

Erik Nicholas Ballesteros

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NASA Space Technology Graduate Research Opportunity (NSTGRO) Fellow

Design, Control, and Human-Robot Interaction of Space Suits Integrated with Supernumerary Robotic Limbs

Academic Advisor: H. Harry Asada

NASA Collaborator: Kalind Carpenter – Jet Propulsion Laboratory

EDUCATION

Doctor of Philosophy, Mechanical Engineering

Massachusetts Institute of Technology

Expected Graduation: Jun 2027

Cumulative GPA: 4.90/5.00

Master of Science, Mechanical Engineering

Massachusetts Institute of Technology

Graduation: May 2023

Cumulative GPA: 4.90/5.00

Bachelor of Science, Aerospace Engineering, Highest Honors

The University of Texas at Austin

Graduation: Dec 2019

Cumulative GPA: 3.99/4.00

TECHNICAL SKILLS

CAD/PLM Software: SolidWorks, PTC Creo (Pro/ENGINEER), Siemens NX, Autodesk Fusion 360, Autodesk Revit, Inventor, Autodesk AutoCAD, OnShape, Teamcenter, Windchill

Programming Languages: C, C++, Python, MATLAB, ROS, ROS2, NI LabVIEW, RTDE, Fortran, SQL

Analysis Toolsets: ANSYS, Nastran, Patran, FalconView, SpaceClaim, Orbital STK

Other Software: Linux, OpenCV, Gazebo, Arduino, Mbed OS, G-Code, REFPROP, MONSID, Office Suite (Excel, Word, etc.)

PATENTS

Asada, H. H., & Ballesteros, E. (2023). *Systems and Methods for Assisting Movement using Robotic Limbs* (Patent No. WO 2023/212212 A2). World Intellectual Property Organization.

RESEARCH PUBLICATIONS

E. Ballesteros, P. Rogers, J. Jenkins, K. Carpenter, and H. H. Asada, "Design of Supernumerary Robotic Limbs for the Augmentation of Astronauts performing Partial-Gravity Extra-Vehicular Activities (EVAs)," *International Journal of Robotics Research (IJRR)*, [In Review], TBD

E. Ballesteros, K. Carpenter, and H. H. Asada, "Supernumerary Robotic Limbs to Augment Astronauts Performing Post-Fall Recoveries During Partial-Gravity Spacewalks," 2025 AIAA SCITECH Forum, January 2025

E. Ballesteros, S. Lee, K. Carpenter, and H. H. Asada, "Supernumerary Robotic Limbs to Support Post-Fall Recoveries for Astronauts," 2024 IEEE Int. Conf. Robot. Autom. (ICRA), [Finalist – Human-Robotic Interaction (HRI)], May 2024

E. Ballesteros, B. Man, and H. Asada, "Supernumerary Robotic Limbs for Next Generation Space Suit Technology," 2023 IEEE Int. Conf. Robot. Autom. (ICRA), May 2023

E. Ballesteros and H. Asada, "Integrating Supernumerary Robotic Limbs onto the xEMU spacesuit to enhance astronaut capabilities and efficiency in Extra-Vehicular Activities," 2022 ACM Conference on Human Interaction (SpaceCHI2.0), April 2022

J. Delaune, J. Izraelevitz, L. Young, W. Rapin, E. Sklyanskiy, W. Johnson, A. Schutte, A. Fraeman, V. Scott, C. Leake, E. Ballesteros, S. Withrow, R. Bhagwat, H. Cummings, K. Aaron, M. Veismann, S. Wei, R. Lee, L. P. Madrid, M. Gharib, and J. Burdick, "Motivations and Preliminary Design for Mid-Air Deployment of a Science Rotorcraft on Mars," 2020 AIAA ASCEND Conference, November 2020

RESEARCH EXPERIENCE

Massachusetts Institute of Technology/d'Arbeloff Laboratory – Graduate Research Assistant

Integration of Supernumerary Robotic Limbs (SuperLimbs) on Space Suit Technology (Dr. Harry H. Asada)

08/21 – Present

- Led development of full-scale ground test unit of SuperLimbs Space Suit prototype
- Developed static bracing/dynamic locomotion models of planetary application of Space SuperLimbs system
- Designed and implemented admittance control synthesis and demonstrated successful implementation

Jet Propulsion Laboratory/Caltech CAST Laboratory – Development Researcher/Engineer

