# Huihua Zhao | Resume

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## Objective

Seeking for a full-time R&D position on Control, Optimization and System Integration for Robotic Systems

## 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 hands-on implementation experiences (sensing, motion control, PCB design and mechatronic system design) with 8 robots

## Education

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| **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++, Matlab, Linux, Mathematica, Git, LaTeX
**Experienced in**: ROS, Python, LabView, IPOPT, CANOpen, Kalman filter, IMUs, SolidWorks, Eagle

## Research 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 in DC, featured in Public Broadcasting Service.

### 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.

- Co-designed and built two generations of a self-contained powered transfemoral prosthetic devices: AMPRO1 & 2. My responsibilities included two major parts: a) software part, which covers modeling, simulation, optimization and control design and b) hardware part, which consists of electric parts selection, sensor fusion, PCB design and embedded software development;
- 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;
- 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; 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.

- Took two machine learning courses: Learning From Data (MOOC, CalTech) and Machine Learning (CS, TAMU);
- 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) **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++.

## 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

## Peer-Reviewed Publications

1. **H. Zhao**, A. Hereid, W. Ma, and A. D. Ames. "Multi-contact bipedal robotic locomotion". Robotica, 1-35, 2015
2. **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, 1-18, 2016
3. **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
4. **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
5. **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
6. V. Paredes , W. Hong, S. Patrick, **H. Zhao**, A. Ames and P. Hur. "Upslope Walking with Transfemoral Prosthesis using Optimization based Spline Generation". To appear in IROS, 2016
7. **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), 2015
8. **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
9. **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 HSCC, Seattle, 2015
10. **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
11. **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**
12. **H. Zhao**, S. Kolathaya, and A. D. Ames. "Quadratic programming and impedance control for transfemoral prosthesis". In Robotics and Automation, International Conference on, 2014
13. **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**
14. 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
15. 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
16. 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
17. **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
18. 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
19. 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
20. 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