

ENGINE 2026

ENGINEERING

INNOVATION

ENTREPRENEURSHIP

W

ELECTRICAL & COMPUTER
ENGINEERING

MESSAGE FROM THE CHAIR



Welcome to the 11th annual Engineering Innovation and Entrepreneurship (ENGINE) Showcase at UW ECE! It's a pleasure to welcome our donors, industry partners, and campus colleagues as we celebrate the hard work and creativity of our students — many of whom will soon graduate as the next generation of electrical and computer engineers.

This year's Showcase features 72 team projects representing nearly 350 students, spanning topics as diverse as digital health, cybersecurity, power systems, quantum technologies, machine learning, communications, electronics, and robotics.

The projects on display arise from ENGINE, our engineering entrepreneurship capstone program. ENGINE enables students to work in teams on industry-sponsored projects and serves as the culmination of their electrical and computer engineering education. Launched in 2015 under the leadership of Professor Payman Arabshahi, UW ECE's industry liaison and associate chair for education, the program has grown from just four projects in its inaugural year to the 72 projects showcased today.

ENGINE is generously endowed by UW ECE alumnus Milt Zeuschel and his wife, Delia, with additional hands-on mentorship provided by Milt's business partner and friend, UW ECE affiliate faculty member John Reece. The program develops students' skills in collaborative systems engineering, innovation, entrepreneurship, project management, and product development, while also offering industry partners access to the rich culture of innovation within UW ECE. Additional thanks go to UW ECE alumnus Ray Kanemori, for supporting cash prizes awarded to winning ENGINE teams.

To our industry sponsors, I extend my sincere thanks for the generous contributions, mentorship, flexibility, and creativity you have brought to this year's projects. I would also like to recognize ENGINE Program Director Payman Arabshahi, College of Engineering Industry Capstone Director Jill Kaatz, Associate Director Kate Cescon, and Program Manager Kae Saeteurn. Together, they establish and coordinate the industry partnerships that make these projects possible.

Finally, I thank our dedicated faculty mentors and ENGINE teaching assistants — Andrew Bergey, Andrew Nguyen, Victor Marcenac, Zane Chalich, Ankit Roshan Talluri, Zach (Xizhe) Hao, Simon Zou, Xinghua Sun, Steven (Chengbo) Sun, and Eric Cho — for their outstanding commitment to student success.

Congratulations to all students on the completion of your capstone projects. The knowledge and experience you have gained through ENGINE will serve you well in the years ahead, and I am confident you will go on to build successful and rewarding careers.

To our donors, industry partners, and campus colleagues, I look forward to speaking with you during the event. Enjoy the ENGINE Showcase!

Best to all,

Eric Klavins
UW ECE Professor and Chair

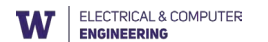


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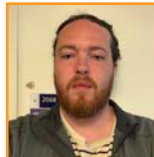
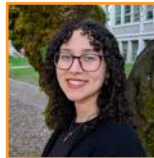
01

GPS-Denied Drone Navigation

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GPS signals are vulnerable to jamming, spoofing, and terrain obstruction, threatening autonomous vehicle operations. ANPC's Transponder Landing System (TLS) offers a GPS-independent positioning solution, currently used for manned military and research aircraft in complex terrain. This project demonstrates TLS as a viable drone navigation system by developing a GPS-TLS toggle algorithm capable of autonomously controlling a drone in GPS-denied environments. The system will maintain a maximum 10 ft deviation from a prescribed flight path at 100–400 ft AGL, reducing dependence on on-site pilots and enabling mission continuity where traditional navigation fails.



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AIWaysion

02

AI Video Analytics for Multimodal Traffic Safety and Design Countermeasures at Burke-Gilman Trail Crossings

This project develops an AI video analytics pipeline to quantify safety risks at the NW 43rd St and 8th Ave NW intersection in Seattle's Ballard neighborhood, where the Burke Gilman Trail crosses local streets. Sponsored by AIWaysion, the system integrates YOLO26 detection, BoT SORT tracking, CVAT based labeling, homography calibration, and short horizon trajectory prediction to compute time to collision and post encroachment time metrics. Outputs include conflict heatmaps and evidence based countermeasure recommendations for City of Seattle stakeholders to support data driven roadway safety decisions.

Authors

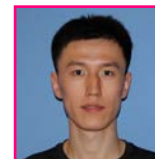
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03

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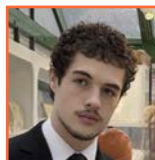
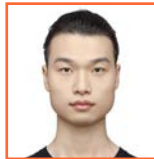
Occupancy-based Control (OBC) Prototype for HVAC Systems Using IoT Sensors

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Commercial buildings often waste energy by ventilating spaces as if they are always fully occupied. This project develops an Occupancy-Based Control (OBC) system that uses IoT sensors and real-time data to adjust HVAC ventilation based on actual occupancy.

An integrated prototype connects sensors, a gateway, and a Building Management System (BMS) to enable automated control. The system is evaluated through testbed experiments and simulation, demonstrating reduced energy use while maintaining indoor air quality and offering a scalable solution for modern buildings.



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IoT Vibration & Temperature Sensor Prototype for Predictive HVAC Motor Maintenance

04

This system delivers predictive maintenance for HVAC equipment through an IoT pipeline. Using Advantech WISE-2410 vibration/temperature/humidity sensors and Milesight CT305 current transformers, data is transmitted through LoRaWAN US915 to a Milesight UG65 gateway. A lightweight control layer is attached to MQTT topics (http for testing) and evaluates signals against ISO-10816 vibration thresholds and motor current baselines, and classifies emerging faults before failure happens. Detected anomalies generate maintenance tickets surfaced through a web dashboard and a fault ticket tracker. The system is also capable of being extended into existing building management systems.

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05

Optimization of Image Generation Models for Edge

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EdgeDiffuse explores the deployment of Stable Diffusion-based image generation models on resource-constrained edge devices. As generative AI models grow increasingly powerful, their computational demands limit accessibility beyond cloud infrastructure. This project addresses that gap by applying mixed-precision quantization, structured pruning, and knowledge distillation to compress Stable Diffusion for deployment on ARM-based hardware (Orange Pi RK3588), with and without NPU acceleration. Our goal is to achieve at least 20–25% model size reduction while maintaining acceptable image quality, enabling real-time, on-device generative AI without cloud dependency.



