

# ALEJANDRO F. AZOCAR

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*I am an engineer and scientist experienced in cross-functional projects spanning mechanical, electrical, and software, with a background in the biomedical and aerospace industries. Currently, I work on bionic exoskeletons and prostheses.*

## SKILLS

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Robotics, Mechatronics, System Integration, Controls, Mechanical/Electrical Design, Prototyping, Optimization, Modeling/Simulation, Biomechanics, Human-machine Interaction, Human-subjects Testing, MATLAB, Python, C/C++, Technical Communication

## EDUCATION

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**University of Michigan**, Ann Arbor, MI

Ph.D. in Mechanical Engineering • GPA: 3.97

September 2020

Thesis: Perception, Design, and Control of Impedance-based Lower-limb Robots

Advisor: Elliott J. Rouse

**Northwestern University**, Evanston, IL

M.S. in Biomedical Engineering • GPA: 3.97

September 2017

Thesis: Stiffness Perception During Active Ankle and Knee Movement

Advisors: Elliott J. Rouse, Todd A. Kuiken

**Texas A&M University**, College Station, TX

B.S. in Aerospace Engineering • GPA: 4.00

May 2015

Thesis: Evaluation of the OpenBCI Neural Interface for Controlling a Quadrotor Simulation

Advisor: Aaron D. Ames

## RESEARCH EXPERIENCE

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**Neurobionics Lab**, University of Michigan/Northwestern University/Shirley Ryan AbilityLab

*Graduate Research Assistant*

September 2015 - Present

- Designed a high-performance, low-cost, open-source robotic knee/ankle prosthesis
- Performed selection, system identification, and characterization of mechatronic systems (motors, transmissions, sensors, *etc.*)
- Created and conducted psychophysical experiments to investigate human-robot interaction
- Developed new tools to improve the prosthesis prescription process using patients' preferences
- Collected and analyzed biological signals: joint kinematics and kinetics, electromyography, and metabolic cost
- Collaborated within a multidisciplinary team of researchers, engineers, clinicians, and therapists

**A&M Bipedal Experimental Robotics (AMBER) Lab**, Texas A&M University

*Undergraduate Research Assistant*

August 2014 - April 2015

- Developed a quadrotor simulation that can be flown using electromyographic (EMG) signals
- Designed Python algorithms to process EMG signals and detect eye wink events in real-time using the OpenBCI neural interface
- Developed a physically accurate, open-loop quadrotor simulation in MATLAB to study the dynamics of quadrotor flight
- Integrated OpenBCI with the quadrotor simulation, enabling control of the quadrotor's altitude using left and right eye winks

**Vehicle Systems and Control Lab (VSCL)**, Texas A&M University

*Undergraduate Research Assistant*

August 2012 - December 2013

- Developed a six-degree-of-freedom, nonlinear aircraft simulation for controls, handling qualities, and human factors research
- Verified simulation accuracy using flight data for the Northrop F-5A Freedom Fighter

**Land, Air, and Space Robotics (LASR) Lab**, Texas A&M University

*Undergraduate Research Assistant*

October 2010 - May 2011

- Analyzed previously developed MATLAB simulations on multivehicle spacing along smooth curvilinear paths
- Implemented vehicle spacing control laws and smoothing algorithms on iRobot Create robots

## PROFESSIONAL EXPERIENCE

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**(Google) X**, Mountain View, CA

*Robotics Resident: Early Stage Project*

May 2019 - Present

- Research and development for an early-stage project focused on mobility assistance
- In first 3 months, led and developed the robotics and biomechanics efforts to graduate the project to X's second phase of funding
- Prototyping, rapidly iterating, deploying, and testing mechanical/electrical/software ideas to de-risk our technology
- Providing technical expertise and assisting in strategic decision-making

