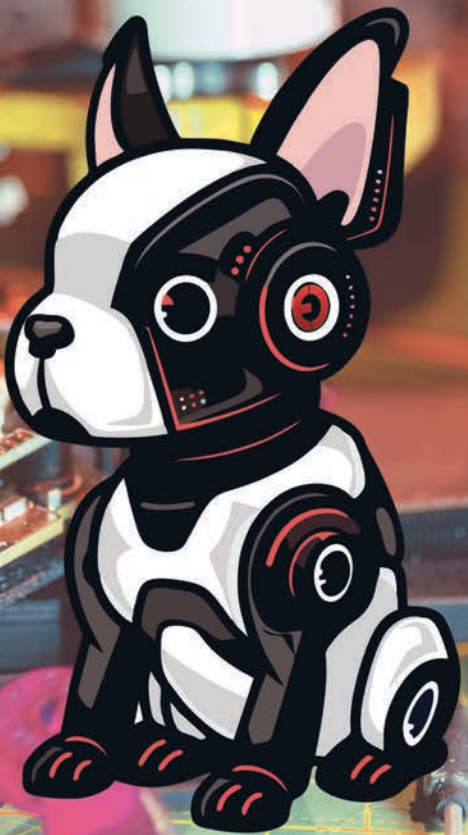
Boston University College of Engineering
Electrical & Computer Engineering

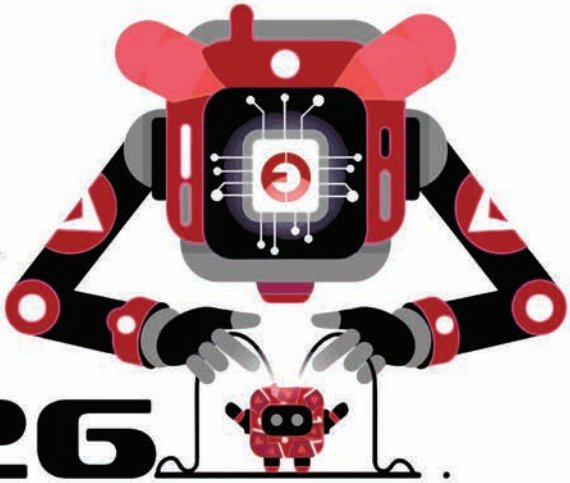
ECE DAY PROGRAM

Senior Design Projects 2026



BOSTON UNIVERSITY

ECE DAY 2026



Friday, May 1 • Photonics Center • 9th Floor

AGENDA

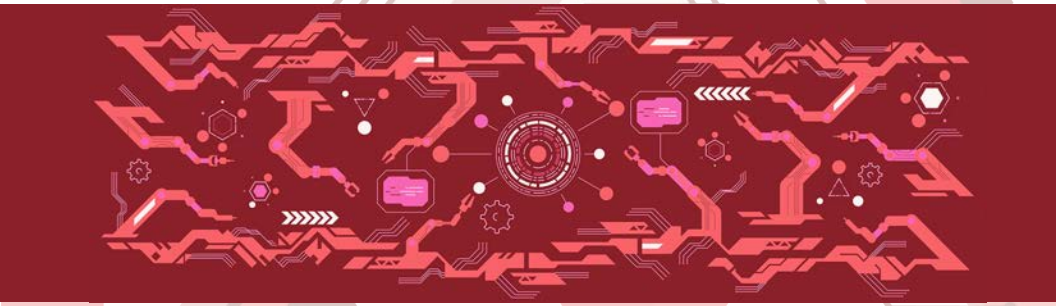
9:00 AM	Breakfast
9:45 AM	Chair's Welcome
10:00 AM	First Demo Session
12:00 PM	Lunch
1:00 PM	Second Demo Session
3:00 PM	Judges Deliberate
3:30 PM	Award Ceremony
4:00 PM	Reception (7th Floor)

ALUMNI JUDGES

Ben Cootner
Ben Duong
Marissa Glassbrook
Eugene Kolodenker
Stanley Nguyen
Andreas Papadakis
Ryan Rosenberger
Bradley Rufleth
Christian So

View the agenda on your phone

CONTENTS



DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

The Boston University Department of Electrical & Computer Engineering (ECE) prepares students to be Societal Engineers for the 21st Century.

The ECE academic experience incorporates guidance from respected faculty members, cutting-edge facilities, a diverse student body and an emphasis on university-wide interdisciplinary research. After establishing a strong engineering theory foundation, students enhance their understanding by developing technical skills.

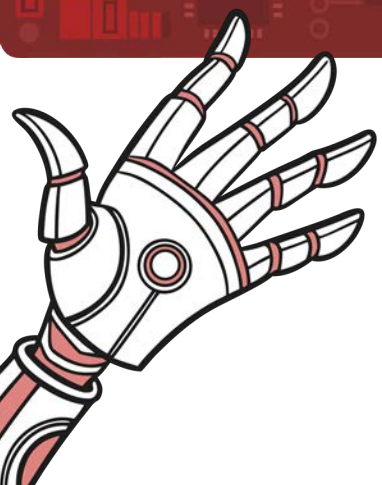
ECE seniors graduate with experience in mobile cloud computing with security, intelligent computation and data science, image and optical science, nanotechnology and bioengineering.

This combination of practical and theoretical education ensures a breadth of experience in innovative problem solving and exploration that will prepare students for careers in industry, academia, and government.

SENIOR DESIGN

The ECE Senior Design capstone course serves as an opportunity for students to execute the education they have gained in the classroom throughout their undergraduate careers, in order to produce prototypes for real-world clients. Student teams serve volunteer customers drawn from industry, government, small businesses, non-profits, schools, artists, faculty, and staff. The course offers:

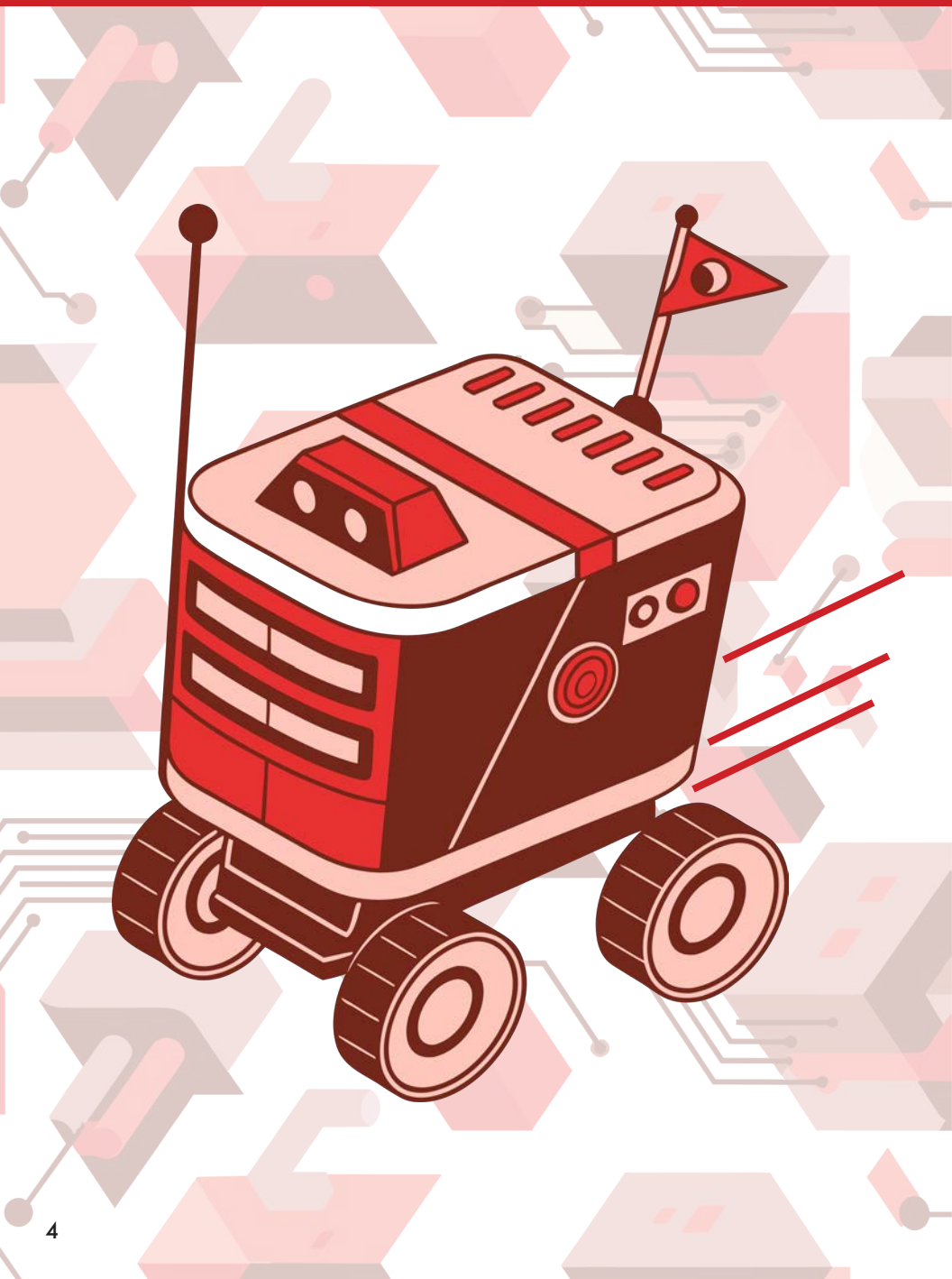
- The technical, communication, individual and teamwork skill-building needed for successful design work in electrical and computer engineering.
- Knowledge of and experience working with specifications and standards, information collection, design strategies, modeling, computer-aided design, optimization, system design, failure, reliability and human factors.
- Proficiency in oral and written communication, particularly when presenting technical information.
- An understanding of team dynamics and ethical issues in design.
- Experience completing a design project for a small-scale electrical or computer system.



