Summer Research Projects 2027

University of Delaware

Explore faculty research projects and the skills associated with each opportunity in the 2027 Summer Research Program.

Project 01

Project title: Fast Generative AI for Satellite Imagery and Compressive Sensing

Faculty supervisor: Prof. Gonzalo Arce

Website: https://www.eecis.udel.edu/~arce/research.html

Description: This project focuses on developing, implementing, and evaluating fast generative AI models for satellite image super-resolution and reconstruction from compressive measurements. Students will explore methods that combine high-quality image recovery with computational efficiency, enabling the processing of satellite imagery at a global scale.

Project 02

Project title: High-Resolution Satellite SAR Tomography and Multisensor Integration

Faculty supervisor: Prof. Gonzalo Arce

Website: https://www.eecis.udel.edu/~arce/research.html

Description: This project aims to bridge the resolution gap between elevation data derived from airborne and satellite synthetic aperture radar (SAR). Students will investigate methods for high-resolution satellite SAR tomography and evaluate how measurements from multiple co-orbiting sensors can improve elevation reconstruction.

Project 03

Project title: Learning Shared and Unique Representations from Multimodal Data

Faculty supervisor: Prof. Austin Brockmeier

Description: Investigate how neural-network optimization can align representations of two data modalities while preserving information unique to each view. The project develops a principled approach using shared views or labeled data to distinguish shared and unique information, with applications in biomedical research and remote sensing.

Required skills: Skills necessary are an understanding of statistics, probability, signal processing, machine learning, and computer vision.

Project 04

Project title: Learning Meaningful Representations from Data: When Does Theory Matter in Practice?

Faculty supervisor: Prof. Burak Varıcı

Website: https://bvarici.github.io/

Description: Examine which assumptions in causal representation learning are essential for recovering underlying structures and which can be relaxed in practice. Under the PI's guidance, the student will study theoretical foundations, develop practical approximations, and test them experimentally to identify effective compromises between theoretical guarantees and learning from imperfect data.

Preferred skills: Python programming and some experience with PyTorch or another deep learning framework. Coursework in linear algebra, probability and machine learning. Motivation to explore fundamental research at the intersection of theory and practice.

Project 05

Project title: Large Language Models for Chip Design

Faculty supervisor: Prof. Satwik Patnaik

Description: Compare large language model approaches to chip design by generating Verilog/SystemVerilog designs, developing testbenches, and annotating outputs to evaluate hardware quality, model behavior, and error patterns. The work requires an understanding of digital hardware design and machine learning.

Preferred skills:

- Strong background in machine learning, including LLM architectures and fine-tuning approaches
- RTL coding experience (Verilog/SystemVerilog) and testbench development
- Knowledge of data structures and algorithms (proficiency in Python)
- Self-motivated and able to work independently, with guidance from Ph.D. students
- Hands-on experience with physical design/layout and Cadence tools is an added advantage

Project 06

Project title: Evaluating Quantum Random Number Generators

Faculty supervisor: Prof. Nektarios Tsoutsos

Role: Associate Director, Center for Cybersecurity, Assurance and Privacy

Website: https://udel.edu/~tsoutsos/

Description: Investigate the physical security of quantum random number generators by setting up a basic hardware module to collect random data. The student will run statistical tests for predictable patterns and examine how simple environmental changes affect device output to evaluate its resilience.

Recommended skills: Good analytical and computer programming skills (C/C++ and Python), Linux OS, understanding of computer security principles, interest in hardware security.

Project 07

Project title: Beam-steering Metasurface Antennas for Space Applications

Faculty supervisor: Prof. Mario Mencagli

Description: Design, fabricate, and test a double-layer metasurface antenna intended to radiate linearly polarized waves with beam-steering capabilities. The upper layer uses differently sized rectangular apertures, while the lower layer launches a plane surface wave. Steering is investigated by tuning the distance between the two layers.

Project 08

Project title: Breaking the Bandwidth Limit of Electrically Small Antennas, Resonators, and Absorbers using time modulation

Faculty supervisor: Prof. Mario Mencagli

Description: Design, fabricate, and test time-modulated matching networks intended to expand the operating bandwidth of electrically small antennas, resonators, and absorbers. The project aims to go beyond the Bode-Fano bound, addressing the narrow bandwidth of these devices and the limits on energy transfer from a source.

Project 09

Project title: Metamaterial Analog Computing

Faculty supervisor: Prof. Mario Mencagli

Description: Investigate a cavity-based analog computing platform for wave-based operations such as matrix-vector multiplication. The project aims to address fabrication complexity and reconfigurability challenges in existing metamaterial approaches by using a platform designed for straightforward fabrication and reconfiguration with few signal controls. Work includes design, fabrication, and testing.

Project 10

Project title: Design and improvement of multichannel acoustic measurement systems for aerial and underwater applications.

Faculty supervisor: Prof. Mohsen Badiey

Description: Design, fabricate, and test UAV-mounted acoustic measurement hardware, improving electronic circuits, microphone configuration, enclosure, and transmission-reception synchronization. Laboratory and outdoor experiments will evaluate performance, reduce interference, and improve ground-reflection measurement accuracy. The project also includes developing and experimentally testing an underwater system with a similar architecture.

Required skills: Strong background in electronics, circuit design, and embedded systems. Experience with microcontrollers, printed circuit board (PCB) design, electronic instrumentation, and programming. Preliminary knowledge of and interest in acoustics, mechanical design, and 3D printing are desirable. Ability to work independently on hardware development and experimental testing.

Project 11

Project title: Signal processing and analysis of acoustic measurements for aerial and underwater applications utilizing both conventional and Machine Learning approaches.

Faculty supervisor: Prof. Mohsen Badiey

Description: Develop and evaluate conventional and machine-learning methods for UAV acoustic recordings to detect reflections, estimate surface distances, and determine frequency-dependent ground reflection coefficients. Analyze rotor noise and interference using matched filtering, spectral analysis, noise reduction, and array processing. Extend methods to underwater measurements and compare experiments with numerical propagation models.

Required skills: Strong analytical and mathematical background, particularly in signal processing, acoustics, and applied physics. Experience with Python or MATLAB programming, digital signal processing, spectral analysis, and numerical methods. Knowledge of acoustic propagation and statistics is desirable. Ability to work independently with experimental data and numerical simulations.

Project 12

Project title: Liquid Metal Electromagnetics for Wearables and Soft Robotics

Faculty supervisor: Prof. Nathan Lazarus

Website: https://lazaruslaboratory.com/

Description: Develop soft, stretchable electromagnetic devices for power and actuation using non-toxic, room-temperature liquid-metal coils designed to match the mechanical behavior of skin and tissue. Applications include stretchable sensors for joint protection in older adults, skin-contact haptic interfaces, and untethered soft robots for underwater and subterranean use.