JONATHAN SHULGACH

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EDUCATION

Carnegie Mellon University (CMU), Pittsburgh, PA
PhD in Mechanical Engineering, GPA 3.80/4.00 — **2021 – Current**
Advisor: Douglas Weber, PhD, Mechanical Engineering, Carnegie Mellon University

M.S. in Biomedical Engineering, GPA 3.40/4.00 — **2018 – 2019**
Master's Thesis Title: "Selective activation of Ferret abdominal vagus nerve fibers using a multi-contact cuff electrode"
Advisors:
Steve Chase, PhD, Neuroscience Institute, Carnegie Mellon University
Lee Fisher, PhD, Swanson School of Engineering, University of Pittsburgh
Course Projects: Team lead for "Flexi-Luminaire" awarded "Most Innovative Project"

University of Maryland Baltimore County (UMBC), Baltimore, MD
B.S. in Mechanical Engineering, GPA 3.24/4.00 — **2013 – 2016**
Honors College Certificate

Harford Community College (HCC), Bel Air, MD
A.S. in Mechanical Engineering & Physics, GPA 3.32/4.00 — **2011 – 2013**

AWARDS AND HONORS

Finalist – CMU Three-Minute Thesis (3MT) Competition (2025)
Recognized among university finalists for clear and impactful communication of PhD research.

Graduate Conference Travel Fellowship — CMU Mechanical Engineering *(2025)*
Awarded to select group of PhD candidates to support conference presentation based on research distinction.

Northeastern Maryland Technology Council — Keynote Speaker Recognition (*2022)*
Invited keynote speaker highlighting translational STEM education and non-linear research pathways.

DARPA Research Contributor Recognition (*2021)*
Contributed to $5M DARPA-funded non-surgical neural interface program at CMU supporting rapid prototyping and system integration.

Most Innovative Project Award – "Flexi-Luminaire" (2019)
Team leader for multidisciplinary CMU design competition project awarded for innovation in engineering design.

Honors College Graduate — University of Maryland, Baltimore County (*2016)*
Completed competitive honors program with academic distinction.

RESEARCH EXPERIENCE

PhD Researcher — **August 2021 - Present**
Neuromechatronics Lab, Carnegie Mellon University, Pittsburgh, PA

- Designed and fabricated a 128-channel flexible high-density electromyography (HD-EMG) sleeve with custom Intan-based electronics, reducing setup time >60% compared to wet grids and enabling reproducible high-fidelity recordings during functional tasks.
- Led an 8-person team to design a 3D-printed wearable hand exoskeleton platform for assisted grasping studies and functional activities of daily living with adaptive EMG-based control

- Designing a 2 mm-pitch ultra-high-density EMG electrode array for selective motor unit recording on facial muscles to guide selective denervation/re-innervation procedures and improve functional outcomes following facial paralysis treatment
- Created OpenCV-based markerless motion tracking pipelines for human and non-human-primate biomechanical movement analysis.
- Developed EMG decoding pipelines with sliding-window feature extraction and k-fold validation for real-time gesture classification in healthy and spinal-cord-injured participants
- Created 3D volumetric muscle reconstruction algorithms integrating freehand ultrasound and motion capture data for cost-effective muscle localization, improving real-time EMG electrode placement
- Developed real-time object detection system using Grounding DINO, SAM2, and Llama 3.1 to interpret high-level user queries to recognize objects for visually impaired individuals
- Assisted in 6 non-human primate (NHP) experiments with HD-EMG sensor placement and signal analysis to record forearm muscle activity during evoked movements
- Co-led hand gesture classification experiments for 2 participants with HD-EMG grid and motion capture marker placement

Graduate Student Researcher
January - December 2019

Rehabilitation and Neural Engineering Lab, University of Pittsburgh, Pittsburgh, PA

- Assisted in data collection experiments for stimulation and recording of vagus nerve activity in ferrets, contributing to research on neural signal modulation and functional outcomes.
- Analyzed neural data to identify firing rates and conduction velocities of vagus nerve signals, using statistical and computational techniques to inform experimental conclusions.