ECE DAY AWARDS

- Alan D. Pisano "Systems-in-Practice" Senior Design Award
- Design Excellence Award
- Michael F. Ruane Award for Excellence in Senior Capstone Design
- Entrepreneurial Award
- Societal Impact Award
- Teaching Assistant Award

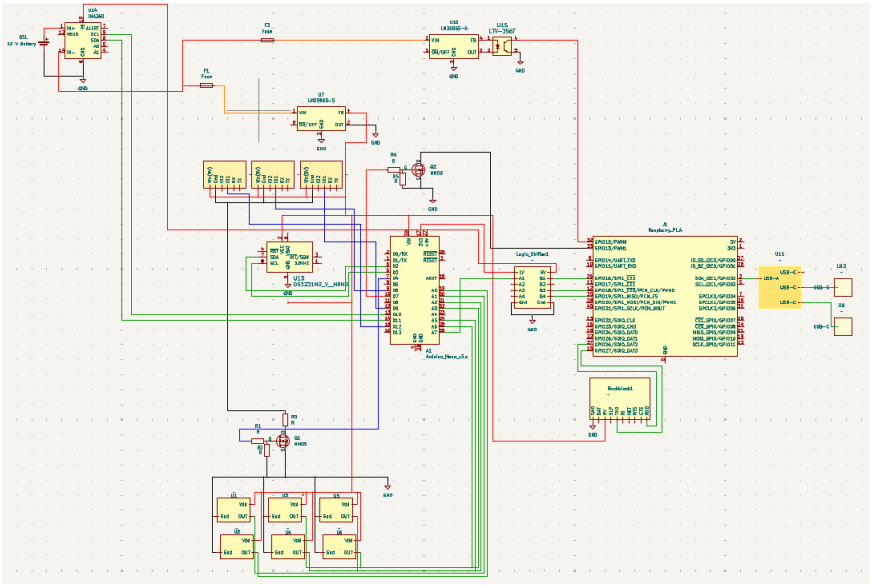
SENIOR DESIGN PROJECTS



TEAM 1 - Polar Eyes

James Conlon, Jackson Clary, Aidan Born, Hieu Nguyen, Zixian Wang
Client: Laura Whitmore

The Polar Eyes system is an autonomous Arctic wildlife monitoring system platform designed to operate continuously for 90 days in extreme sub-zero conditions without human intervention. The system captures 360° high-resolution imagery using Insta360 X5 cameras, triggered by cascaded PIR+mmWave sensor array, while transmitting telemetry data via Iridium satellite.



TEAM 2 - The Pickle, Inc.

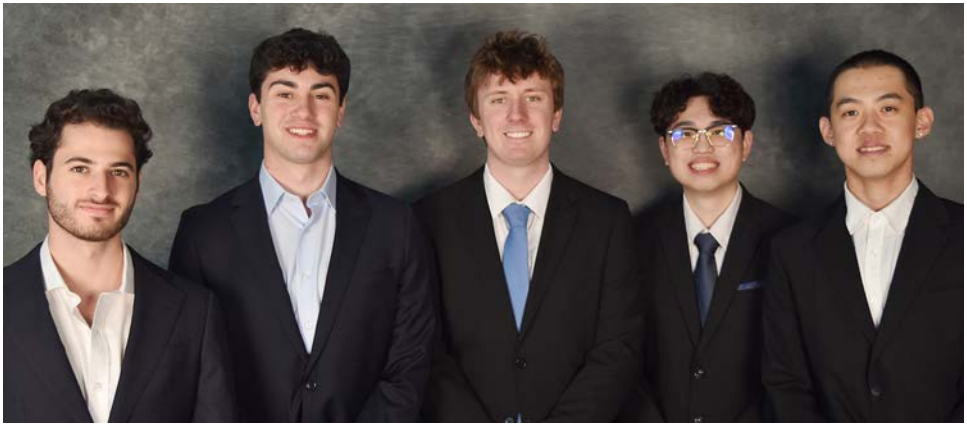
Back: Pippi Pi, Julie Green, Simone Gelman
Front: Vanshika Chaddha, Elena Berrios, Rawisara Chairat

Student-Defined Project

We built a pickleball video game! Compete against AI or play with friends in fast, engaging matches—perfect for house parties or family game nights. Inspired by Wii Sports, the game brings familiar motion-based gameplay into a modern experience with improved graphics and responsiveness.

Our project has two parts: a game built in Unreal Engine and a custom wireless paddle with motion tracking, haptics, and lighting. In-game, AI opponents can move, swing, and strategize. Players choose from six unique "Pickleball Legends" and customize match settings, including rallies and score limits. The paddle tracks real-world movement and sends input via Wi-Fi, so your on-screen character mirrors your actions. Vibrations and lights respond to in-game events for added immersion.

This game brings the fun of pickleball anywhere—ideal for beginners, casual play, or players looking to stay sharp indoors.



TEAM 3 - HUDini

Joseph Attie, Adam Yanai, Ryan Smith, Leo Chen, Hanks Lin

Student-Defined Project

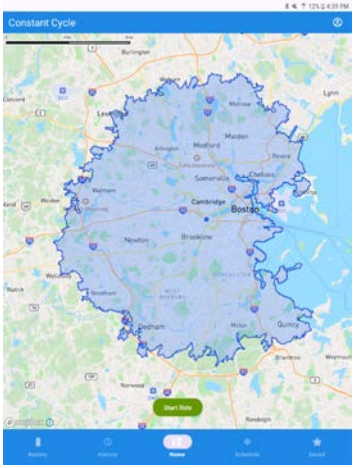
Our product, HUDini, is a pair of smart glasses that enable live, two-way, frictionless communication across languages. The glasses listen for nearby speech, recognize the language, translate it into the user's native language, and present the translation on a display visible only to the user. Additionally, the AI component utilizes relevant context and user data to generate a suggested response to be shown on the display. The response is phonetically typed and accompanied by the translation in the user's native language, allowing the user to directly reply to the original speaker. The product includes a heads-up display (HUD), an integrated microphone, a long-lasting battery, and a high-performance Bluetooth processor, as well as a mobile companion app that allows users to manage their accounts, access device settings, and view previous conversations for learning purposes.