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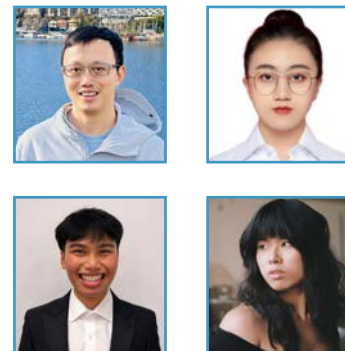
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Advancing Public Traffic Accident Data Analysis with LLMs

Traffic crash data is critical for improving roadway safety. However, data is fragmented, inconsistent, and difficult to use. Key details (maneuvers, severity, context) are buried in unstructured records, limiting ability to identify patterns and make data-driven decisions.

What does crash data have to do with LLMs? Large Language Models (LLMs) enable structured extraction from messy data and acts as an opportunity to transform raw crash data into analysis-ready datasets.



06

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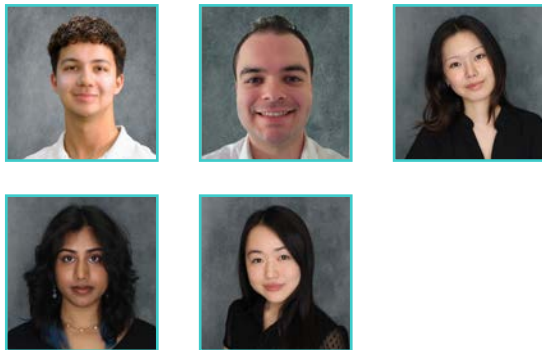
07

NFL Blind Flag Football

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Approximately 1 million people in the United States experience blindness or low-vision conditions. Despite football being the most popular American sport, accessibility in football is an underexplored field. Our team is developing the first rechargeable football with variable haptic and auditory feedback. Changing haptic patterns indicate proximity to the endzone, while pulse and continuous modes of auditory feedback relay whether the ball is airborne or carried. This technology enables people with varying levels of blindness to play an adapted version of flag football by signaling the location and state of the ball.



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Evaluation of High Frequency Substrates for Antenna Designs

08

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This project examined and compared different circuit board materials to determine which ones worked best for small wireless antennas. The antennas were designed to operate around 2.45 GHz, a common wireless frequency used by devices such as Wi-Fi and Bluetooth. Our team designed the antennas, simulated, tuned, fabricated and measured their performance in terms of return loss, gain patterns, Axial Ratio, and polarization, and compared the results. We evaluated the tradeoff between performance, cost, manufacturability, and the ease of design for each material. The goal was to identify a material that provided the best antenna performance while still being practical and affordable to produce.



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09

Temporary Aerospace Fastener Install Automated Tool

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To support the increased production cadence of the New Glenn launch vehicle, Blue Origin is transitioning high-volume manufacturing processes from manual labor to fully automated systems. A critical bottleneck in this transition is the installation of temporary fasteners, which prevent panel gaps during the drilling of rocket skins. This capstone team was tasked with developing a functional testbed to receive, verify, and install these fasteners. The goal of this project is to provide a low-risk environment to explore automation solutions, identify integration challenges, and establish "lessons learned" for future flight-line implementation.



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Synthetic Training Data Generation for Side-Scan Sonar

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Side-scan sonar (SSS) imaging is an acoustic imaging system used in underwater mapping and exploration, search-and-recovery, and environmental monitoring. Training sonar image recognition models requires a large volume of labeled SSS images, whose acquisition involves specialized hardware, crews, and lengthy field assignments. To address this, we present a synthetic data-generation system for SSS imagery in partnership with Booz-Allen-Hamilton. Our solution is a physics-based simulator, built on the Unity game engine and grounded in the preeminent models of acoustic imaging, producing high-quality, automatically labeled SSS imagery that can accelerate sonar image-recognition model development.

Authors

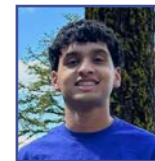
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11

AI Vision Autonomous Navigation in Dense Crowds

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Autonomous navigation needs to consider various factors. This project develops an AI-driven navigation system for autonomous wheelchairs operating in heavily crowded environments. Using a machine learning pipeline, the system detects nearby pedestrians and classifies situations as “avoid” or “don’t avoid” based on crowd density. A Gazebo simulation with configurable crowds is used for development and testing. The classifier is integrated into the motion planner to enable real-time decisions such as yielding, stopping, or rerouting. The system is validated through simulation and targeted for real-world deployment in environments like hospitals and airports to improve mobility and safety.



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Deep-RL Local Planners for Autonomous Wheelchair Navigation

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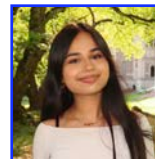
This project reimplements and evaluates deep reinforcement learning-based local planners (SACPlanner and a hybrid classical/RL planner) against a classical TEB baseline for autonomous wheelchair navigation. The system is integrated into the ROS1 Noetic navigation stack and validated in both Gazebo simulation and real-world wheelchair experiments. Evaluation scenarios include narrow corridors, dynamic obstacles, and localization challenges. Performance is measured using success rate, collision rate, trajectory deviation, and planning latency to assess robustness and sim-to-real feasibility, leading to a deployment recommendation for assistive wheelchair navigation.

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13

Modular Open-Source PTZ AI Camera Platform for Smart Neighborhood Applications

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This project builds a prototype modular PTZ camera system with on-device AI detection and tracking. The goal is to create an open system that is easy to modify and extend. Currently available similar systems are typically proprietary and thus are difficult to extend or customize based on the use case. This system supports different power, network, and hardware modules so that each potential user can tailor the device to their specific needs. The compute platform runs AI directly on the device to reduce delay and improve reliability, and the device is powered via either PoE (power over ethernet) or USB-C with battery and solar support to increase reliability.



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GE Vernova

14

Modeling UW Campus and Battery Design as Flexible Load

In partnership with GE Vernova, this project aimed to improve energy efficiency, flexibility, and cost performance on the University of Washington Seattle campus through electrical system modeling and battery storage design. An OpenDSS model of the campus distribution system, including feeders, transformers, and building loads, was developed. With this model, steady-state and time-series power flow studies were conducted to identify congestion and peak demand periods. Based on these results, HOMER Grid software was used to design battery energy storage systems for peak shaving and load shifting, supporting cost savings, long-term grid flexibility, and future campus energy planning.