**NASA- Johnson Space Center**, Houston, TX

- Co-op: Human Systems Engineering* May 2015 - August 2015
- Oversaw development of electrical improvements for a tissue equivalent proportional counter
  - Tested a new radiation detector before launch to the International Space Station
- Co-op: Flight Mechanics and Trajectory Design* May 2014 - August 2014
- Developed a rocket ascent simulation for the Space Launch System and Commercial Crew Program
  - Simulated the UP Aerospace sounding rocket launch to predict flight test behavior
- Co-op: Robotic Systems Technology* January 2014 - May 2014
- Developed a soft robot medical probe (5 mm in diameter) for minimally invasive fetal surgeries
  - Assisted with Robonaut hardware assembly, troubleshooting, and replacement
- Co-op: Applied Aeroscience and Computational Fluid Dynamics (CFD)* May 2013 - August 2013
- Updated the Orion aerodynamic and aerothermal databases using Direct Simulation Monte Carlo and free molecular simulations
  - Modeled the plume flow field environment for the Japanese HTV using Computational Fluid Dynamics
- Co-op: Flight Mechanics and Trajectory Design* May 2012 - August 2012
- Built and tested the capsule release and parachute deployment systems for a high-altitude capsule drop test
  - Developed a physics model for the ascent of weather balloons up to 100,000 ft and optimize the landing footprint of the capsule
- Co-op: Mission Operations Directorate, Expedition Vehicle Division* January 2012 - May 2012
- Completed the first phase of Flight Controller training for the International Space Station (ISS) Electrical/Thermal Systems
  - Updated software tools for the ISS power systems model and create command scripts for ISS battery capacity tests
- United Launch Alliance (ULA)**, Decatur, AL
- Intern: Atlas V Integration, Assembly and Checkout (IACO)* June 2011 - August 2011
- Evaluated Atlas V test equipment to ensure hardware meets reliability and safety standards
  - Revised and updated test procedures and create a database for equipment tracking

**TEACHING EXPERIENCE****Department of Mechanical Engineering**, University of Michigan

- Graduate Student Instructor* January 2019 - May 2019
- Co-developed a new graduate-level class: Locomotor Mechanics and Design/Control of Wearable Robotic Systems (ME/BME 646)
  - Taught a guest lecture on sensors and series elastic actuators for wearable robots
  - Selected class topics, weekly readings, and create in-class robot demonstrations
  - Developed homework/exam questions and case studies to reinforce lecture/literature content by considering real-world scenarios
  - *Course Description:* The primary objective of this course is to learn how to analyze, understand, and model human locomotion, as well as develop bio-inspired assistive technologies and assess their impact. We will learn about the human machine—the sensing, acting, and reasoning components of the human neuromusculoskeletal systems, as well as how to replicate this functionality with traditional approaches from robotics, including modeling, machine design, mechatronics, and control.

**HONORS AND AWARDS**

- 2019 **Rackham Predoctoral Fellowship**, University of Michigan: for “students working on dissertations that are unusually creative, ambitious and impactful.”
- 2018 **Finalist**, BioRob Best Hardware Demo
- 2018 **Finalist**, BioRob Student Paper Competition (2 papers)
- 2018 **2<sup>nd</sup> Place**, EMBC Student Paper Competition
- 2018 **Inclusion@RSS**, Robotics: Science and Systems
- 2018 **Awardee**, De Luca Foundation Student Travel Award
- 2018 **Finalist**, National Defense Science and Engineering Graduate (NDSEG) Fellowship
- 2018 **Semifinalist**, Hertz Foundation Fellowship
- 2018 **Honorable Mention**, Ford Foundation Fellowship
- 2017 **Diversity Travel Award**, American Society of Biomechanics (ASB)
- 2016 **Becas Univision Scholarship**
- 2016 **Hispanic Scholarship Fund Scholarship**
- 2015 **NSF Graduate Research Fellowship**
- 2015 **GEM Associate Fellowship**
- 2015 **Ammon S. Andes National Award**, Sigma Gamma Tau: recognized as the top aerospace engineering senior in the United States. Based on academic, service, and extracurricular accomplishments.
- 2015 **1<sup>st</sup> Place**, AIAA Region IV Student Paper Conference

- 2015 **Larry Anderson Outstanding Senior Award**, Texas A&M University Aerospace Engineering: for “exuberance for aerospace engineering, demonstrated leadership within the Department, and service to the Department and its students.”
- 2014 **Outstanding Co-op Award**, NASA Johnson Space Center
- 2013 **NASA Aeronautics Scholarship**
- 2013 **1<sup>st</sup> Place**, AIAA Region IV Student Paper Conference
- 2012 **Outstanding Co-op Award**, NASA Johnson Space Center
- 2012 **Columbia Crew Memorial Scholar**, Texas Space Grant Consortium
- 2011 **HENAAC Scholarship**, Great Minds in STEM
- 2011 **1<sup>st</sup> Place, Aerospace Engineering Poster Session**, Texas A&M Student Research Week
- 2011 **1<sup>st</sup> Place, Aerospace Engineering Overall Subject Area**, Texas A&M Student Research Week

## JOURNAL ARTICLES

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- [J4] **A F Azocar**, L M Mooney, J F Duval, A M Simon, L J Hargrove, and E J Rouse, “Design, Control, and Clinical Implementation of an Open Source Bionic Leg,” *Nature Biomedical Engineering*, accepted, in press.
- [J3] **A F Azocar**, A L Shorter, and E J Rouse, “Damping Perception During Active Ankle and Knee Movement,” *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 2019.
- [J2] M K Shepherd, **A F Azocar**, M J Major, and E J Rouse, “Amputee Perception of Prosthetic Ankle Stiffness During Locomotion,” *Journal of NeuroEngineering and Rehabilitation*, 2018.
- [J1] **A F Azocar** and E J Rouse, “Stiffness Perception During Active Ankle and Knee Movement,” *IEEE Transactions on Biomedical Engineering*, 2017.