TEAM 4 - Constant Cycle

Back: Alexander Panteleos, Anya Agidi, Jorge Armenteros
Front: Jessica Ramirez, Junseo Lee

Client: Professor Thomas Little

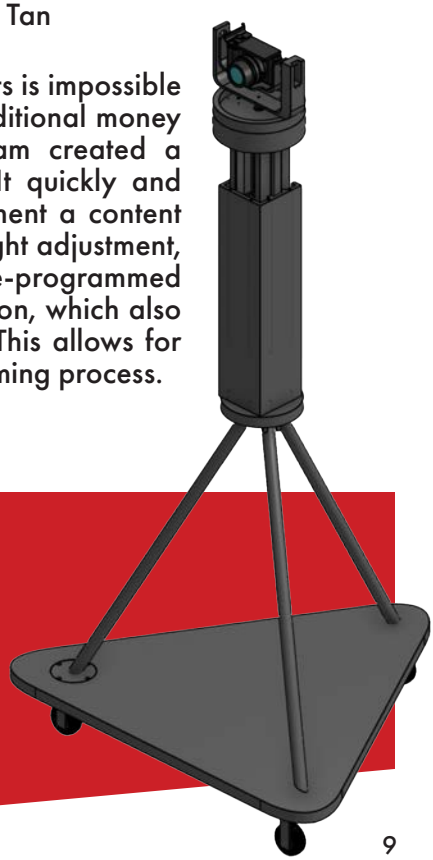
Constant Cycle is a system designed to reduce e-bike range anxiety by combining real-time battery sensing, GPS data, and rider inputs such as assist level and route. An on-bike module measures battery voltage and current, which is transmitted via BLE to a mobile application and backend for processing. The system estimates remaining range, evaluates trip feasibility based on available and required energy, and provides assist-level recommendations when needed. Results are delivered through an intuitive interface that displays battery status, range, and route feasibility, enabling riders to make informed decisions before and during a ride.



TEAM 5 - TakeOne Tripod

Back: Mohamed Sultan, Ksenia Suglobova, Roger Brown
Front: Mirclea Tan, Rafi Uddin, Vallerie Sapphira
Client: Mirclea Tan

For solo filmmakers, filming certain shots is impossible alone, and hiring cameramen costs additional money and limits creative freedom. Our team created a motorized tripod to solve this issue. It quickly and precisely performs any camera movement a content creator may need (panning, tilting, height adjustment, and/or rolling) via real-time or pre-programmed commands sent from a phone application, which also supports real-time footage playback. This allows for complete touch-free control over the filming process.

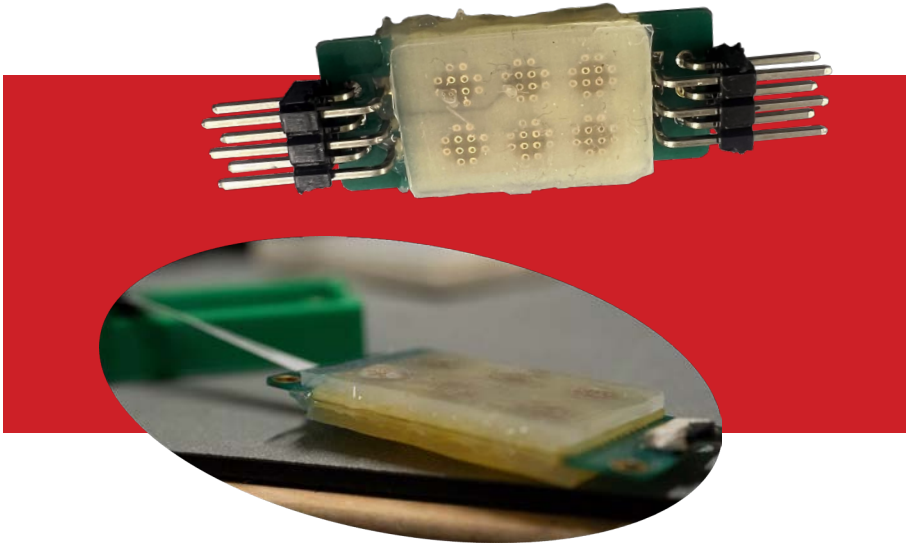


TEAM 6 - Braille

Back: Wenyuan Liu, Tadiwa Zingyongo, Astrid Elder, Charles Van Hook
Front: Leah Jones, Yena Yu

Client: Massachusetts Association for the Blind and Visually Impaired

Visually impaired people face barriers in literacy and independence due to the current refreshable braille devices being expensive, heavy, or incompatible with different devices. Our project aims to fix this by developing an affordable, portable and reliable refreshable braille device.

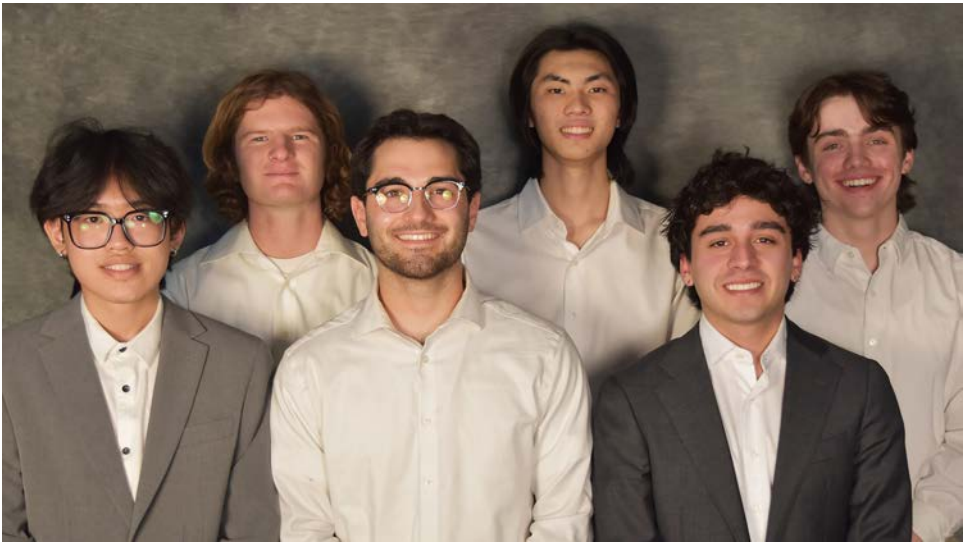


TEAM 7 - Tunebox

Elias Guermazi, Henry Bega, Anas Benhamida,
Bashir Khalil, Sheraz Saadat

Student-Defined Project

The Tunebox is a portable, compact device that attaches to an acoustic six-string guitar, capturing its vibrations and processing them to create electric guitar-like effects. An accessory app provides a non-mechanical, auditory-guided tuning mode that plays specific referenced notes, allowing users to tune their guitar without requiring additional hardware or musical expertise. The app also provides a platform to switch between different electric guitar modes or "presets" for the user to enjoy.