Authors

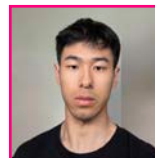
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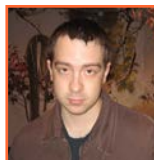
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Flight Vehicle Visualization

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This project develops a tool to visualize drone flight using both simulated and real telemetry data. The system creates a complete pipeline that takes raw flight data, converts it into a standardized format, and generates a realistic 3D animation of the drone's motion. The key components include a 6DOF physics-based simulation, telemetry data processing, and an interactive user interface that was built in MATLAB/Simulink. This framework allows users to analyze drone behavior and compare simulated results with real-world data, supporting the development of promotional material to highlight product capabilities.



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ClairVoyan DAA System: Intelligent Vision-Based Detect- and-Avoid Framework for UAVs

16

ClairVoyan is a vision-based Detect-and-Avoid (DAA) framework for small unmanned aerial vehicles (UAVs), developed in partnership with Guide Air Labs. Unlike conventional DAA systems relying on radar or ADS-B transponders, which are too heavy for small platforms, ClairVoyan employs a passive, camera-only pipeline integrating deep learning detection to identify non-cooperative airborne intruders at long range. The system targets compliance with RTCA DO-387 operational performance standards.

Authors

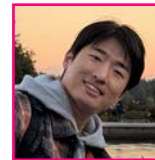
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17

Smart Hardware Inspection for Early Latency Detection (SHIELD)

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Project SHIELD (Smart Hardware Inspection for Early Latency Detection) addresses a critical gap in safety-critical embedded systems: the lack of proactive, on-device sensor failure detection. Sensor degradation in UAVs, autonomous vehicles, and medical devices often goes undetected until functional loss, with potentially catastrophic consequences. To support a predictive TinyML framework, the team designed a custom DAQ PCB around an ESP32-S3, integrating eight sensor modalities including IMU, barometer, microphone, temperature, photodiode, vibration, and current sensors. Data collection spans nominal operation and fault injection, generating a labeled dataset for ML model training.



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Agentic Productivity in the Third Place: Enabling Executive Performance through AI-Assisted Inking and Immersive Communication

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Productivity often declines in “Third Place” settings like commuting or between meetings, where attention is fragmented and context switching is frequent. Mobile professionals, especially executives, may lose ideas, disrupt cognitive flow, and delay follow-ups. Existing tools are fragmented and non-agentic, forcing users to manually connect capture, organization, and action across apps. This project proposes an agentic AI workflow that integrates a lightweight assistant with digital inking and immersive communication, enabling fast capture, structured next steps, and seamless follow-up without leaving the current context.

Authors

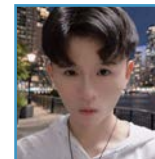
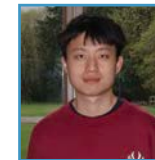
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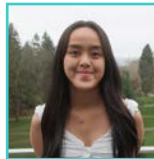
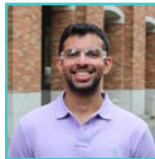
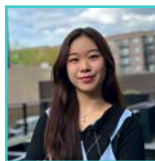
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Smart Beacon System for Industrial Process Optimization

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Hytek Finishes currently uses manual beacons to communicate machine statuses; but these systems only provide basic visual signals and are found ineffective by workers. The existing system also fails to notify all relevant personnel of status changes. This project developed an integrated system featuring four-state industrial beacons and a touchscreen interface that combines visual indication, issue logging, and notifications while withstanding the plant's harsh environments. Through its scalable design and integration with company servers, the system enables comprehensive issue tracking, enhancing communication, minimizing downtime, and supporting process optimization at Hytek Finishes.



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Impinu

RAIN RFID Smart Storage

20

This project develops a RAIN RFID based smart storage system for bottle detection and relative fullness estimation. Using commercial RFID readers and passive tags, we collect RSSI, phase, and frequency response data to analyze how RF signals vary with liquid levels. To improve robustness, we introduce reference tags to mitigate environmental variation and signal drift. Through controlled cabinet experiments, we address challenges such as interference and material effects, demonstrating a low cost and scalable solution for multi object sensing and intelligent storage applications.

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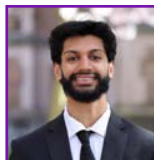
21

Kibble: An Automated and Modular Monitoring System

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Rohan Sabhaya

Test engineers rely on complex computer networks to coordinate tests on products. When a fault occurs in the network, engineers need to be notified so that tests can resume as soon as possible. Our project solves the problem of test networks going down for extended periods of time by notifying engineers as soon as an issue is detected. The system continuously monitors and logs the status of the network. Once a fault is detected, engineers are notified via email to check the logs to determine which part of the network has failed, preventing major delays.



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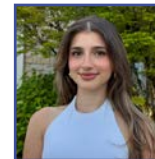
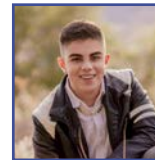
Therapeutic Incentive Spirometer with Digital User-Interface

22

Post-operative pulmonary complications significantly increase patient mortality. Spirometers are simple medical devices that help improve lung function through guiding sustained inhalations. Conventional devices lack the objective feedback needed to monitor patient adherence outside of healthcare provider supervision. This projects aims to design a compact, ergonomic spirometer with an integrated user interface that tracks proper usage. Together, this device provides reliable feedback to healthcare providers while incentivizing patient compliance through real-time feedback and engagement.

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23

Solar-Powered Ocean Camera Buoy Development

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Our project will be a buoy that will utilize solar energy to operate an underwater camera and internal data collection and processing which can be tailored depending on client requirements. The camera will be powered by a battery, which will be charged by solar panels. There will be a router used for wireless communication with an external antenna. A microcontroller will be used to turn on and off the system when it's not needed to conserve energy. The solar charge controller will control the power flow from the solar panels to the battery and DC load. And a computer will be used to process data from the camera.



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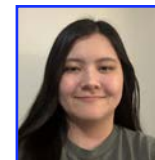
24

Waste Heat to Warm Cities: Using Micro-Data Centers to Decarbonize Seattle

Much of Seattle's heating is currently done using fossil-fuel based heating systems, such as natural gas combustion and district steam. Converting those systems to electric heat pumps is a great method of decarbonization. This project involves designing a heat recovery system in vacant office space in downtown Seattle to capture and repurpose the great amount of waste heat generated by micro-data centers, so that the building owner can meet decarbonization goals and have a better and cheaper way to heat their building.

