ALEJANDRO F. AZOCAR

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I am a roboticist and scientist with experience in the biomedical and aerospace industries. Currently, I work on high-performance prostheses and exoskeletons. I am an NSF Graduate Research Fellow, GEM Associate Fellow, and NASA Aeronautics Scholar.

EDUCATION

University of Michigan, Ann Arbor, MI
Ph.D. in Mechanical Engineering • GPA: 3.97   May 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

Neurobionics Lab, University of Michigan/Northwestern University/Shirley Ryan AbilityLab
Graduate Research Assistant   September 2015 - Present

- Design a high-performance, low-cost, open-source robotic knee/ankle prosthesis
- Develop biologically-inspired control systems and evaluate their effects on amputee gait
- Create and conduct psychophysical experiments to investigate human-robot interaction
- Develop new tools to improve the prosthesis prescription process using patients' preferences
- Collect and analyze biological signals: joint kinematics and kinetics, electromyography, and metabolic cost
- Collaborate 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

- Develop a quadrotor simulation that can be flown using electromyographic (EMG) signals
- Design 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
- Integrate 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

- Develop a six-degree-of-freedom, nonlinear aircraft simulation for controls, handling qualities, and human factors research
- Verify 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

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

TEACHING EXPERIENCE

Department of Mechanical Engineering, University of Michigan
Graduate Student Instructor   January 2019 - Present

- Co-develop a new graduate-level class: Locomotor Mechanics and Design/Control of Wearable Robotic Systems (ME/BME 646)
- Teach a guest lecture on sensors and series elastic actuators for wearable robots
- Select class topics, weekly readings, and create in-class robot demonstrations

- Develop 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.

PROFESSIONAL EXPERIENCE

NASA- Johnson Space Center, Houston, TX

Co-op: Human Systems Engineering   May 2015 - August 2015
- Oversee development of electrical improvements for a tissue equivalent proportional counter
- Test a new radiation detector before launch to the International Space Station

Co-op: Flight Mechanics and Trajectory Design   May 2014 - August 2014
- Develop a rocket ascent simulation for the Space Launch System and Commercial Crew Program
- Simulate the UP Aerospace sounding rocket launch to predict flight test behavior

Co-op: Robotic Systems Technology   January 2014 - May 2014
- Develop a soft robot medical probe (5 mm in diameter) for minimally invasive fetal surgeries
- Assist with Robonaut hardware assembly, troubleshooting, and replacement

Co-op: Applied Aeroscience and Computational Fluid Dynamics (CFD) May 2013 - August 2013
- Update the Orion aerodynamic and aerothermal databases using Direct Simulation Monte Carlo and free molecular simulations
- Model the plume flow field environment for the Japanese HTV using Computational Fluid Dynamics

Co-op: Flight Mechanics and Trajectory Design   May 2012 - August 2012
- Build and test the capsule release and parachute deployment systems for a high-altitude capsule drop test
- Develop 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
- Complete the first phase of Flight Controller training for the International Space Station (ISS) Electrical/Thermal Systems
- Update 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
- Evaluate Atlas V test equipment to ensure hardware meets reliability and safety standards
- Revise and update test procedures and create a database for equipment tracking

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 **2nd 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 **1st 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 **1ˢᵗ 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 **1ˢᵗ Place, Aerospace Engineering Poster Session,** Texas A&M Student Research Week
2011 **1ˢᵗ Place, Aerospace Engineering Overall Subject Area,** Texas A&M Student Research Week

JOURNAL ARTICLES

[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

[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 Biomechatronics (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 Biomechatronics (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. 2ⁿᵈ 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

[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)*, (submitted).

[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)*, (submitted).

[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*, (accepted).

[A14] **A F Azocar** and E J Rouse, "Characterizing Open-loop Impedance Control in a Powered Ankle Prosthesis," *Dynamic Walking Conference*, (accepted).

[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*, (submitted).

[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. | 1st 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. | 1st 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. | 1st Place, Overall Subject Area | | 1st 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.

SKILLS

Robotics, Mechatronics, Mechanical/Electrical Design, Controls, Data Acquisition/Analysis, Modeling/Simulation, Machine Learning, Biomechanics, Human-machine Interaction, Human-subjects Testing, MATLAB, Python, C/C++, Technical Communication

MENTORSHIP

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

OTHER EDUCATIONAL EXPERIENCES

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

Membership

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