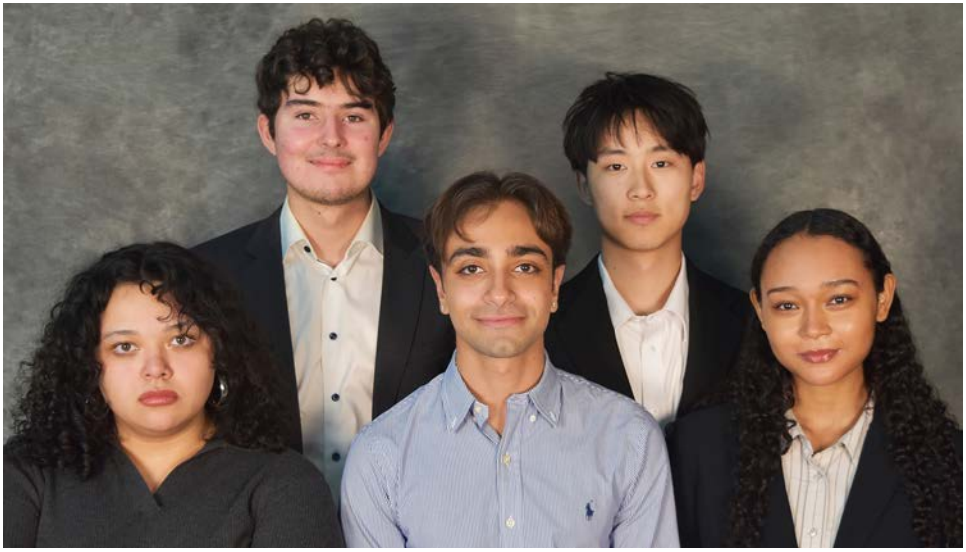


TEAM 8 - H2Open

Back: Larkin Tanner, Dylan Ling, Frederick Grass
Front: Chenyi Jiang, Brian Sahagian, Guillermo Ortega

Student-Defined Project

Our product is an E. coli and Cyanobacteria estimation device that aims to provide real-time water safety assessments for the Charles River and its watershed. The device is a standalone, low-power, and rapidly deployable buoy that contains an array of onboard water property sensors used to estimate E. coli and Cyanobacteria concentrations. Using these estimates, the system predicts whether the water is safe for recreational use and updates a visible signal accordingly. The system also populates a web app with historical water safety data. Using this device, those who swim in, kayak through, or otherwise enjoy the Charles River Watershed can make informed and safe decisions about their summer recreation.

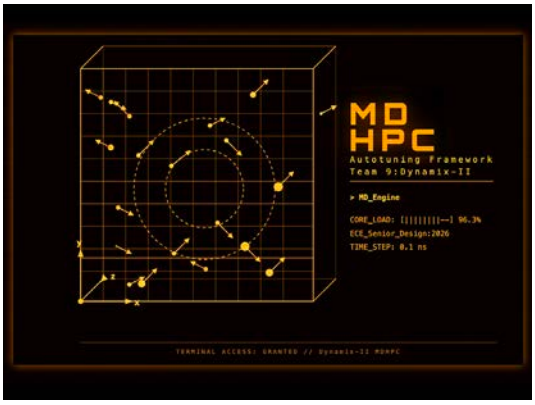


TEAM 9 - Dynamix-II

Back: Alexander Hack, Eugene Seoh
Front: Melissa Regalado, Daniel Gergeus, Cynthia Young

Client: Professor Martin Herbordt

Our project develops an autotuning framework for molecular dynamics (MD) simulations that removes the need for manual optimization. Molecular dynamics simulations approximate particle movement over time by computing the forces that particles exert on one another and moving the particles accordingly. These simulations are of great interest to scientists and drug developers who use this information for protein modeling and drug discovery. Yet, these MD simulations are computationally intensive and long-running which presents a significant incentive for optimization. And since the best code is not universal across hardware platforms, we build a solution that empirically determines the fastest code for a user's platform (CPU or GPU). In High Performance Computing, this is called autotuning. The framework will explore the various mappings of MD algorithms to architectures to identify the optimal choice.



TEAM 10 - Mug Exchange

Patthaphol Chotikakovit, Phyo Kyaw, Juhan Lee,
Mahnoor Ghani, Amado Diallo, Phyliss Darko

Client: Emily Lam

Customers need a convenient, sustainable alternative to single-use coffee cups. Current reusable systems are inconvenient and disrupt cafe workflows. Our project provides an RFID-enabled reusable mug exchange system that makes reusing mugs easy for customers, seamless for baristas, and cost-effective for cafe owners.

TEAM 11 - Solar Heat Dissipator

Back: Jon Cili, David Gardner, Gabe Malek
Front: Paulina Garcia, Kevin Tu

Client: Brian Kotiuga

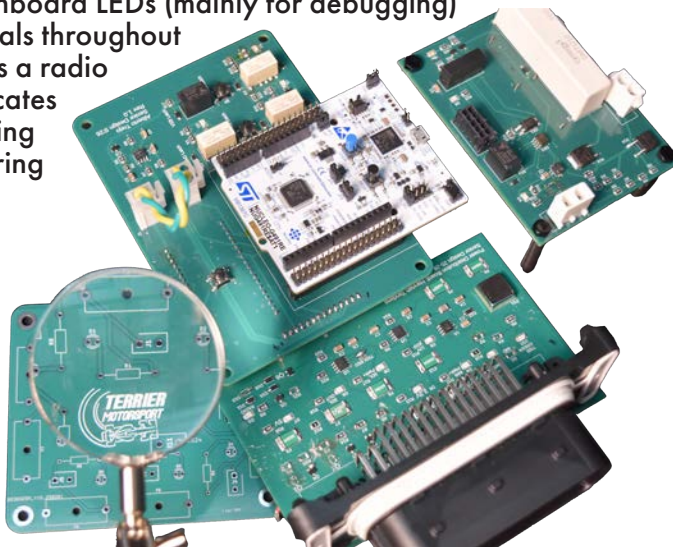
Our project entails enabling energy recovery between multiple forms of solar panels. We intend to maximize the capture of solar energy by taking the heat energy lost from the photovoltaic process to make thermal solar energy for recovery. This project is a union between electrical, computer, and mechanical engineering with applications in heat transfer, controls, and power systems.

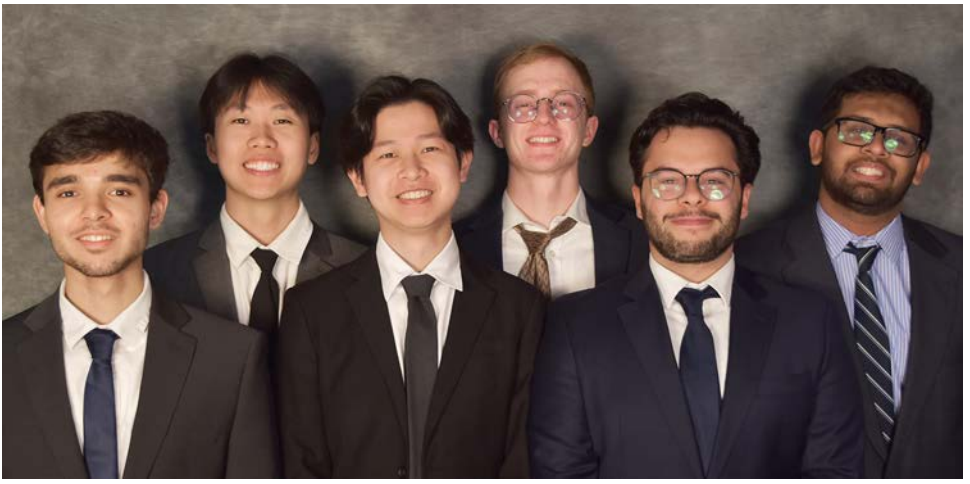
TEAM 12 - Terrier Motorsport Safety

Back: Justin Nascimento, AJ Chiaravalloti, Alberto Trejo
Front: Alex Jones, Hannah Tandang

Client: Terrier Motorsport

Our project is a safety system for Terrier Motorsport, Boston University's Formula Hybrid + Electric team, which builds a fully electric F1-style racecar. It consists of three PCBs that control when the battery can power the motor; if any sensor detects a fault, a signal is sent to isolate the battery. The system provides visual and audible status indicators via onboard LEDs (mainly for debugging) and external peripherals throughout the car. It also includes a radio module that communicates with pit control, enabling remote monitoring during operation.