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25

SmartPDN: Forging the Future of Scalable Power Delivery

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SmartPDN is an early-stage chip power modeling tool developed in collaboration with Micron Technology. It allows engineers to describe a chip's power system using simple input files containing chip design information such as its components and connections, then generates chip visualizations, design scripts, and simulation-ready circuit netlists before the full chip layout is completed. By supporting early impedance estimation, hierarchical modeling, and simplified circuit generation, SmartPDN helps engineers explore design options earlier in the development process, improve consistency between design intent and implementation, and reduce risks of costly issues later in semiconductor design.



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26

Using Machine Learning to Translate In-Situ Battery Measurements to Optimize Battery Performance

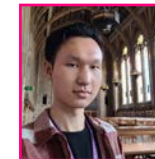
In collaboration with Microsoft, we developed a machine-learning pipeline to track the contributing factors behind battery swell in Microsoft Copilot PCs. Battery swell is a persistent issue in lithium batteries that arises from electrochemical processes that current methods cannot effectively predict from within the device. This project aims to monitor and estimate swell using on-device resources, enabling better control of its progression. To this end, we analyzed extensive battery data gathered by Microsoft's Battery Lab to identify the features most correlated with swell and developed scripts to capture device data and feed it into our prediction model.

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27

Advanced System for Testbed Recording and Analysis

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AISTRA is an intelligent engineering assistant developed for NASA JPL robotic testbeds. Our system reduces operator workload during long duration missions by automatically capturing voice observations and syncing them with live hardware data. Using WebRTC and the OpenAI STT API, AISTRA transcribes speech in real time. It then queries the InfluxDB telemetry pipeline to fetch the exact sensor values from that specific moment. Finally, a LLM synthesizes both inputs into a structured, searchable engineering note. This event driven approach ensures every spoken observation is instantly backed by hard data, creating a highly traceable timeline for aerospace engineers.



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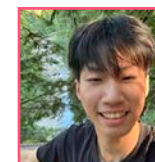
28

AI Framework to Automate Reverse Engineering of the Service Interface of Embedded Elevator System

This project presents an AI-powered framework for the autonomous reverse engineering of proprietary Otis elevator service interface protocols, extensible to competing platforms. Using a stimulus-response methodology on an elevator simulator, the framework monitors serial communications, maps state transitions with protocol messages, and generates structured documentation by clustering diagnostic symbols into their signal state groups. Through a structured data collection process, engineers can feed elevator data into the system, eliminating manual protocol decoding. The framework enables querying of the elevator controller for specific signal states, bypassing the diagnostic tool entirely.

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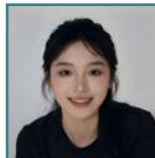
29

Distributed AI and Maritime Traffic

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This project develops a distributed system for real-time tracking and prediction of trans-oceanic vessels using clipper race telemetry and AIS data. Built on the Parant framework, our system enables dynamic communication across distributed nodes, including data ingestion, vessel nodes, and a marine overview interface. Beyond tracking, we explore transformer-based models for trajectory prediction and investigate the integration of environmental factors such as wind and ocean currents. Our work highlights both the challenges of limited maritime data and the potential for intelligent, predictive marine systems.



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Positive / Negative Torque Control

In collaboration with UW, E-Truck, and PACCAR, our team contributed to the electrification of a donated truck chassis. To advance this initiative, we developed torque logic using Simulink, CANalyzer, and Raptor, for deployment on the electronic control unit. Prioritizing safety and efficiency, our software ensures precise and reliable power delivery to the wheels all while using SAE J1939 standards for easy integration and seamless adaptation.



30

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Battery-Truck Plant Model

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The Battery Truck Plant Model is a PACCAR-sponsored UW ECE capstone project focused on developing a system-level MATLAB/Simulink model of a battery electric truck. The model integrates major subsystems, including the high-voltage battery, motor drive unit, vehicle dynamics, controller, and thermal monitoring. Using CAN test data from the actual truck, the team will calibrate and validate the simulation to study energy use, acceleration, braking, range, and subsystem interactions. The final deliverable is a modular, documented plant model that supports performance analysis and future electric truck development.

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Charging HW & SW

The charge control unit (CCU) of an electric vehicle is an integral component, as it regulates the current flow between the charging station (EVSE) and the vehicle's battery. As the truck is converted from a diesel-based system to an all-electric vehicle, the CCU must process an increased number of signals from other components, such as the vehicle control unit (VCU). This project involved developing software for the handshake sequence required to initiate charging using CAN bus signal messaging, the Raptor system, and the charging inlet. The software was then tested on physical hardware using hardware-in-the-loop testing with CANalyzer.

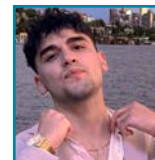
32

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Battery Electrical Interface

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The battery electrical interface project seeks to develop a system connecting a 620 VDC battery to a battery electric vehicle (BEV) truck. In support of UW's E-truck project, this project will integrate and test systems such as a high voltage junction box, DC-DC converters, S-box and ECU. The focus is on creating a safe integration into the E-truck system to ensure proper communication between the different power systems and power distribution for other vehicle functions such as steering, torque, and motor control function.



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Scaniano

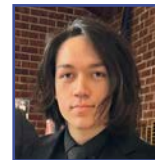
Scaniano2: AI Optical Character/ Music Recognition to QR Code

34

Scaniano is a platform that allows people of all ages to make music without prior experience. Users arrange labeled note cubes on a board, and a scanner is used to convert the blocks to music notes for playback, which can be encoded into QR codes and printed as labels for physical songbooks. Scaniano2 is a continuation of this project, which significantly improved the hardware and features of the prototype. Key upgrades include a custom touch-screen interface and optical music recognition, which allows users to scan both blocks and music sheets with a camera. By integrating the camera and printer interfaces, Scaniano2 provides a scalable, user-friendly workflow wrapped in an intuitive app.

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35

Long-term Cellular Signal Quality Logger

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Our solution supports Seattle City Light's smart switch deployment via data-driven site qualification. We built a battery-powered LTE signal quality logger measuring RSSI, RSRQ, RSRP and SINR over months optimized for ultra-low power on our custom PCB designed for outdoor deployment. Robust firmware pairs with a scalable website to visualize device health, GPS location, ping time and outage patterns in real time. This end-to-end pipeline reduces installation risk and enables informed deployment decisions for switch locations, accelerating Seattle's shift from legacy grid infrastructure to a connected smart electric grid.