Undergraduate Research Assistant
May – August 2015

Food and Drug Administration, Silver Spring, MD

- Developed a visuotactile stimulation model to evaluate embodiment biomarkers using the Rubber Hand Illusion, recording and analyzing EEG data to assess limb embodiment conditions.
- Conducted developer testing and provided implementation feedback for DARPA HAPTIX virtual hand simulator programs, contributing to advancements in prosthetic arm technologies.
- Designed a MATLAB-based EEG data pipeline that enhanced data filtration and improved analysis efficiency, reducing processing time for research workflows

PROFESSIONAL EXPERIENCE

Software Engineer Consultant
January 2020 – Present

Pittsburgh, PA

- Designed and deployed robotic control package using MoveIt2 on NVIDIA Jetson platform for real-time teleoperation, enhancing adaptability with industrial manipulators
- Created a visualizer package in ROS2 to integrate workspace zoning for robot-assisted knee replacement surgery system
- Developed biomechanical mimicry system using 2 IMUs to convert upper limb kinematic motion to 3-DOF robot arm control signals

Mechatronics Engineer
January – August 2021

Neuromechatronics Lab, Carnegie Mellon University, Pittsburgh, PA

- Created and fully assembled mechanical rig designs and neural recording interfaces using SolidWorks, rapid prototyping, and custom circuits to support a $5 million DARPA research contract for non-surgical brain interfaces
- Spearheaded rapid prototyping initiative in lab, utilizing 3D printing and laser cutting to improve turnaround times for critical components by 60%

- Led a team to develop an open-source ROS2 driver for the Delta.3 and Sigma.7 haptic robot controllers and integrate with a “center-out” motion planning task in Unity

Lab Manager
December 2019 – May 2021

University of Pittsburgh, Pittsburgh, PA

- Directly assisted the surgical implantation of personally made patch electrodes in the abdomen of 9 cats supporting the primary surgeon for recording gastric and electrophysiological activity
- Led personalized training sessions with 9 students through microscope imaging software with Nikon microscope, neural spike detection software, and analysis techniques with electrophysiological data using Python and MATLAB software
- Analyzed electrophysiological recordings to identify unique gastric biomarkers preceding emesis from nausea

Control Systems Engineer
June 2016 – August 2018

Acquired Data Solutions, Rockville, MD

- Designed and implemented turnkey automated control systems for real-time data acquisition, fieldbus communications, and event control using LabVIEW, MATLAB, and Python
- Delivered on-site support for system installation, troubleshooting, and debugging, ensuring seamless integration of client hardware with software

CEO
June 2013 – May 2017

Limitless Productions, LLC, Bel Air, MD

- Founded production services company for local student and independent film projects in the Maryland, Delaware, and Virginia areas, supporting the creative community with technical and artistic expertise
- Directed and produced *Star Wars* fan film "Revan" and three additional short film projects, overseeing all aspects of production, including budget management, location scouting, and on-site coordination of filming events and personnel
- Designed and sold custom cosplay masks on a digital marketplace, inspired by film characters, generating additional revenue for production efforts

TECHNICAL SKILLS

Design & Prototyping: SolidWorks, AutoCAD, 3D Printing, Arduino, KiCad, Resin Casting, Laser Cutting

Programming & Frameworks: C/C++, Python, MATLAB, LabVIEW, ROS2, TensorFlow, OpenCV, MicroPython, Git

Systems & Tools: Linux (Debian), NVIDIA Jetson, Raspberry Pi, Rviz, Simulink, Anaconda, PyCharm, Unity

Specialization: Pose Tracking, Machine Learning, Signal Processing, Communication Protocols (I2C, Serial, TCP)

LEADERSHIP AND SERVICE

Board Member
August 2025 - Present

Accessible Prosthetics Initiative, Pittsburgh, PA

- Provide strategic guidance on initiatives, partnerships, and educational programs supporting global prosthetics accessibility and training
- Support curriculum development and organizational planning to expand low-cost prosthetics education and access

TEACHING AND MENTORING EXPERIENCE

Research Mentor
May – August 2025

Office of Undergraduate Research and Scholar Development, Carnegie Mellon University, Pittsburgh, PA