## CONFERENCE PAPERS

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- [C5] **A F Azocar**, L M Mooney, L J Hargrove, and E J Rouse, “Design and Characterization of an Open-source Robotic Leg Prosthesis,” *Proceedings of the IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechanics (BioRob)*, August 2018. Finalist, Best Hardware Demo Finalist, Student Paper Competition
- [C4] M K Shepherd, **A F Azocar**, M J Major, and E J Rouse, “The Difference Threshold of Ankle-Foot Prosthesis Stiffness for Persons with Transtibial Amputation,” *Proceedings of the IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechanics (BioRob)*, August 2018. Finalist, Student Paper Competition
- [C3] **A F Azocar**, A L Shorter, and E J Rouse, “Perception of Mechanical Impedance During Active Ankle and Knee Movement,” *Proceedings of the IEEE International Conference on Engineering in Medicine and Biology (EMBC)*, July 2018. 2<sup>nd</sup> Place, Student Paper Competition
- [C2] **A F Azocar**, “Preliminary Evaluation of an Electromyographically Controlled Quadrotor,” *Proceedings of the AIAA Science and Technology (SciTech) Forum and Exposition 2016: 54th Aerospace Sciences Meeting*, January 2016. Finalist, Student Paper Competition
- [C1] **A F Azocar** and J Valasek, “High Fidelity Simulation of a Nonlinear Aircraft,” *Proceedings of the AIAA Science and Technology (SciTech) Forum and Exposition 2014: 52nd Aerospace Sciences Meeting*, January 2014. Finalist, Student Paper Competition

## ABSTRACTS & POSTERS

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- [A17] **A F Azocar**, L M Mooney, J F Duval, A M Simon, L J Hargrove, and E J Rouse, “An Open Source Robotic Leg Prosthesis: Design and Locomotion,” *World Congress of the International Society for Prosthetics and Orthotics (ISPO)*, October 2019.
- [A16] **A F Azocar**, J K Leestma, P Kudzia, M Lazzaroni, Y Liu, C Bayón, W F Rampeltshammer, and E van Asseldonk, “Passive Knee Exoskeleton Reduces Quadriceps Muscle Activation During Downhill Skiing: A Pilot Study,” *IEEE International Conference on Engineering in Medicine and Biology (EMBC)*, July 2019.
- [A15] **A F Azocar**, L M Mooney, J F Duval, A M Simon, L J Hargrove, and E J Rouse, “Lowering the Barrier to Entry with an Open Source Robotic Leg Prosthesis,” *International Society for Prosthetics and Orthotics (ISPO) Canada*, June 2019.
- [A14] **A F Azocar** and E J Rouse, “Characterizing Open-loop Impedance Control in a Powered Ankle Prosthesis,” *Dynamic Walking Conference*, June 2019.
- [A13] **A F Azocar**, U H Lee, L M Mooney, L J Hargrove, and E J Rouse, “The Open Source Leg: Steps Toward Real-world Deployment of Bionics,” *IEEE International Conference on Robotics and Automation (ICRA). Workshop: Towards Real-World Deployment of Legged Robots*, May 2019. 1<sup>st</sup> Place, Poster Competition