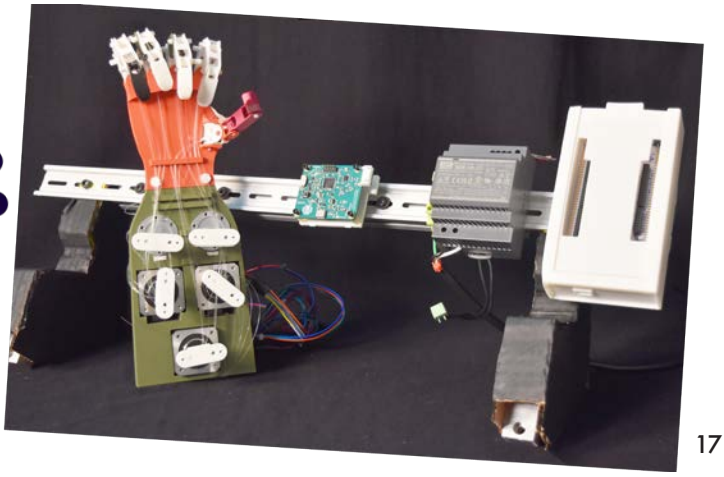


TEAM 13 - MakeyDooey

Back: Koen Lin, Dom Murphy, Benjamin Joseph
Front: Vikram Singh Bhalla, Jonny Wu, Leonardo Mattos Martins

Student-Defined Project

MakeyDooey is an end-to-end development platform for real-time control applications, combining the accessibility of hobbyist microcontroller boards with the safety and robustness of industrial PLCs. Our platform encompasses: a set of custom embedded boards, each with ruggedized modular enclosures, firmware for real-time deterministic control, a progressive web app IDE, and a demo element showcasing the extent of our platform's capabilities involving the fine movement of a prosthetic hard. All hardware and software related to this project is open-source, and was created with sustainability via low-power operation in mind.



TEAM 14 - Robo Cayote

Jacob Perry, Bogdan Sadikovic, Zhakhangir Mamayev,
David DeAcereto, Christopher Hyun, Maria Davey, Eiki Hayasaki

Client: Professor Thomas Little

Robo Cayote is a patrol robot that autonomously detects and keeps deer away from a designated area. Through a website interface, a user is able to define boundaries for the robot and it will patrol that area until its battery level is low enough, at which point it will return to its charging station to begin charging. Upon detection of deer, the robot will perform its scaring mechanism, making sure the deer is run off the designated boundary. Robo Cayote sends all its video feed and capture information to the user securely after it has finished with its patrolling.

TEAM 15 - Treebot

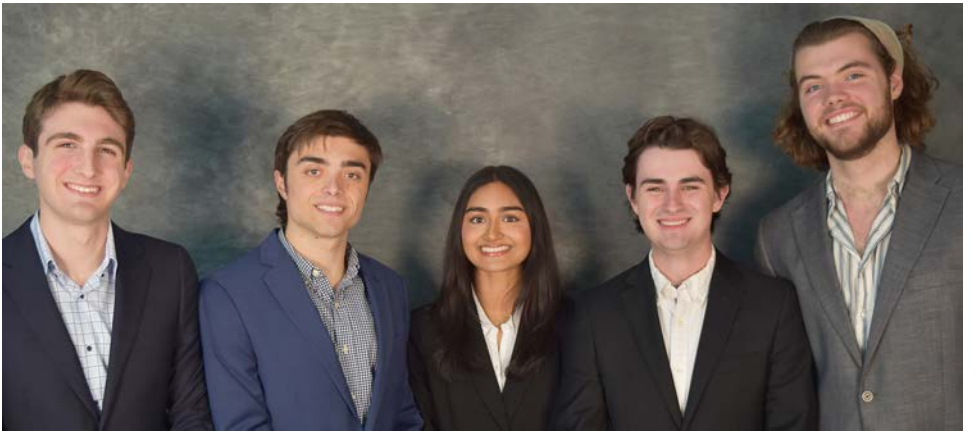
Back: Zachary Nassar, Bryan Ginenthal, John Goytia
Front: Prashast Pandey, Ezan Khan, Keimaree Smith
Client: Professor Michael Ruane

Treebot is a remote controlled robot that climbs trees up to 15 feet high to safely cut off branches. It combines climbing, gripping, cutting, and sensing into one system built specifically for tree maintenance. Users control it through a simple website with a live video feed, making branch removal safer, easier, and more accessible for both homeowners and professionals alike.

TEAM 16 - BO-AT

Back: Jason Pliszak, Egor Podkosov, Michael Daniels, Trac Nguyen,
Front: Luke Parrella, Aaron Villagomez-Quant, Cheng-Shu Kuo
Client: Ryan Lagoy and WHOI

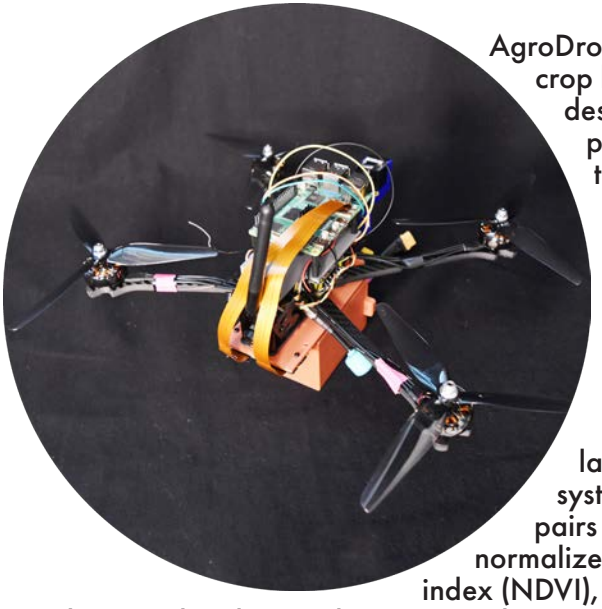
Researchers at the Woods Hole Oceanographic Institute (WHOI) commissioned our team to build an autonomous research vessel to assist in calibrating the NOAA's HF IOOS radars that monitor ocean currents off the shore of southern Massachusetts and Rhode Island. Our vessel must be able to make a two-hour journey, up to a kilometer from shore, without human intervention. Our boat is able to switch between emergency manual control, autonomous navigation under motor power, and autonomous navigation with sail power. The vessel is constructed from 3D printed PLA reinforced with fiberglass, achieving a IP67 waterproofing rating. A custom sail, rudder, and keel were also 3D printed. The electronics are powered by a custom PCB and the vessel is controlled by a custom web app.



TEAM 17 - AgroDrone

Ryan Bernard, Carlo Lanza, Siara Patel, Ryan Malone, Luke McCarthy

Student-Defined Project

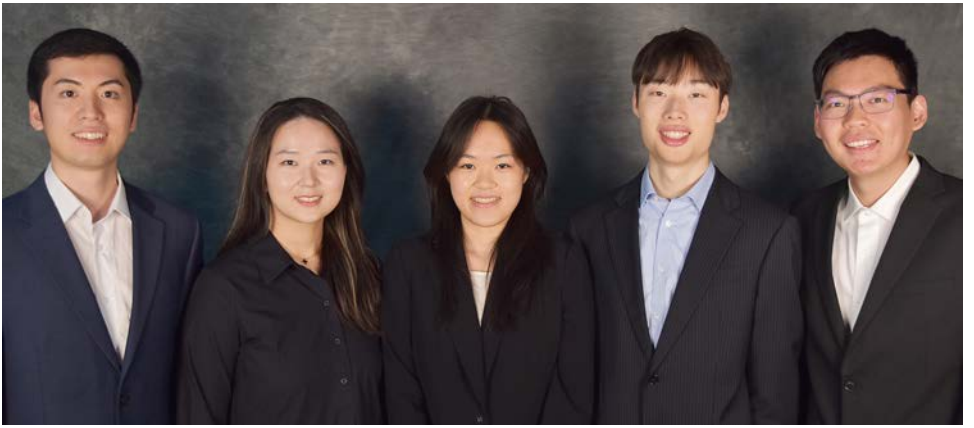


AgroDrone is a semi-autonomous crop health monitoring system designed to undercut the price of current solutions that are out of reach of small-to-medium sized farms. Our solution conducts scheduled flights through user-designated regions to capture high resolution color and infrared images of agricultural land. Upon landing, our system processes image pairs to calculate the normalized difference vegetation index (NDVI), a common crop health indicator. This datq is then sent to the AgroDrone web app, where users can see an NDVI heatmap overlaid on their field. This data is collected over time, allowing a user to gain long-term insights into the health of their land and crops.