Autonomous Fault Detection System Development (Dr. Lorraine Fesq)

07/20 – 09/20

- Developed functional prototype MONSID model of Iris Radio Subsystem being developed for Artemis-1
- Identified telemetry from Iris system to enhance autonomous fault-detection capabilities

Rotorcraft Vortex Ring State Model Development (Dr. Jeff Delaune)

07/20 – 09/20

- Developed Python-based model describing Vortex Ring State phenomenon in rotorcraft
- Translated model to Martian atmospheric conditions to synergize with Mars Helicopter project

- Performed signal processing/interpretation of analog rotorcraft tests performed at Caltech CAST Laboratory

The University of Texas at Austin – *Undergraduate Researcher*

Quadratic Programming Controller Development (Dr. Efstatios Bakolas)

08/17 – 12/17

- Developed PID controller that allows for stability control of dynamic systems via Quadratic Programming
- Created wireless interface between microcontroller and dynamic system for autonomy research

WORK EXPERIENCE

Jet Propulsion Laboratory – *Hardware Quality Assurance Engineer*

Hardware Quality Assurance Engineer

02/20 – 08/21

- Trained in JPL internal practices to inspecting/qualifying spaceflight hardware
- Assisted in inspection operations for in-situ hardware development (Mars 2020 – PIXL)
- Participated in Assembly and Testing of spacecraft system (NISAR)
- Reviewed flight project inspection reports for potential auxiliary effects

Texas Spacecraft Laboratory – *Spacecraft/Satellite Research and Development Engineer*

Flight Hardware Researcher/Specialist

02/19 – 12/19

- Led FPGA selection and satellite computer/control system hardware development
- Aided in design of customized I/O board to support neural network based logic computer
- Selected, specified, and verified vendor supplied I2C/SPI sensors for flight performance payload
- Wrote and debugged various Python based scripts to be utilized on flight performance computers
- Drafted and finalized satellite system performance/design requirements

Walt Disney Imagineering – *Professional Internship*

Show Mechanical Engineer

06/18 – 01/19

- Designed mechanical assemblies for Advanced Audio-Animatronics
- Performed rigid body dynamic (RBD) analyses of anthropomorphic/non-anthropomorphic motion envelopes
- Selected and organized electric motor drives, encoders, and connectors for in design audio-animatronics
- Specified connectors subject to environmental, maintenance, and space constraints
- Developed functional prototype from servo motors for finalist PitchFest 2018 presentation
- Supported wiring layout for customized breakout boards for encoders and motor drives

Walt Disney World Resort – *Professional Internship*

Quality/Safety Engineer

01/18 – 06/18

- Actively participated in development of ASTM standard for Steam Train Locomotives
- Performed auditing of Walt Disney World attractions for state safety requirements compliance
- Assisted in BIM environment development for various Walt Disney World attractions
- Directed and collected attraction lighting data for guest safety studies

NASA Johnson Space Center – *Pathways Intern/Co-op*

Propulsion Systems Engineer

06/19 – 08/19

- Developed industry baseline parameters for hypergolic startup ignitions
- Conducted thermal load testing and X-Ray evaluation on experimental composite propellant tanks
- Performed Computational Fluid Dynamics (CFD) on various hypergolic propellant interactions

Propulsion Systems Engineer

06/15 – 08/15

- Developed structural design and integration of Mars Ascent Vehicle (MAV) propulsion system
- Fabricated and integrated support structure for propellant system on Morpheus vehicle
- Performed testing/validation of insulation for prototype cryogenic propellant COPV

Space Suit Engineer

01/16 – 06/16

- Conducted hazard analysis and testing on space suit and pressure garment materials
- Developed space suit internal architecture analog for reliability and safety assurance
- Tested and performed anthropometric analysis on Z-2 space suit
- Designed, drafted, and machined component enhancements for space suit soft goods
- Designed and integrated electric drive motor system for space suit tribosystem experiment

Portable Life Support Systems Engineer

06/16 – 08/16

- Performed rapid prototyping of critical space suit life support component
- Designed and installed space suit ventilation filtration system

Operational Engineer/Diver, Neutral Buoyancy Laboratory

06/17 – 08/17

- Developed and supervised data acquisition/instrumentation infrastructure for hydrodynamic loading experiment

- Tested and evaluated oceanic conditions inside pool environment for feasibility studies