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Snohomish County PUD

Darrington Community Microgrid

36

In partnership with Snohomish PUD, our team developed multiple microgrid designs that aim to reduce utility costs and provide outage support for the critical loads of the remote community of Darrington, WA. HOMER PRO and Helioscope were utilized to recommend optimized battery and solar array sizes. Additionally, design aspects were developed for a micro-controller that maintains system stability between changing operation modes and worst-case scenarios. While designs supporting existing load profiles were technically viable, their associated costs were exorbitant enough that we also designed and recommended a full HVAC retrofit, enabling a significantly more cost-effective microgrid solution.

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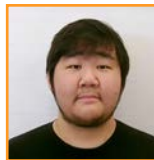
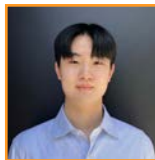
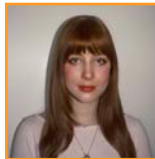
37

Demand Response Applications for Utilities

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Snohomish County Public Utility District is exploring automated demand response to manage the growing number of distributed energy resources (DERs). This project investigates communication between utilities and residential devices using the IEEE 2030.5 communication standard. We develop a simulated client-server environment modeling utility-issued control events and device responses. The system includes device identification, event scheduling, polling-based communication, and status reporting. Results demonstrate the feasibility of standardized DER communication while highlighting challenges in certificate management and interoperability, informing scalable real-world deployment.



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Tacoma Power

38

Dynamic Line Rating Deployment Feasibility Study

Modern power grids face increasing load demands, forcing utilities to improve efficiency instead of pursuing costly infrastructure upgrades. Our team was tasked with evaluating Dynamic Line Ratings (DLRs) as a feasible alternative. This evaluation was done by developing a tool that calculated theoretical DLR ratings through an analysis of historic weather data. These ratings were then compared to Tacoma's existing methodology. We also identified transmission routes that would benefit most from DLR implementation. We concluded that DLR technology would increase line ratings by a meaningful margin, thereby allowing Tacoma to safely meet load demands without requiring expensive upgrades.

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39

Monocular Cable Layer Segmentation and Dimension Measurement

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This project presents a cross-platform mobile application for industrial cable dimension measurement. The system integrates AI segmentation (trained on a synthetic dataset) and advanced depth sensing, utilizing a multi-sensor fusion pipeline to support both LiDAR and non-LiDAR devices. To further enhance robustness, we developed an independent calculation framework, effectively mitigating errors from imperfect AI masks. This approach eliminates single-point failures, delivering stable results for professional quality control.

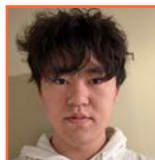
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40

Drone AI: Real-Time 5G Video Analysis and Agentic LLM

This project, a collaboration between the University of Washington and T-Mobile, develops a 5G-based real-time drone video analysis system integrated with agentic LLMs. Drone video and telemetry data are transmitted via 5G to an edge node, where YOLOv12 performs object detection and Gemma3-4B generates captions. GPT-based models handle higher-level summarization and reasoning. Results, including detections and key flight/network KPIs, are stored in a database and visualized through an operator dashboard. The system supports natural language queries via an agent orchestrator and features an end-to-end, real-time, asynchronous processing pipeline.

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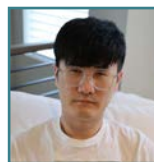
41

Autonomous Algorithm Development for Exploring Deep-Sea Hydrothermal Plumes

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The Autonomous Vent Finder project utilizes Gaussian regression, machine learning, and computer vision to locate deep-sea hydrothermal vents using an autonomous underwater vehicle. These vents discharge plumes that spread thousands of kilometers. They sustain distinctive deep-sea ecosystems and have large impacts on global ocean biogeochemistry. As the AUV traverses the plume, it collects plume-related data using onboard sensors and estimates the vent location. By training the algorithm to adapt to the changing conditions of the plume, the AUV can re-align itself to locate the vent more efficiently than traditional methods, which rely on pre-programmed paths and post-dive data analysis.



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42

Profiling the Ocean for Health

Expendable conductivity-temperature-depth profilers (XCTDs) record salinity and temperature profiles across depths to assess ocean conditions. These single-use devices often cost thousands of dollars per unit, creating an economic barrier for oceanographic research. We introduce Ion-XCTD: a lower-cost platform that preserves core XCTD functionality, integrating UW-APL's recently developed ion-potential-based salinity sensor, a depth sensor, and a temperature probe. Ion-XCTD houses its embedded system in a waterproof enclosure and collects data as it descends via a spooled tether. The collected data is sent up the tether to a floating buoy where, it is wirelessly relayed to a remote receiver.

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Enabling a Novel Low-Cost Salinity Sensor through Machine Learning

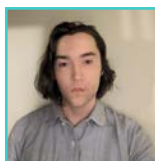
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We developed a robust machine-learning framework that corrects long-term drift in low-cost salinity sensors. Salinity data is vital for monitoring ocean health, tracking climate change, and managing sustainable aquaculture, yet high-quality equipment is often very expensive. While these low-cost sensors offer a scalable alternative compared to more expensive conductivity-temperature-depth instruments, they suffer from physical degradation like membrane hydration and ionophore leaching. By analyzing time-series data, which includes features such as voltage, impedance, and temperature, our model automatically separates true environmental variations from apparent changes caused by sensor drift.

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44

SmartHook - An Underwater Robot for Attaching Recovery Lines

Ocean floor sensors are required for a variety of data collection purposes. Generally these are attached to buoys for ease of location, however there are times when standalone ocean floor systems are desirable. Current solutions to recover these untethered sensors are expensive and require specialized retrieval tools.

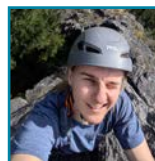
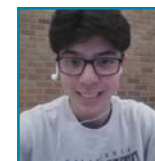
The Smarthook is a low cost adaption kit for a BlueROV that allows users to attach it onto generic recovery lines and is equipped to handle high loads. It is designed to autonomously locate and latch onto ocean floor sensors, thereby reducing operational costs and improving efficiency.

