Preston **Peranich**

Research Engineer · Real-Time Systems · Neural Interfaces

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Summary

Research engineer with **6+ years** building latency-critical sensing and control systems at Johns Hopkins APL. I work full-stack—from embedded firmware and edge deployments to GPU-accelerated processing to researcher-facing visualizations—with emphasis on reproducible research infrastructure, modular architectures, and rapid prototyping that enables experimental validation. Maintainer of ezmsg (adopted by multiple research groups) and sole firmware author of DC Mini (open hardware + Rust firmware for a 16-channel EEG wearable), pairing algorithm development and scientific computing with hands-on hardware integration for closed-loop organoid experiments, noninvasive & intracortical neural sensing, and real-time additive manufacturing quality control.

Experience

Research Engineer

Laurel, MD

Johns Hopkins University Applied Physics Laboratory — Neural Interfaces (REDD) June 2021 — Present

Neural Interfaces — noninvasive & intracortical

- Extended a real-time optical sensing stack for high-speed acquisition, timing/synchronization , and comprehensive GUI for hardware control, parameter tuning, and real-time interactive visualization essential for system alignment and data collection. Delivered analysis/tooling that informed next-phase proposals.

Organoid Intelligence — closed loop, reinforcement learning

- Lead developer for closed-loop organoid experiments: MEA control/data bindings, spike-to-action units, and latency-minimized experiment loops; progressed from proof-of-concept to first closed-loop runs and systematic parameter sweeps.
- Built reusable Python components for online RL and offline analysis, aligning collection control, state, and logging for reproducible experiments.

Additive Manufacturing — real-time control GUI & sensor fusion

- Architected comprehensive GUI for laser AM control: real-time melt pool monitoring, temperature profile analysis, and process quality assessment. Integrated ingest → correction → binning → GPU visualization pipeline with interactive controls for processing parameters and hardware settings.

Edge & platform engineering — Jetson deployments

- Authored robust Jetson 5→6 provisioning: CUDA toolkits, Python envs, Docker images, and ROS integration, enabling reproducible, portable deployments for AR/robotics and real-time sensing pipelines.

Optical instrumentation — OCT & holography

- Developed full-featured GUIs for multi-axis instrument control and phase-shifting (e.g., 4-phase piezo) in full-field Optical Coherence Tomography (OCT)/holography systems. Integrated high-speed camera controls with real-time interactive visualization and hardware parameter adjustment, significantly shortening alignment cycles and enabling rapid experimental iteration.

Smart operating room — sensor fusion & edge compute

- Software lead for next-generation OR capture system: deployed NVIDIA Jetson edge devices running CV algorithms (object detection, pose tracking), multi-camera registration with stereo cameras, ultrawideband trackers, and environmental sensors. Expanded team to 6 engineers and met all critical milestones leading to contract extensions.

College Intern

Laurel, MD

Johns Hopkins University Applied Physics Laboratory — RF Engineering (Space Sector) May 2019 — May 2021

- Co-created a spacecraft avionics testbed on an embedded Xilinx SoC running RTEMS.
- Built custom interfaces for the COSMOS ground system and cross-platform tooling to exercise test equipment and devices under test.
- Authored a testing environment and documentation adopted by external groups for requirement verification.

Graduate Research Assistant — Mississippi State, MS

Mississippi State University — Aug 2019 — May 2021

- Designed a P-band receiver to measure direct/reflected Signals of Opportunity for soil-moisture inversion.
- Advanced a wearable sensor device to capture movement of the foot/ankle complex (soft robotic sensors, 3D motion capture).

Undergraduate Research Assistant — Starkville, MS

Center for Advanced Vehicular Systems, Mississippi State University — Aug 2016 — May 2019

- Prototyped a real-time wearable device with wireless sensors; authored a GUI for live graphing.
- Built a platform for a high-power three-phase voltage-source inverter with grid-tie capability; co-developed a robust switching algorithm and a TI-MCU GUI.

System Test Intern — Boulder, CO

FreeWave Technologies — May 2018 — Aug 2018

- Developed and executed network/system tests for radio products; automated tests with Python and unit tests.
- Contributed to CI pipelines for faster firmware feedback; visualized test data with Splunk.

Avionics College Intern (G500/G600) — Savannah, GA

Gulfstream Aerospace — May 2017 — Aug 2017

- Performed Integrated Test Procedures and resolved problem reports; delivered compliance reports and system documentation.
- Authored Kinds of Operations reports; coordinated with engineers and test pilots for regulatory compliance.

Projects (Open Source)

ezmsg — ezmsg-org/ezmsg

Core contributor · Pure-Python, SHM-backed, multi-process DAG framework for real-time pipelines

- Implemented high-throughput shared-memory transport, reusable processing blocks, and operator-facing visualization modules adopted across optics and neuro projects.

DC Mini — 16-channel EEG wearable (Rust firmware + open hardware) — dcmini-org/dcmini-fw

Sole firmware developer · Modular BSP / boot manager / application crates

- Hardware: ADS1299 (4–16 ch, DC-coupled), nRF52840 BLE, USB isolation, ICM-45605 IMU, APDS-9253 ALS, PDM mic, nPM1300 PMIC, haptics, NFC, microSD.
- Firmware: three-crate architecture (BSP drivers, boot manager with fallback, application); Nix-based reproducible toolchain; USB/SD storage, BLE streaming, watchdog safety.