- [A12] **A F Azocar** and E J Rouse, “The Open-source Leg: A Robotic Prosthesis for Controls Research,” *Dynamic Walking Conference*, May 2018.
- [A11] **A F Azocar** and E J Rouse, “Stiffness Perception at the Human Ankle and Knee,” *41st Annual Meeting of the American Society of Biomechanics (ASB)*, August 2017.
- [A10] **A F Azocar** and E J Rouse, “An Open-source Robotic Leg Prosthesis,” *RehabWeek: IEEE International Conference on Rehabilitation Robotics (ICORR). Workshop: Towards a next generation of wearable robotic devices for human-oriented assistance and therapy*, July 2017.
- [A9] **A F Azocar** and E J Rouse, “An Open-source Robotic Ankle Prosthesis,” *Dynamic Walking Conference*, June 2017.
- [A8] **A F Azocar**, T Reissman, and E J Rouse, “Preliminary Psychophysical Analysis of Ankle Interaction Stiffness,” *IEEE International Conference on Engineering in Medicine and Biology (EMBC)*, August 2016.
- [A7] **A F Azocar**, T Reissman, and E J Rouse, “Preliminary Psychophysical Analysis of Ankle Interaction Stiffness,” *The National GEM Consortium Conference*, August 2016.
- [A6] **A F Azocar**, “Preliminary Evaluation of an Electromyographically Controlled Quadrotor,” *AIAA Region IV Student Paper Conference*, April 2015. 1<sup>st</sup> Place, Student Paper Competition
- [A5] **A F Azocar** and A D Ames, “Evaluation of the OpenBCI Neural Interface for Controlling a Simulated Quadrotor,” *Texas A&M Student Research Week*, March 2015.
- [A4] **A F Azocar** and J Valasek, “High Fidelity Simulation of a Nonlinear Aircraft,” *AIAA Region IV Student Paper Conference*, April 2013. 1<sup>st</sup> Place, Student Paper Competition
- [A3] **A F Azocar**, A Siddarth, and J Valasek, “Performance Evaluation of Stabilizing Nonlinear Controllers for Varied Flight Conditions and Maneuvers,” *Texas A&M Student Research Week*, March 2013.
- [A2] **A F Azocar**, L A Weitz, and J E Hurtado, “Formation Control of Autonomous Vehicles,” *Texas A&M Student Research Week*, March 2011. 1<sup>st</sup> Place, Overall Subject Area 1<sup>st</sup> Place, Poster Session
- [A1] **A F Azocar**, L A Weitz, and J E Hurtado, “Formation Control of Autonomous Vehicles,” *Louis Stokes Alliance for Minority Participation (LSAMP) Symposium*, February 2011.

## MENTORSHIP

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2017 - 2019	<b>Michigan Engineering Zone</b> Mentored Detroit high school students for the FIRST Robotics Competition
2017 - 2018	<b>826michigan</b> Mentored and provided academic support to Ann Arbor youth
2017	<b>Jugando con la Ciencia (Playing with Science)</b> , Washington Elementary School Taught science programs in Spanish to Chicago youth
2016 - 2017	<b>Reusable Rocket Design via Spaceplane Research</b> , Downers Grove N High School Mentored the Science and Engineering Club developing prototype rockets
2016	<b>Introduction to Engineering Design</b> , New Trier High School Mentored Chicago high school teams designing devices for amputees and people with paralysis: floor hockey sled, cutting board, locking door, crutches, phone charging station
2014	<b>Solar Car Race</b> , Alexander Middle School Mentored Houston middle school students designing solar powered cars for a school-wide race

## OTHER EDUCATIONAL EXPERIENCES

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2019	Winter School on Wearable Robotics, Kranjska Gora, Slovenia
2017	Dutch-US Summer School for Neurorehabilitation, Delft University of Technology
2016	Dutch-US Summer School for Neurorehabilitation, Northwestern University

## SERVICE, SOCIETIES, AND LEADERSHIP

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### Memberships

2016 - Present	Institute of Electrical and Electronics Engineers (IEEE)
2016 - Present	IEEE Engineering in Medicine and Biology Society (EMBS)
2016 - Present	IEEE Robotics & Automation Society (RAS)
2016 - Present	Latinos in Science and Engineering (MAES)
2010 - 2016	American Institute of Aeronautics and Astronautics (AIAA)
2010 - 2011	Society of Hispanic Professional Engineers (SHPE)
2015 - Present	Tau Beta Pi Honor Society
2014 - Present	Sigma Gamma Tau Honor Society

### Peer Reviewer

2019 - Present	Transactions on Medical Robotics and Bionics (TMRB), IEEE
2018 - Present	Robotics and Automation (ICRA), IEEE
2018 - Present	Biomedical Robotics and Biomechatronics (BioRob), IEEE
2016 - Present	Assistive Technology, Rehabilitation Engineering and Assistive Technology Society of North America (RESNA)

### Leadership Positions

2019	Student Representative, Administrative Committee, IEEE EMBS
2017	Journal Club Chair, Center for Bionic Medicine, Shirley Ryan AbilityLab
2015 - 2016	Department Liaison Chair, Department of Biomedical Engineering, Northwestern University
2013 - 2015	Member, Texas A&M Foundation Maroon Coats, Texas A&M University
2013 - 2015	Vice Chair, AIAA, Texas A&M University
2011 - 2015	University Scholar, Honors and Undergraduate Research, Texas A&M University
2011	Career Fair Director, Student Engineers' Council, Texas A&M University
2010 - 2011	Industry Chair, SHPE, Texas A&M University