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45

Prototyping a Self-sufficient Harvester of Electricity-Water (SHEW) for Tall Buildings

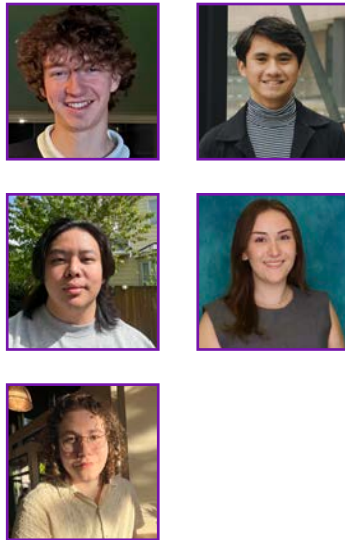
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The SHEW project seeks to develop a prototype system for harvesting electrical power by utilizing the collection of rain-water in conjunction with a hydro-turbine. With the help of UW CEE, among others, this project aims to design and test the feasibility of a compact hydroelectric system. The prototype consists of a rainwater collection tube and several systems that automate the release of water to drive a turbine. With the capability of producing energy for small and large-scale urban buildings, the system will store power for future use by smaller devices. The power produced can be used to support critical systems such as data centers and communication networks during power outages.

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46

Computer Vision Pipeline to Detect, Track, and Quantify Feeding Habits of Katmai NPP Alaskan Brown Bears

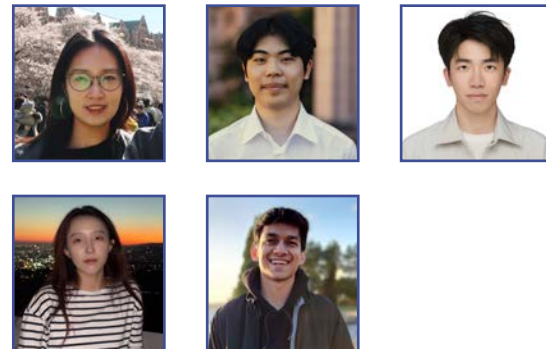
We built an open-source computer vision pipeline that automatically identifies, tracks, and counts Alaskan brown bears from live webcam footage from Katmai National Park, achieving 91% recall using fine-tuned YOLOv8 and ByteTrack. The system also quantifies individual feeding behavior and integrates real-time environmental data to produce structured ecological research insights. Katmai is home to 2,200 bears that congregate annually at Brooks Falls to feed on spawning salmon. Monitoring one of the most concentrated wildlife spectacles on Earth, however, currently relies on error-prone manual observations. Our project addresses this problem and improves ecologic measurements through continuous computer vision data analysis.

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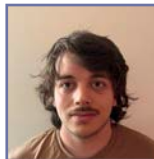
47

Miniaturization of UWMC Medical Equipment Asset Tracking Device

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Every month, 10-15 pieces of medical equipment go missing at UW Medical Center because current tracking devices lose power and go silent, which costs the hospital \$30 per replacement and hours of staff time. Our team is building a smarter, smaller asset tracker with a long-lasting battery, motion-based smart wakeup, and a live dashboard that sends maintenance alerts so staff always know where every device is. We're turning a chronic, expensive problem into a solution that hospitals can actually use to track these expensive tools.



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UW Medical Cyclotron Facility

PLC Test Bench

48

This project develops a reliable, external testbench for the UW Medical Cyclotron Facility (UWMC). The testbench is meant to serve as a safe environment to test updates for the Programmable Logic Controller (PLC) system before pushing them to the main system. We focused on compiling a Standard Operating Procedure (SOP) for the software and hardware components of the test bench and trained the UWMC staff on using the testbench environment. By building a separate, independently functioning PLC testbench, where new hardware and software designs can be implemented and tested, plant reliability will be increased and cyclotron downtime will stay minimal.

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UW Neurological Surgery

49

Bidirection Neural Test Interface

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Our project is a closed loop, bidirectional, neural testing interface. Utilizing the Cirtec CSI040 and CSI080 neural sensing and stimulation chips, we have created custom PCBs that allow us to sense neural signals and send stimulation signals. The sensing is also recorded and displayed on a connected computer to allow a user to easily analyze the recorded data. The stimulation signals can both be manually controlled by a user, or automatically sent based on what was sensed. The system as a whole is an easily interchangeable and modular system, used for testing different aspects of a neural interface.

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Optical Triangulation Platform for the Study of Ionospheric Transient Events

50

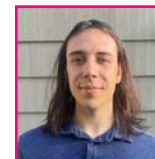
Meteor entries deliver both atmospheric physics and impact hazards, yet existing networks reconstruct trajectories with straight-line fits that discard curvature and fragmentation signatures. We develop a three-station optical triangulation platform that reconstructs curved-path trajectories. Each station streams 4K monochrome imagery at 30 fps through a 130° fisheye lens with sub-millisecond GPS timestamps. A software ring buffer preserves 10 seconds of pre-trigger frames before each detected event. At 30 km baselines, the network triangulates 70% of usable sky and resolves 0.3° curvature on bright fireballs, enabling deceleration profiling and fragmentation-induced lateral velocities.

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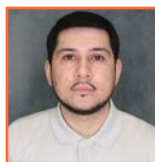
51

Low Power Magnetic Linear Actuator for Camera Positioning

Authors

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Wide-angle lenses bend and stretch images, which makes them a poor choice for astronomers studying and taking accurate data measurements for meteor observations. This project builds a small, battery-powered cart that slides a camera back and forth along a track driven by magnets, letting the camera use a regular lens to capture a wider view. The cart is moved by a reliable custom magnet and coil system using very little battery power. A small computer keeps the camera's position accurate to within a millimeter and lets the user control everything wirelessly from a phone or laptop.



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Gas-Leak Autonomous Sensing, Localization, Evaluation, and Active Detection (GASLEAD) System

GASLEAD (Gas Leak Early Anomaly Detection) is an autonomous vibration-based sensing system designed to detect compressed gas leaks in industrial manufacturing environments. Sensor nodes clamp onto compressed air lines, continuously capturing high-frequency pipe vibration data and transmitting it wirelessly over a LoRa network to a central hub. A machine learning model analyzes the data and identifies anomalous vibration signatures indicative of turbulent flow caused by leaks. Unlike traditional methods, GASLEAD operates non-intrusively without requiring system shutdowns or manual inspection, helping facilities reduce energy waste, lower operational costs, and improve workplace safety.