Skills

Programming Languages	Python, Rust, C++, C
Embedded	embassy-rs, nRF52, SPI/I^2C/UART, BLE
Tools & Platforms	Linux, Git, Nix, GitHub Actions, CI/CD, Docker, ROS

Education

Mississippi State University — Starkville, MS

M.S., Electrical & Computer Engineering — 2019 — 2021

Mississippi State University — Starkville, MS

B.S., Electrical & Electronics Engineering — 2015 — 2019

Honors & Awards

- MSSGC NASA Fellow (2019–2020)
- MSSGC NASA Fellow (2020–2021)

Selected Highlights

Noninvasive Brain-Computer Interface Breakthrough

APL News — Nov 2024

- Demonstrated nanometer-scale neural tissue deformations via digital holographic imaging; established new noninvasive BCI signal modality extending beyond current surgical implants.
- **Full article**

POSITRONIC Platform for Organoid TBI Research

APL News — July 2024

- Integrated brain organoids with pressure-generation and noninvasive optical imaging to study repeated low-level blast exposures; enables military mTBI research.
- **Full article**

Real-Time Additive Manufacturing Flaw Detection

APL News — May 2024

- Developed monitoring system detecting keyhole flaws in 952 nanoseconds via thermal disruption measurement; prevents vapor bubble formation in cooling metal.
- **Full article**

Navy-APL Additive Manufacturing Collaboration

APL News — Mar 2024

- Providing in situ monitoring technologies and standards for real-time quality control; accelerating submarine production and fleet sustainment.
- **Full article**

SURPASS Organoid Intelligence Initiative

JHU SURPASS — Ongoing

- Pioneering integration of human brain organoids with AI/robotics; advancing biological intelligence understanding, disease modeling, and biocomputing applications.
- **Program page**

Publications

StARS DCM: A Sleep Stage-Decoding Forehead EEG Patch for Real-time Modulation of Sleep Physiology

arXiv preprint — 2025

- Presents the DC Mini platform for sleep stage decoding; demonstrates real-time sleep physiology monitoring using forehead-mounted EEG patch.
- Link: arXiv:2506.03442

Recent Results from P-Band Signals of Opportunity Receiver Deployed on a Multi-Copter UAS Platform

IEEE IGARSS (Kuala Lumpur) — Session TH5.V17 — 2022

- UAS-mounted P-band SoOp receiver results toward soil/vegetation sensing; discusses instrument design iterations and field integration.
- Contribution: system integration and UAS instrumentation.
- Link: IGARSS 2022

Closing the Wearable Gap — Part IX: Validation of an Improved Ankle Motion Capture Wearable

IEEE Access — 2021

- Validation of improved ankle motion capture using soft robotic sensors; demonstrates enhanced accuracy in foot-ankle kinematics measurement.
- DOI: 10.1109/ACCESS.2021.3102880

A Low-Cost Research Platform for Brain-Computer-Interface Applications in Mixed Reality

IEEE NER — 10th Int'l Conference on Neural Engineering — 2021

- BCI platform for mixed reality applications; low-cost approach to neural interface development for AR/VR environments.

- DOI: 10.1109/NER49283.2021.9441381

Evaluating Performance of Extended Kalman Filter Based Adaptive Cruise Control Using PID Controller

Proc. SPIE 11748 — Autonomous Systems: Sensors, Processing, and Security for Vehicles 2021

- Comparative analysis of EKF-based adaptive cruise control with PID controller; performance evaluation for autonomous vehicle applications.
- DOI: 10.1117/12.2585688

Implementation of UAS-Based P-Band Signals of Opportunity Receiver for Root-Zone Soil Moisture Retrieval

Master's Thesis — Mississippi State University 2021

- UAS P-band SoOp receiver for root-zone soil moisture inference; RF front-end, synchronization, calibration, flight testing.
- Link: MSU repository

A UAS-based RF Testbed for Water Utilization in Agroecosystems

Proc. SPIE 11747 — Autonomous Air & Ground Sensing Systems for Agricultural Optimization and Phenotyping VI 2021

- UAS RF testbed combining radiometry, scatterometry, wideband GPR, and SoOp for soil moisture/vegetation traits at different depths.
- Role: testbed development and sensor integration.
- DOI: 10.1117/12.2591895

Low-Voltage Capacitive Measurement Methodology for Dielectric Elastomers

Proc. SPIE 11757 — Smart Biomedical and Physiological Sensor Technology XVIII 2021

- Phase-based (Goertzel) capacitance measurement on a low-cost MCU for dielectric elastomer sensing in wearables.
- Role: embedded/measurement prototyping; algorithm integration.
- DOI: 10.1117/12.2587797

Deterioration of Textile vs. Electronic Components over Time in Athletic Wearable Devices

Proc. SPIE 11757 — Smart Biomedical and Physiological Sensor Technology XVIII 2021

- Longitudinal durability comparison of garment vs. embedded electronics; guidance for reliability-aware wearable design/maintenance.
- Link: NSF Public Access

Closing the Wearable Gap — Part VII: A Retrospective of Stretch Sensor Tool Kit Development for Benchmark Testing

Electronics (MDPI) — Feature/Review 2020

- Retrospective on stretch-sensor toolkit development (hardware, fixtures, and protocols) to standardize benchmark testing for soft robotic sensors.
- DOI: 10.3390/electronics9091457

Closing the Wearable Gap — Part VI: Human Gait Recognition Using Deep Learning Methodologies

Electronics (MDPI) 2020

- Foot-ankle kinematics with soft robotic sensors (SRS); compares linear, ANN, and LSTM models for gait recognition; ANN lowest average RMSE.
- DOI: 10.3390/electronics9050796

Closing the Wearable Gap — Part II: Sensor Orientation and Placement for Foot and Ankle Joint Kinematic Measurements

Sensors (MDPI) 2019

- SRS placement/orientation study with 3D motion capture ground truth; reports RMSE/R^2 across movements.
- DOI: 10.3390/s19163509