TEAM 18 - NurseAid: Delivery Robot

Back: Kevin Liu, Matthew Kweon
Front: Varsha Singh, Audrey Wang, Lillian Chung
Client: Professor Eshed Ohn-Bar

Nurses in large hospitals complete an average of over 70 tasks per hour, with a significant portion of their time spent transporting medications, supplies, and lab samples rather than providing direct patient care. The logistical burden contributes to fatigue, inefficiency, and burnout, all factors closely tied to medical error rates and staff turnover. NurseAid addresses this challenge by developing an autonomous mobile robot designed to safely handle repetitive delivery tasks in dynamic hospital environments. By offloading transport duties, the system enables clinicians to spend more time with patients, improving workflow efficiency while reducing operational strain. Our motivation is to build a practical, hospital-ready platform that meaningfully enhances care delivery.

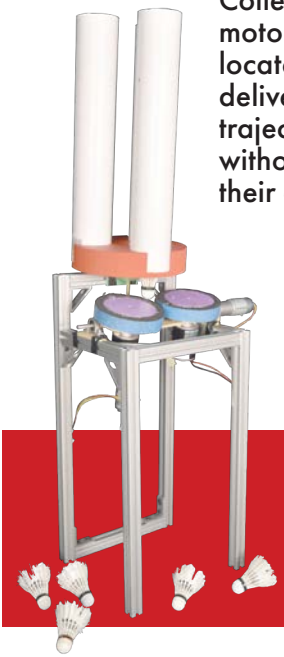


TEAM 19 - Badminton Buddy

Maosheng Wu, Ho Ian (Kelly) Ye, Selena Liu, Ethan Liang, Gordon Zhu
Client: BU Badminton Club

Badminton Buddy is a semi-autonomous, dual-robot system designed to revolutionize badminton training by eliminating its two most time-consuming and repetitive tasks: feeding shuttles to players and collecting them from the ground. Outlasting the drills themselves, these interruptions break a player's rhythm, waste valuable court time, and prevent coaches from fully focusing on instruction.

Collector utilizes camera-based object detection and a motorized brush-and-belt mechanism to autonomously locate, orient, and store shuttles into tubes. The Feeder delivers shots to players with customizable speed, trajectory, and timing. This enables players to practice without interruption and coaches to focus entirely on their athletes.

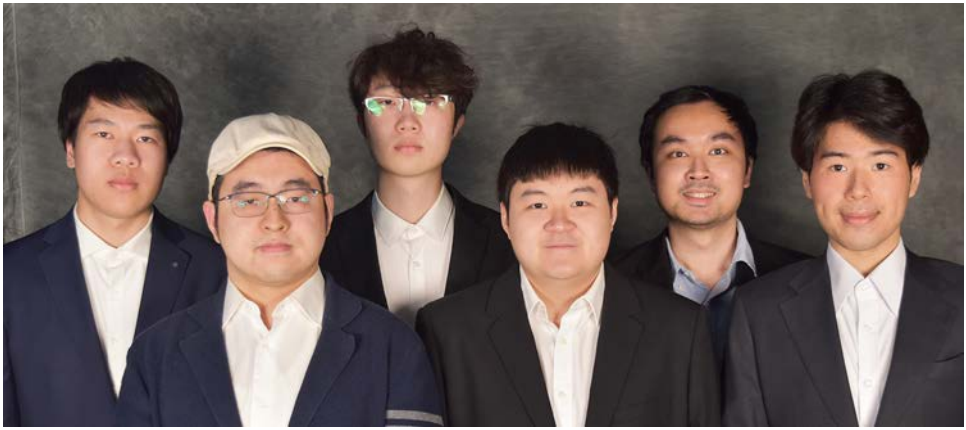


TEAM 20 - ROB Smart Wheelchair

Back: Anthony Capraru, Joshua Arrevillaga, Bryan Lam
Front: David Edelist, Phillip Widjaja, Muayad Al-Barwani
Client: Professor Osama Alshaykh

ROB is a smart wheelchair designed to improve mobility, independence, and safety for users with mobility disabilities. ROB provides the user with access to multiple control modes: remote control, touch control, voice control, EEG-headset control, and autonomous indoor navigation, enabling flexible operation.

ROB uses sensors to detect obstacles and proactively prevent collisions, improving safety in environments where small objects or uneven surfaces may be difficult to see. ROB's LiDAR and camera-based autonomous navigation systems enable the user to navigate spaces using waypoints or destinations, reducing the need for constant input.



TEAM 21 - GOFR: Grocery Operations & Fulfillment Robot

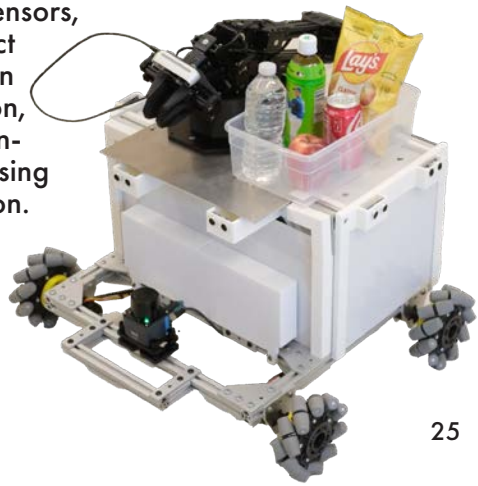
Back: Bernie Xu, Feng Tai, Pree Simphliphan
Front: Xingjian Jiang, Darren Figo Sajino, Bach Thien Nguyen
Client: Professor Thomas Little

SICK Challenge Finalists & Capstone Design Conference Invited Attendees

In the retail industry, an annual employee turnover rate of 80% creates operational inefficiencies and higher labour costs. Employees also face an increased workload managing inventory, restocking shelves, and assisting customers, leading to reduced service quality. Furthermore, 27% of adults are disabled, meaning the retail environment poses accessibility problems for everyday activities such as shopping.

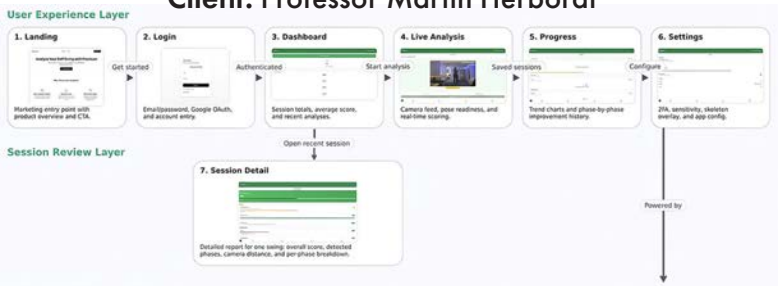
GOFR is an autonomous mobile robotic solution created to address these challenges in the retail sector: fulfilling in-store orders, assisting customers, and managing inventory. GOFR is powered by an NVIDIA Jetson Nano, embedded devices, sensors, and local servers to perform product manipulation through the integration of a robotic arm and computer vision, whilst safely traversing store environments via autonomous navigation using LiDAR, SLAM, and collision detection.

GOFR



TEAM 22 - GolfMate

Back: Pranav Shrihari, Ethan Levine, Siddharth Shiv Kumar
Front: Venessa Maduka, Leo Phung, Jaleel Heath
Client: Professor Martin Herbordt



Most athletes know the frustration of practicing a movement for hours, only to realize their form was slightly off the whole time. Our project addresses this by extending the 2024–25 ExerSights concept into the realm of 3D modeling to provide more precise feedback. Using a device camera, the system captures an athlete's movement and analyzes key aspects of their technique to identify areas for improvement.

