. Reher, V. Paredes, and A. D. Ames. "A hybrid systems and optimization-based control approach to realizing multi-contact locomotion on transfemoral prostheses". In Decision and Control (CDC), IEEE International Conference on, 2015

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, J. Reher, J. Horn, V. Paredes, and A. D. Ames. "Realization of nonlinear real-time optimization based controllers on self-contained transfemoral prosthesis". In Cyber Physics System, 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**

Wen-Loong Ma, **H. Zhao**, Shishir Kolathaya, and A. D. Ames. "Human-inspired walking via unified pd and impedance control". In International Conference on Robotic and Automation. IEEE, 2014

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, IEEE, 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

Matthew J Powell, **H. Zhao**, and A. D Ames. "Motion primitives for human-inspired bipedal robotic locomotion: walking and stair climbing". In Robotics and Automation, IEEE 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

R. W. Sinnet, **H. Zhao**, and A. D. Ames. "Simulating prosthetic devices with human- inspired hybrid control". In Intelligent Robots and Systems, International Conference on. IEEE, 2011