- Mentored 6 undergraduate students through CMU's Summer Undergraduate Research Apprenticeship Program, holding weekly meetings to guide experimental design, provide technical feedback, and support project execution and presentation development

Student Mentor
August 2022 - Present

Carnegie Mellon University, Pittsburgh, PA

- Volunteer with Mechanical Engineering Graduate Student Organization, providing mentorship and guidance to graduate students in the Mechanical Engineering program
- Provide academic and career planning guidance, offering practical advice on coursework, research, and navigating graduate life

STEM Instructor
May 2016 - August 2018

Acquired Data Solutions, Rockville, MD

- Created lesson plans and taught a 3D printing course at Ron Brown High School for a class of 8 students, introducing CAD design and 3D printing fundamentals during the summer of 2018
- Designed and led a 6-week annual summer STEM program, teaching 40 high school students programming with Arduino, engineering design, and robotics, fostering hands-on experience in STEM principles and project-based learning.

Educator and Lecturer
January 2021 - Present

Accessible Prosthetics Initiative, Pittsburgh, PA

- Taught rapid prototyping concepts to graduate students at the University of Pittsburgh. Course development assistance acknowledged in publication: *Fiedler, Goeran, and Joseph Samosky. "User-Centered Design of Limb Prostheses." Canadian Prosthetics & Orthotics Journal 6, no. 2 (2023)*
- Served as Education Team Co-Lead for API, developing middle and high school curricula in prosthetics for underserved communities.

Assistant Coach
August 2016 - May 2018

FIRST Robotics, Baltimore, MD

- Assisted in the foundation and coaching of a FIRST Robotics Competition (FRC) team, supporting 8-12 students in best practices of manual and CNC machining tools, programming, and design cycles with advanced CAD
- Facilitated and guided strategic planning, leadership development, and organizational meetings culminating in the completion of a 120-pound purpose-built competition robot during an officially limited six-week design/build/test season

Peer Mentor, M.O.D.E.L. M.E Program
Fall 2015 - Spring 2016

University of Maryland, Baltimore County, Baltimore, MD

- Served as a positive role model and resource to two undergraduate students in the Mechanical Engineering program, providing guidance in personal and academic development.

PUBLICATIONS

Shulgach, Jonathan, Alpaslan Ersöz, Max Murphy, Prakarsh Yadav, Luigi Borda, Douglas J. Weber. **"**Design and Validation of a Flexible High-Density Electromyography Cuff for Neuromotor Applications". (2025). Manuscript in preparation

Forssell, Mats, Maxwell Murphy, Vishal Jain, **Jonathan Shulgach**, Derya Tansel, Jiaming Cao, Shanila Reza, Maysamreza Chamanzar, Darcy Griffin, Gary K. Fedder, Douglas J. Weber, and Pulkit Grover Preliminary study of steerable pulsed transcranial electrical stimulation (TES) of motor cortex in humans. 47th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2025. *(Accepted as full contributed paper.)*

Forssell, Mats, Rabira Tusi, Jeehyun Kim, Maxwell Murphy, **Jonathan Shulgach**, Prakarsh Yadav, Alonso Buitano Tang et al. "Reducing scalp pain for pTES of motor cortex using background hums." (2025).

Murphey, Charles P., **Jonathan A. Shulgach**, Pooja R. Amin, Nerone K. Douglas, John P. Bielanin, Jacob T. Sampson, Charles C. Horn, and Bill J. Yates. "Physiological changes associated with copper sulfate-induced nausea and retching in felines." *Frontiers in Physiology* 14 (2023): 1077207.

Zhang, Elric, Mostafa Abdel-Mottaleb, **Jonathan Shulgach**, Manuel A. Campos, Max Murphy, Brayan Navarrete, Shawnus Chen et al. "Wireless Magnetoelectric Neural Interfaces." In *2023 IEEE International Magnetic Conference-Short Papers (INTERMAG Short Papers)*, pp. 1-2. IEEE (2023).