International Space Station (ISS) Flight Controller, ETHOS

08/14 – 12/14

- Actively monitored and maintained ISS Life Support and Internal Cooling Systems
- Trained Astronauts and Cosmonauts on ISS emergency response

Lockheed Martin Aeronautics – Internship

F35 and Skunkworks Analyst

06/13 – 08/13

- Performed Finite Element Analysis (FEA) on F35 composites
- Performed Computational Fluid Dynamics (CFD) on Skunkworks proprietary hardware
- Supported Materials Review Board (MRB) team to improve F35 work floor productivity

Jet Engine Engineer, Commercial Engine Solutions

06/14 – 08/14

- Optimized and supervised Maintenance, Repair, and Overhaul (MRO) processes for work floor
- Developed Failure Mode and Effects Analysis (FMEA) models of various jet engines
- Improved Quality Control (QC) toolset for jet engine development
- Executed Critical Process Control (CPC) data analysis on work floor

NASA Kennedy Space Center – Internship

Cryogenics Testing Engineer

01/14 – 05/14

- Experimented on new launch pad support materials and multi-layer insulation
- Constructed and tested various cryogenic storage and transfer launch pad hardware
- Performed thermodynamic experimentation on proposed Space Launch System (SLS) insulation foams
- Designed, specified, and integrated thermal measurement system for cryogenic wicking experiment

AWARDS

Eagle Scout Award, Spring 2012

NASA Space Technology Graduate Research Opportunity (NSTGRO) Fellowship, Fall 2023 – Fall 2027

Thomas W. Folger Fellowship, Fall 2021 – Spring 2022

Mars 2020 SHA Z-Stage Testing: For completion of the SHA z-stage Tiger Team investigation, development of new in-flight measurement methods, and validation of these methods in test, Fall 2021

Distinguished Scholar Award, Spring 2019

Outstanding NASA JSC Co-op Award, Summer 2017

Lockheed Martin Corporate Award, Summer 2013, Summer 2014

Crystal Yvette Miller Award, Summer 2013, Summer 2014

AIAA Liquid Propulsion Award, Summer 2015

AIAA Outstanding Student Award, Summer 2014

EXTRACURRICULAR ACTIVITIES

President, American Institute of Aeronautics and Astronautics (AIAA), 2013-2015

Secretary, Society of Hispanic Professional Engineers (SHPE), 2013-2015

Active Member, Tau Beta Pi Engineering Honor Society (TBP), 2016-2019

Active Member, Sigma Gamma Tau Aerospace Engineering Honor Society (SGT), 2016-2019

Active Member, Longhorn Rocketry Association (LRA), 2015-2018

Mentor, FIRST Robotics (Watertown HS), 2021 – Present

Team Co-Lead, Aero Mavs, 2012-2015

Director, Pathways Agency Cross-Center Connections (PAXC), 2016

President/Chapter Founder, National Space Society (NSS), 2013-2015

Active Member, INROADS, 2013-2015

CERTIFICATIONS

NAUI SCUBA Open Water Certification, Summer 2015

International Space Station (ISS) Commanding Certification, Fall 2014

Lean Six Sigma Green Belt Certification, Summer 2014

National Association of Rocketry (NAR) Level 2 Certification, Spring 2017

NASA Cryogenics Handling Certification, Spring 2014

NASA Pressure Vessel Systems Certification, Spring 2014

SUPERVISORS - REFERENCES

Dr. H. Harry Asada – Massachusetts Institute of Technology

Academic Advisor/Supervisor

Email: asada@mit.edu

Phone: 781-572-5938

John O'Donnell – Jet Propulsion Laboratory

Branch Chief/Upper Supervisor

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Mike Sanders – Jet Propulsion Laboratory

Group Supervisor

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Phone:

Dr. Lorraine Fesq – Jet Propulsion Laboratory

Team Lead/Reference

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Phone:

Kalind Carpenter – Jet Propulsion Laboratory

Collaborator/Reference

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Brian Orr – Walt Disney Imagineering

Supervisor

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Dr. James Fesmire – NASA Kennedy Space Center

PI/Reference

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Amber Tucker – NASA Johnson Space Center

HR/Supervisor

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Dr. Manuel Rausch – The University of Texas at Austin

Reference

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Mark Johnston – Lockheed Martin Aeronautics

Supervisor/Reference

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Robert (Bob) Conway – Walt Disney World Resort

Supervisor/Reference

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Dr. Efstathios Bakolas – The University of Texas at Austin

Reference

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