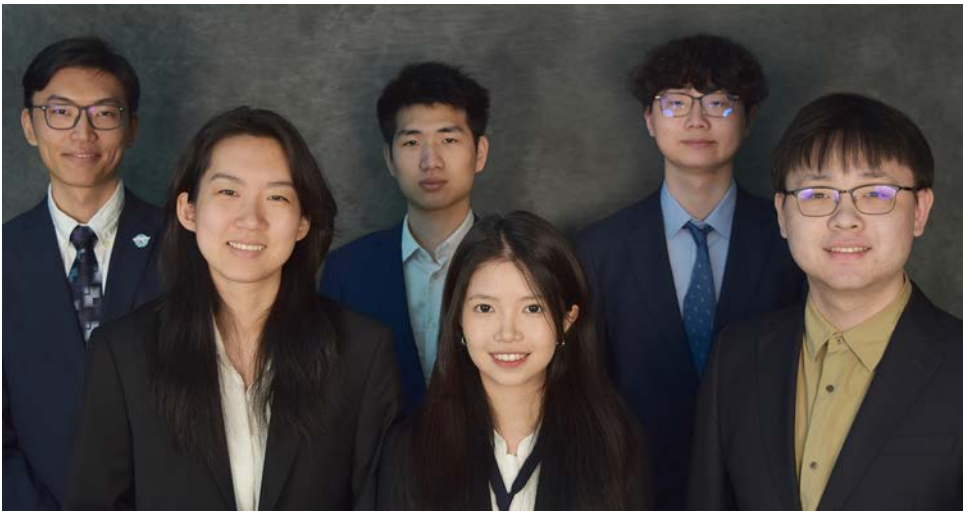
This is applied to golf swing mechanics, where the system evaluates critical phases of the swing to detect inconsistencies in form. These insights are translated into clear, actionable feedback that supports more effective practice. By enabling personalized technique analysis without requiring specialized equipment, SportMate makes high-quality training more accessible. While the current implementation focuses on golf, the underlying framework has potential applications across other sports involving structured movement.

TEAM 23 - FrostByte

Back: Hudson Reynolds, Jacob Collier, Arnouv Nayana
Front: Connor Casey, Arjun Mowzoon

Student-Defined Project

FrostByte is a scalable ice detection platform designed to help two main stakeholders - municipalities & land-managing organizations - preventing accidents through targeted ice removal alongside pedestrians & drivers trying to avoid ice on their route. Each FrostByte device is equipped with a weatherproof, multi-modal sensor array consisting of a visible light camera, thermal infrared camera, millimeter-wave radar, and temperature sensors, enabling comprehensive surface analysis across a wide range of conditions. FrostByte devices connect over Power over Ethernet to a cloud backend where a management dashboard provides complete sensor control, automated time-of-day configuration scheduling, and a data labeling tool for building ice detection datasets, designed to support many concurrent devices and users. The synchronized multi-modal data is used to train on-device deep learning models, improving detection accuracy at each location. Pedestrians and drivers are served through companion iOS and Android apps delivering proximity and route-based ice alerts with user-defined notification settings.

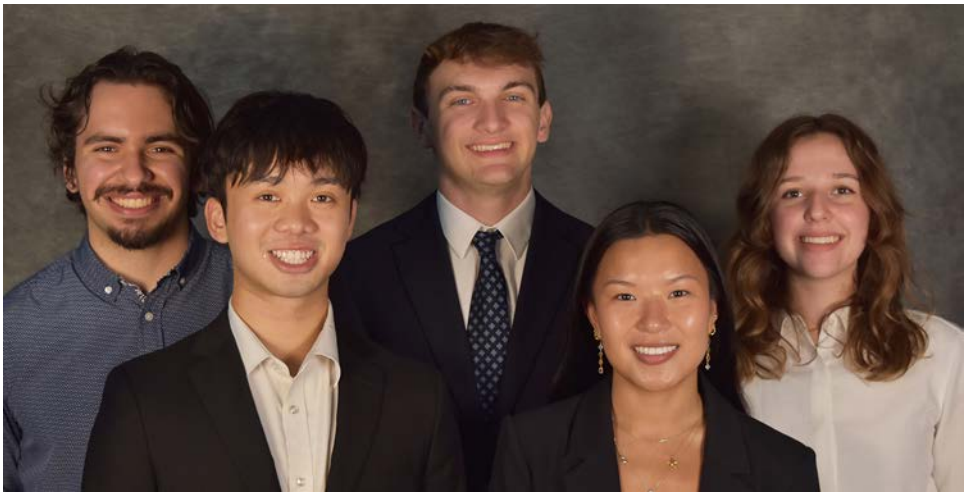


TEAM 24 - EmoQ

Back: Xinyu Wu, Zean Wan, Fuyang Chen
Front: Esther Xu, Zitong He, Jian Dang

Student-Defined Project

EmoQ is a desktop emotional companion robot designed to support older adults through natural, empathetic interaction. The system combines speech recognition, facial recognition, facial emotion detection, and speech emotion analysis to understand both who the user is and how they may be feeling. Based on this input, EmoQ generates context-aware responses through an AI dialogue system and delivers them through an onboard speaker. Our project integrates embedded hardware and software across the Jetson platform, with a focus on real-time interaction, accessibility, and user-centered design. By creating a companion that can listen, recognize, and respond with emotional awareness, EmoQ aims to provide comfort, engagement, and a more human-centered approach to everyday assistive technology.

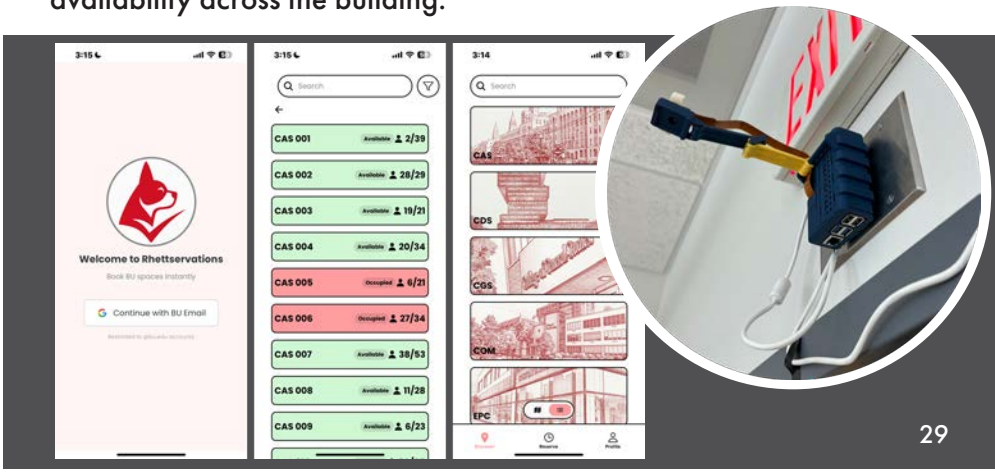


TEAM 25 - Rhettservations

Back: Angel Amaya, Matthew Hendsch, Eve Cruanes
Back: Tyler Nguyen, Ella Grace Conley

Student-Defined Project

Rhettservations addresses a common challenge among Boston University students — finding and reserving available study rooms and classroom spaces in real time. Currently, students have no reliable way to know whether a room is occupied before making the trip, reducing the efficiency of campus spaces. Our system integrates real-time occupancy tracking, automated notifications, and calendar synchronization to provide a seamless and intuitive booking experience. Students can reserve available rooms for study sessions, office hours, or group hangouts directly through the Rhettservations app. Using AI-powered camera nodes deployed across classrooms, the application continuously monitors and updates room occupancy, ensuring students always have an accurate picture of space availability across the building.



TEAM 26 - OMNI: The Smart Cycling Helmet

Sienna Chien, Derek Xu, Peter Zhao, Jared Shi, Jason Jiang

Student-Defined Project

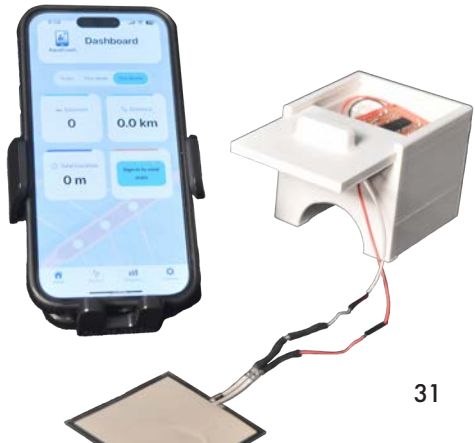
Each year, approximately 45,000 cyclists are injured on US roads. While cars have a myriad of safety features built in, bikers lack similar safeguards. Current technologies for bikers, such as mounted GPS units and phone stands, can be distractions to riders and contribute to accidents. Our project, the OMNI Smart Cycling Helmet, solves this by bringing critical information directly into the rider's line of sight through an integrated Head-Up Display (HUD).

