# Huihua Zhao | Resume

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 • Motion control of robotic systems • Embedded system software development using MATLAB (7 years), C++ (4 years) and ROS (2 years) • Machine learning for intention recognition • PCB design with Eagle • Rich robotic hardware implementation experiences (including sensing, motor control and mechatronic system integration) with 8 robots • Skilled scientific writer with 18 peer-reviewed publications • Conference presentation experience and excellent communication skills • Leadership experience in multiple projects

## Education

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|---|---|---|
| **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**: C/C++, MATLAB, Linux, Mathematica, Git, LaTeX
**Experienced in**: ROS, Python, Machine learning, IPOPT, CANOpen, IMUs, SolidWorks, Eagle
**Basic knowledge of**: AutoCAD, LabView, Perl

## Research Experience

### 1) 3-Dimensional Prosthetic Walking Design and Implementation with AMPRO 3

*Project Leader: 3D humanoid robot modeling, trajectory optimization, motion control and sensing* *2016.2–current*

**Skills learned:** 3D asymmetric humanoid robot modeling; Trajectory optimization using IPOPT; hardware implementation 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 with complaint ankle roll degree for better comfortability and energy consumption;
- Achieved stable compliant prosthetic walking outdoors, featured in PBS.

### 2) Translating Robotic Locomotion to Prostheses Walking (AMBER 1&2 and AMPRO 1&2)

*Project Leader: dynamical system modeling, optimization and control, hardware implementation* *2014.5–2015.6*

**Skills learned:** Embedded system programming with C++ and ROS; Robotic modeling and analysis; Trajectory optimization and motion control; PCB board design; CANOpen implementation; Hardware experience.

- 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 three compact self-contained powered transfemoral prosthetic devices: AMPRO1&2;
- 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);

### 3) Endurance Competition with DURUS at DARPA Robot Challenge Finals 2015

*Simulation Expert: 3D humanoid robot modeling, motion control and optimization* *2015.6.5–2015.6.6*

**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.

### 4) Automatic Intent Recognition for Prosthetic Walking with Machine Learning

*Project Leader: data collection with IMUs, neural network implementation* *2015.3–2015.5*

**Skills learned:** machine learning, SVM, neural network.

- 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) **Human-Inspired Multi-Contact Locomotion with AMBER2**

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

**Skills learned:** Embedded system programming with LabView; Trajectory optimization; Hardware implementation

- 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);

## 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

**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". Submitted to Decision and Control (CDC), 2016

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

**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), 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 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