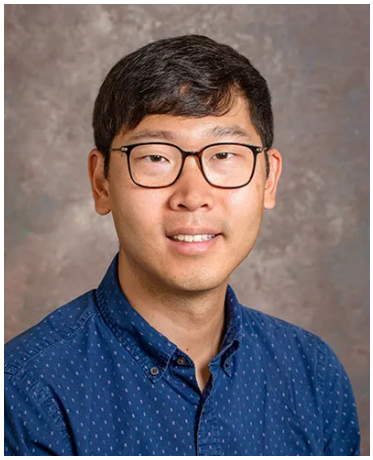
UR-ECE (Undergraduate Research in ECE) REU

2024 Projects

Faculty Advisor	Project Title and Description
 **Ken Barner**	**ML processing of LIDAR drone data** ***Grand Challenge:*** *Restore and improve urban infrastructure* This project will focus on processing volumetric LIDAR data acquired from drones. The goal is to develop 3D models using machine learning techniques. The project will involve acquiring data with a LIDAR capable drone. The acquired data will be machine learning processed to render 3D models. The reconstructed models will also be 3D printed. **Suggested coursework:** signals and systems, analog and/or digital signal processing, programming experience, particularly in Python.
 **Austin Brockmeier**	**Simultaneous localization and mapping with brain waves** ***Grand Challenge:*** *Reverse-Engineer the Brain* Mammalian brains consist of circuits of neurons spatially organized and interconnected. The activity of populations of these neurons produce brain waves that can be recorded as signals with implanted, flexible micro-electrodes. The goal of this project is to see if the occurrence of distinct patterns in the brain waves (local field potentials), which are specific to the circuits involved, can be used to deduce where in the brain the electrode is. **Suggested coursework:** signals & systems, Python/Matlab programming, linear algebra, statistics and/or probability.
 **Hui Fang**	**Scientific Literature Mining** ***Grand Challenge:*** *Engineer tools of scientific discovery* The project focuses on developing machine learning and artificial intelligence tools that can help domain experts to access and mine scientific literature, which can enable new discovery in important science domains such as chemical engineering. **Suggested coursework:** good programing skills in C++/Java/Python, data structure, algorithm.



David Hong

Discovering low-dimensional patterns in messy scientific data

Grand Challenge: *Engineer tools of scientific discovery*

Modern scientific data is both big and messy, e.g., big datasets in genomics and astronomy have heterogeneous noise. An important scientific goal is to discover low-dimensional structure in the data, but heterogeneity in the data can make this challenging. The aim of this project is to contribute to the development of principled unsupervised machine learning methods for discovering low-dimensional phenomenon in heterogeneous scientific data.

Suggested coursework: programming experience (Julia, Python, or Matlab), linear algebra, statistics and/or probability.

Nathan Lazarus

3D Printed Biosensors for Telemedicine

Grand Challenge: *Advance health informatics*

This project will investigate the use of 3D printing, building parts layer by layer from digital files, to print biocompatible elastomeric conductive composites for the creation of wearable biomedical monitors. Important biomedical indicators such as temperature, force, and muscle electrical signals can be measured using a low cost printed part. We envision the ability to rapidly print a complex biomedical sensor on-site from a digital library, ideal for a remote area with limited care.

Suggested coursework: Experience in additive manufacturing, solidworks or sensors is a plus.

Satwik Patnaik

Secure Hardware Design Using Generative Artificial Intelligence

Grand Challenge: *Secure Cyberspace*

Leveraging the power of generative AI, this research focuses on developing advanced techniques to design and fortify hardware systems against evolving hardware-based threats. This project is an exciting opportunity for students to engage in pioneering work at the intersection of AI and cybersecurity, contributing to developing next-generation secure hardware solutions.

Suggested coursework: good programing skills in Python and C, circuits.

Jamie Phillips

Thermoradiative Energy Conversion for Space Exploration

Grand Challenge: *Engineer Tools of Scientific Discovery*

Thermoradiative cells operate like a “solar photovoltaic cell in reverse”, converting waste heat to useful electrical power. This could improve power generation capabilities for space exploration, either to improve the efficiency of space solar cells or to generate electricity from a heat source when solar energy is not available. In this project, students will study new materials to explore their potential for thermoradiative energy conversion, and to develop useful models for these new and exciting energy conversion devices.

Suggested coursework: Physics (Electricity and Magnetism), Circuits, general programming skills.

Nektarios Tsoutsos

New Cybersecurity Tools and Datasets for Cybersecurity Education

Grand Challenge: *Secure Cyberspace*

Securing the cyberspace has evolved as one of the most complex engineering challenges we are facing today. To prepare the next generation of cybersecurity professionals, students in this project will be exposed to a variety of modern cybersecurity tools, develop security solutions, and analyze security vulnerabilities. Students will also develop algorithms, frameworks and datasets related to open cybersecurity challenges.

Suggested coursework: Python/C programming (assembly optional), computer networks, web programming (e.g., Javascript), operating systems (e.g., Linux), cybersecurity.

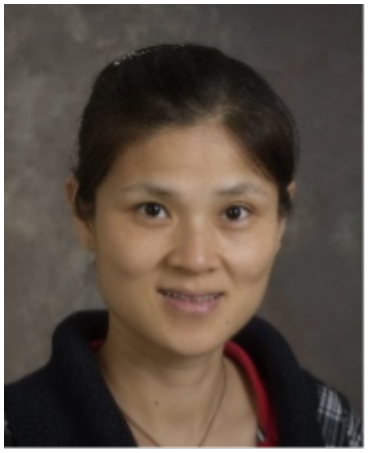
Chengmo Yang

IoT Hardware Security

Grand Challenge: *Secure Cyberspace*

As Internet-of-Things (IoT) allows different smart devices to collect and exchange data seamlessly, sophisticated cyberattacks could be initiated from any IoT device over the Internet. This project centers on the study of side-channel attacks and fault injection attacks in IoT and embedded devices. Students will learn to collect digital signals (e.g., performance counters) and/or analog signals (e.g., power traces) from the target IoT devices, and adopt signal processing and machine learning techniques to detect potential attacks.

Suggested coursework: good programing skills in Python and C, statistics, signals, circuits.



Yuping Zeng

Advancing compound semiconductor device performance

Grand Challenge: *Make Solar Energy Economical*

We seek students who are interested in developing advanced device technology using different material systems, such as GaN, InAs, TiO_2, GeSn through innovations in materials design, device fabrication process design as well as device architecture design.

Suggested coursework: good logic thinking, understanding of how electronic devices work.