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53

Smart Enclosure Design for Resilient Measurement Systems

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The IonoSense System provides thermal and humidity management for sensitive signal measuring equipment in harsh outdoor environments. It uses two physically isolated enclosures for its analog and digital subsystems. The analog enclosure protects against EMI and maintains low-noise operation, while the digital enclosure handles data acquisition and active thermal control using infrared temperature sensor readings to drive PWM fans and polyimide heaters for stable internal conditions. The SHT31 humidity sensor serves as an excess humidity alarm. Signal integrity is protected through copper shielding and filtered connectors. Applications include space weather monitoring and geophysical sensing.



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MiniDICE: General-Purpose Dataflow Intelligent Compute Engine

MiniDICE is a general-purpose dataflow intelligent compute engine: a CGRA-based GPU core taped out in TSMC 180nm. Conventional GPUs use wide SIMD backends that offer high throughput but spend substantial energy on large register files and repeated operand movement. MiniDICE replaces that backend with a 4x4 INT16 CGRA, executing dataflow graphs directly from bitstream configurations to keep operands local. The chip includes the scheduling, control-flow, routing, register, and memory-access support needed for SIMT-style execution across 32 threads, with BaseJump STL's bsg_link providing a lightweight packetized off-chip interface for scalable chip-to-chip communication.



54

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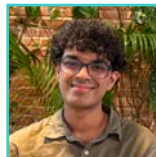
55

Systolic Array Matrix Multiplication Accelerator (SAMMA)

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Our project aims to compare the industry-standard Systolic Array-style Matrix Multiplication Accelerator ASIC designs (Vanilla), similar to Google's latest TPU7x (Ironwood), comparing it with PNCel Lab's prototype Twisted Torus arrangement code-named Pipette. PNCel's arrangement uses a pipelined mesh with a double-buffer and a custom weight-loading algorithm to eliminate staggered shift-register loading. Our design will be taped out on the TSMC 180 nm process node, with a target frequency of 50 MHz. We will tape out two chips with matching instruction sets, allowing us to compare the PPA and measure the gain of Pipette over Vanilla.



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uLED Optical Signal Recovery

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This project presents a physically implementable ASIC for optical signal recovery in uLED communication systems. The design integrates a configurable 25-tap FIR equalizer and a Temporal Convolutional Network (TCN) accelerator to reduce inter-symbol interference and noise in sampled optical signals. Implemented in TSMC 180 nm technology, the chip supports programmable filtering, runtime configuration, and a complete RTL-to-GDSII implementation flow. Experimental results show that the TCN-based recovery achieves higher classification accuracy than the FIR baseline under noisy ISI conditions, demonstrating the potential of neural temporal processing for future high-speed optical receivers.



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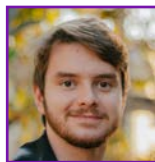
57

Tactile Sensing Compute Chip

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This project implements a custom multi-chip deep learning accelerator (DLA) ASIC for low-power edge inference of a quantized CNN+GRU classifier on 16×16 imagery at 30 fps. Up to 62 DLA chips connect in a ring through bsg_link DDR source-synchronous IO, orchestrated by a single CTRL chip. Each DLA executes a custom 32-bit ISA (compute, strided conv, SFU activations, element-wise gating, AM->IMB recurrent copy, cross-chip kickoff) with 8-bit operands, dual input memories enabling on-chip GRU recurrence, NDP parallel dot products over 16-element vectors, and per-chip SPI flash weight storage. A piecewise-linear SFU provides ReLU, sigmoid, tanh, exp, logit, one-minus, and requantize.

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58

Tactile Sensing Control ASIC

We present a control ASIC for a tactile sensing system that captures pressure data from a 16×16 sensor glove and offloads inference to a companion convolution accelerator chip. A SERV RISC-V core orchestrates the pipeline: scanning sensors through an SPI ADC, streaming frames over a high-speed chip-to-chip serial link, and reporting results to a host via UART. The chip integrates a full SoC with on-chip RAM, peripheral controllers, and runtime-loadable firmware. We prototyped the design on a DE1-SoC FPGA with the full sensor hardware connected, demonstrating end-to-end operation. The design targets silicon manufacturing for tapeout.

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59

Reconfigurable Tensor Array

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We propose a dual-mode reconfigurable fabric that combines TPU MXU-style systolic dataflow with CGRA-style pipelined spatial execution on the same array. Modern AI workloads interleave dense GEMM kernels with non-matrix operators such as activation functions, elementwise arithmetic, normalization, softmax, reductions, and other non-linear transformations. These are often handled by separate vector units, increasing data movement and integration overhead. Our design explores a unified, tapeout-feasible fabric that can morph between deterministic systolic execution and compiler-scheduled CGRA pipelines on a single chip.

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Analog Neural Network

60

This project presents the design of a high-speed analog neural network implemented in TSMC's 180nm CMOS process. The network performs inference entirely in the analog domain, including both multiply-accumulate operations and activation functions, supporting signed weights without reliance on non-volatile memory elements. By keeping the signal chain fully analog and bypassing the overhead of analog-to-digital conversion within the computational core, the design aims to achieve high throughput at reduced power compared to conventional digital approaches, targeting input signal bandwidths up to 100MHz.

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61

Delta-Sigma ADC for Wearable Radiation Dosimetry

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Advancements in radionuclide imaging and therapy require portable, low-power electronics for at-home biomedical monitoring. This project presents a noise-shaping analog-to-digital converter (ADC) integrated onto a radiation dosimeter ASIC for tapeout in TSMC 180 nm CMOS. Using a 2nd-order delta-sigma modulator with programmable digital filtering, our ADC aims to provide a selectable resolution of 9 to 14 bits at 500 kSPS with a 32 MHz clock. The goal of this work is to create a low-cost, low-power integrated circuit to enable research of at-home dosimetry and the future miniaturization of wearable biomedical devices.



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Cryogenic RF Frontend for Qubit Readout

Qubit readout uses 2-8 GHz RF signals reflected from superconducting/spin qubits, with information extracted from the phase shift of the returned signal. This project explores integrating a novel CMOS isolator with a low-noise amplifier (LNA), power amplifier (PA), and attenuator to build a fully CMOS RF front-end for qubit readout operating at cryogenic temperatures (~4 K). Operation at 4 K introduces challenges due to unpredictable behavior in active CMOS devices. This work aims to enable a scalable CMOS RF front end for quantum systems, increasing qubit density while reducing cost and area of cryogenic quantum computing platforms.