Murphey, Charles P., **Jonathan A. Shulgach**, Pooja R. Amin, Nerone K. Douglas, John P. Bielanin, Charles C. Horn, and Bill J. Yates. "Prodromal Physiologic Changes During Copper Sulfate-Induced Nausea and Vomiting: Potential Use of Intestinal EMG Recordings as a Marker for Nausea." *The FASEB Journal* 36 (2022).

Amin, Pooja R., Jacob T. Sampson, Xiaoying Dong, John P. Bielanin, Charles P. Murphey, **Jonathan A. Shulgach**, Brandon L. King, Nerone K. Douglas, Bill J. Yates, and Carey D. Balaban. "Distribution of c-Fos Labeling Elicited by Intragastric Copper Sulfate: Comparison with Labeling Induced by Galvanic Vestibular Stimulation." *The FASEB Journal* 36 (2022).

Shulgach, Jonathan A., Dylan W. Beam, Ameya C. Nanivadekar, Derek M. Miller, Stephanie Fulton, Michael Sciullo, John Ogren et al. "Selective stimulation of the ferret abdominal vagus nerve with multi-contact nerve cuff electrodes." *Scientific Reports* 11(1), 12925 (2021).

Bielanin, John P., Nerone O. Douglas, **Jonathan A. Shulgach**, Andrew A. McCall, Derek M. Miller, Pooja R. Amin, Charles P. Murphey, Susan M. Barman, and Bill J. Yates. "Responses of neurons in the medullary lateral tegmental field and nucleus tractus solitarius to vestibular stimuli in conscious felines." *Frontiers in Neurology* 11 (2020): 620817.

Harms, Jonathan E., Derek Miller, **Jonathan A. Shulgach**, Ameya C. Nanivadekar, Stephanie Fulton, Michael Sciullo, Lee E. Fisher, Bill J. Yates, and Charles C. Horn. "Gastric Distension-induced Nodose Ganglionic Cell Responses Using a High-throughput Multi-electrode Array in the Ferret." *The FASEB Journal* 34, no. S1 (2020): 1-1.

Roth, Aaron M., Samantha Reig, Umang Bhatt, **Jonathan Shulgach**, Tamara Amin, Afsaneh Doryab, Fei Fang, and Manuela Veloso. "A robot's expressive language affects human strategy and perceptions in a competitive game." In *2019 28th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, pp. 1-8. IEEE, 2019.

CONFERENCE PRESENTATIONS

Oral Presentations

"Non-linear Pathways in STEM". Keynote Speaker at the Northeastern Maryland Technology Council Visionary Awards, Aberdeen, MD, 2022

Poster Presentations

Shulgach, Jonathan A., Max Murphy, Elric Zhang, Mostafa Abdel-Mottaleb, Shawnus Chen, Sahkrat Khizroev, Ping Liang, Darcy Griffin, Douglas Weber. (2022, November). "Verification of neurostimulation with magnetoelectric nanotransducers using motor-evoked potentials in primary motor cortex." *Poster session presented at Society for Neuroscience*, San Diego, CA

Shulgach, Jonathan A., Max Murphy, Elric Zhang, Mostafa Abdel-Mottaleb, Shawnus Chen, Sahkrat Khizroev et al. (2022, April). In vivo selective motor neuron recruitment with ICMS and wireless brain stimulation using targeted delivery of magnetoelectric nanoparticles". *Poster session presented at Neural Control of Movement*, Dublin, Ireland

Shulgach, Jonathan A., Max Murphy, Jacklyn Hull, Mostafa Abdel-Mottaleb, Elric Zhang, Shawnus Chen et al. (2022, January) "Using MeNTs to Lower Recruitment Threshold of Motor Units with ICMS and EMAG" *Poster session presented at Carnegie Mellon University Mechanical Engineering Symposium*, Pittsburgh, PA

Shulgach, Jonathan A.,Talia Seiff, Elizabeth Kilpatrick, Heather Benz, Eugene Civillico. (2015, August) "Limb Embodiment and Virtual reality Simulator Programs for prosthesis Functional Development." *Poster presented at the 2015 FDA White Oak Science Forum*, Silver Spring, MD.