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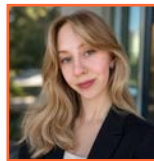
63

Direct VCO Modulating FM

Authors

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This project presents the design and implementation of an FM Transmitter utilizing a phase-locked loop (PLL) with in-loop modulation. The system employs a narrow loop bandwidth to ensure a precise carrier frequency within the FM frequency band whilst allowing an input audio signal to directly control the voltage-controlled oscillator (VCO). The modulator is tunable across the standard FM range of 88–108 MHz, demonstrating both flexibility and stability for communication applications.



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Analog Front-End Readout for a Wearable Radiation Dosimeter in Neuroendocrine Tumor Therapy

Peptide Receptor Radionuclide Therapy (PRRT) requires careful dose optimization to deliver sufficient radiation for tumor control while minimizing unnecessary exposure to healthy organs. This project develops a self-clocked analog front-end readout for a wearable radiation dosimeter. The system processes sensor-induced pulses through two complementary paths: a fast self-clocked comparator path that extracts time-over-threshold information, and a slow integrator path that accumulates signal charge for localized dose estimation.

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Discontinuous Instrumentation Amplifier for Low $1/f$ Noise Biomedical Amplification

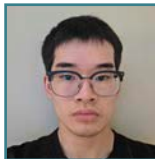
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This project presents a discontinuous instrumentation amplifier designed for high-precision biomedical signal acquisition, such as EEG and ECG. A primary challenge in these applications is $1/f$ noise, which often obscures small differential signals. To address this, we implement a bias-switching technique that periodically drives the amplifier into deep accumulation, significantly reducing flicker noise. The architecture features a gain-boostered telescopic cascode with a fast-startup bandgap reference, targeting a 100dB open-loop gain and 100MHz GBW. This design optimizes power efficiency and noise performance for next-generation wearable biomedical sensors and brain-computer interfaces.

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Exploration of Low Cost Solutions for Sub-THz Phased Array Systems in TSMC 180nm

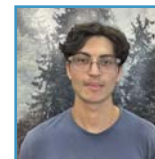
Authors

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Modern mm-wave systems need interconnects that are low-loss, compact, and low-cost. This project explores sub-THz phased-array support structures in TSMC 180nm by studying how RF signals cross chip-to-chip and chip-to-dielectric boundaries. The work includes a Marchand balun with GSG/GSSG probing to characterize wirebond and E-jet interconnect performance, a dielectric waveguide launcher for low-loss contactless signal transfer, and a sample-and-hold test structure for accurate phased-array bias control. The goal is to improve signal transfer near 200 GHz while maintaining matching, phase integrity, and practical measurement access. It also supports future beamforming IC validation.

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67

Exploring Quantum Error Reduction with Amazon Braket

Authors

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Students will build on a foundation in quantum mechanics and circuit-model quantum computing to create a series of explainer laboratory notebooks that explore quantum error suppression, error mitigation, and error correction. Students will leverage the unique capabilities of Amazon Braket — including access to real QPUs, on-demand simulators, and integration with other AWS services — to scale their experiments beyond what is possible in a purely simulated environment.

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Microsoft

Benchmarking Tetron Arrays Using Random Circuit Sampling

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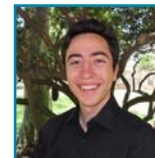
This project translates Google's 2019 quantum advantage demonstration through random circuit sampling, into Microsoft's measurement-based quantum computing (MBQC) tetron architecture, where Majorana qubits compute via joint fermion parity measurements rather than unitary gates. We simulate an 8x3 tetron array reproducing Sycamore's rectangular lattice nearest-neighbor connectivity. All 30 of Google's 12-qubit circuits are converted into MBQC equivalents decomposed into Qiskit-compatible form and benchmarked via Linear Cross-Entropy Difference against published bitstrings. The resulting open-source pipeline supports future MBQC simulations and informs Microsoft hardware R&D.

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69

Implementation of Extended Stabilizer Simulator for Erasure Noise Simulation

Authors

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Many quantum computing platforms: photonic, neutral-atom, and distributed architectures, exhibit detectable loss and leakage errors that are well modeled as erasure or flag channels. While existing frameworks support qudit simulation, they are often limited in circuit formats and do not fully handle composite-dimension or heterogeneous (qubit-dit) systems. We develop ExStabSim, an extended stabilizer simulator within the PNNL quantum simulator framework that supports higher-dimensional systems and incorporates erasure and flag error channels as native qudit operations. ExStabSim enables scalable evaluation of QEC under realistic noise, supporting the design of fault-tolerant quantum systems.

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PsiQuantum

Quantum Routines: Implementation, Verification, and Resource Estimation

70

As quantum computing matures, basic algorithms are needed to begin implementing software while abstracting the underlying hardware implementation. These algorithms include adders and multipliers, and are restricted by the rules of quantum computing to be unitary and reversible. They should also be as efficient as possible, utilizing minimal resources. We examine several such algorithms, writing up new implementations in code for the PsiQuantum Workbench platform and documenting their resource usage.

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71

Optimal Design of Evaluation Point in Error-Budgeting

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Riverlane's open source Python SDK DeltaKit benchmarks Quantum Error Correction (QEC) using Logical Error Probability (LEP). The Threshold theorem identifies the noise level where increasing code distance improves performance, quantified by the error scaling parameter. High lambda values indicate superior error suppression with fewer qubits. DeltaKit's new error-budgeting feature estimates error contributions by evaluating inverse lambda across noise levels. To enhance precision, we optimize point selection beyond standard linear or logarithmic spacing. By minimizing standard deviation, the tool provides highly accurate performance metrics for near-future error-corrected quantum hardware.



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Active-Noise-Aware Qubit Mapping via Monte Carlo Tree Search and Reinforcement

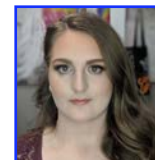
Qubit mapping is a crucial step in quantum computing in which virtual qubits from a given coded circuit are translated to optimal physical qubits in order to maximize algorithmic performance within hardware constraints. However, the translation between virtual and physical qubits is not simplistic, and challenges arise when considering the connectivity constraints, noise heterogeneity, and exponential search space with increasing the number of qubits. Here, we will present our results in improving qubit mapping by implementing a Monte Carlo Tree Search (MCTS) algorithm with reinforcement learning in order to improve the final circuit fidelity.

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