By projecting real-time directions and blind-spot alerts into the rider's field of view, OMNI allows cyclists to keep their eyes fixed on the road ahead. Beyond visuals, the helmet uses vibrating haptic feedback to alert the rider when a vehicle enters their blind spot. In the event of a fall, built-in sensors automatically detect the impact to trigger emergency protocols. Combined with a mobile app for easy setup, OMNI replaces distracting handheld devices with seamless, life-saving technology.

TEAM 27 - Aquacoach

Back: Alp Gelgen, Arnav Shah
Front: Kayla Hall, Chiara Marzovilla, Kayla Tracey, Makayla Tajalle
Client: Professor Anna Swan

Our project is a real-time rowing stroke analysis device that provides immediate, actionable feedback to improve technique and performance. The system uses a force sensor integrated into the handle and an embedded microcontroller to capture stroke data, which is transmitted via Bluetooth to a mobile app. The app visualizes key metrics such as force profile, stroke consistency, and timing, while also allowing users to create accounts, set workout goals, and save workout history for progress tracking. The current implementation focuses on reliable real-time data acquisition and intuitive feedback. The device is designed to integrate seamlessly with standard rowing machines (ergs) and support training across different intensity zones, helping athletes refine their form and optimize workouts.



TEAM 28 - SmartBuoy

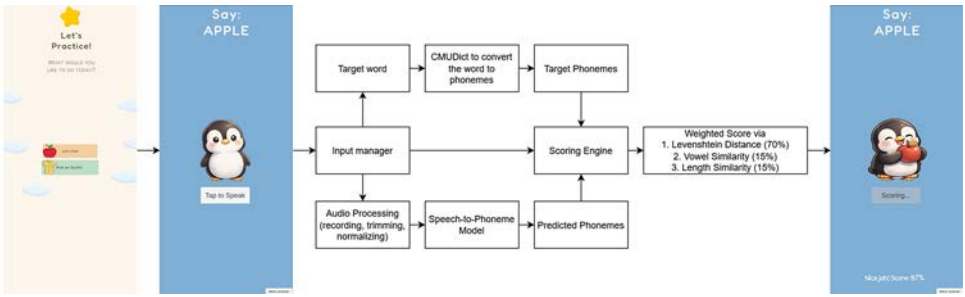
Back: Sterling Wodzro, Daigen Burton, Benjamin Dekan
Front: Lauren Monahan, Nandana Alwarappan
Client: Ryan Lagoy

SmartBuoy is a buoy-mounted monitoring system designed to enhance lobster fishing efficiency while promoting marine conservation. The device integrates GPS, temperature, and pressure sensors with LTE connectivity to provide real-time insights into trap conditions. It tracks buoy location, monitors environmental data, and detects abnormal events such as wildlife entanglement or tampering. Data is transmitted to the cloud and displayed through a web dashboard, allowing fishermen to monitor multiple buoys, receive alerts, and locate traps quickly. Engineered to be rugged, waterproof, and compatible with existing gear, SmartBuoy operates autonomously for up to seven days, supporting continuous environmental monitoring. Its scalable design combines embedded systems, wireless communication, and cloud services to improve operational efficiency, reduce wildlife risk, and support the long-term sustainability of lobster fisheries.

TEAM 29 - V-to-T

Back: Zonggyu Zhang, Yuhao Liang, Jacky Chen
Front: Denalda Gashi, Aarush Duvvuri, Isaac Williams
Client: Dr. Andrey Vyshedskiy

This project develops an AI-powered voice-to-text system to support speech therapy for minimally verbal children with autism. The system uses state-of-the-art apps as well as AI tools for the speech recognition model to convert children's vocalizations into text. By comparing these vocalizations with model words spoken by therapists, the software calculates similarity scores and provides adaptive feedback, reinforcing progress toward better speech. This project combines advances in audio processing, artificial intelligence, and therapeutic software design to deliver accessible, effective tools that empower children with autism to develop communication skills.



TEAM 30 - Pokerbot

Back: Jiawei Xiang, Panqi Gu, Kevin Zhang
Front: Lorraine Graham, Sarah Koesema, Varsha Athreya
Student-Defined Project

The goal of this project is to design and build a robot inspired by the maintenance drones from the 1972 film *Silent Running* that is capable of playing poker. This includes picking up cards, detecting playing cards on the table, and optimizing poker strategy.

SENIOR THESIS

THESIS STUDENT
Redi Begaj

ADVISOR: PROFESSOR ENRICO BELLOTTI

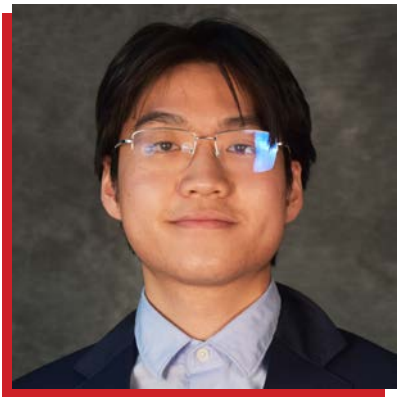
"Developing a Quantitative Model for Radiation Damage In AlGaN/GaN HFETs"

Electronic systems used in space are susceptible to radiation induced malfunctions, known as single-event effects (SEEs). These events occur when energetic ions deposit charge within semiconductor devices, altering device performance and hindering their operation. Gallium nitride (GaN) is a technologically important material with high electron mobility and high breakdown voltage and, together with its ternary alloy AlGaN, can be used to design heterojunction field-effect transistors (HFETs). These HFETs have higher switching speed and greater power density compared to silicon-based devices. When used in space applications, GaN HFETs are at risk of radiation-induced damage such as single-event burnout (SEB).

This thesis contributes to the development of a simulation framework that uses Geant4 Monte Carlo simulations with Synopsys Sentaurus TCAD to model heavy-ion energy deposition and the impact on GaN HFET operation.

Geant4 simulations are first used to analyze ion-matter interactions and extract three-dimensional energy-deposition profiles within the HFET structure and semiconductor materials. The secondary delta-electron transport produces complex branched charge tracks that cannot be accurately represented by simplified linear models. The energy deposition data are converted into electron-hole pair generation rates and integrated into transient TCAD simulations as bias conditions.

Simulation results show a double-peak drain-current response following heavy-ion strikes and a strong dependence on operating voltage. At lower drain bias, the device recovers to its original state, indicating a single-event transient (SET), while higher bias conditions lead to a sustained current increase and potential SEB. This work establishes a validated simulation model for predicting radiation effects in GaN HFET devices.



THESIS STUDENT
Kelvin Huang

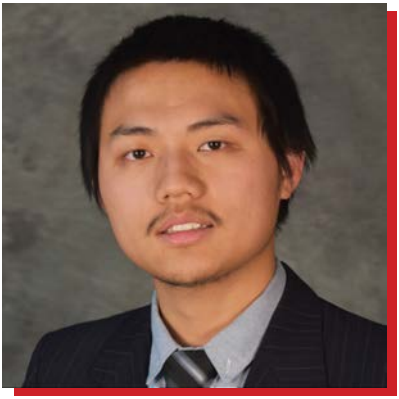
ADVISOR: PROFESSOR
SAHAR SHARIFZADEH

"Thermodynamics of CuPc Adsorption on Twisted Bilayer Graphene"

Graphene, a single layer of carbon atoms in a honeycomb lattice, hosts massless Dirac fermions and exhibits exceptionally high carrier mobility and tunable electronic properties, making it a central platform in two-dimensional materials research. Building on this, stacking and twisting graphene layers has opened a route known as "twistronics" to engineer electronic structure through relative orientation rather than chemical composition. In particular, twisted bilayer graphene (tBLG) forms a moiré pattern when two graphene sheets are rotated by a small angle, generating an emergent periodic potential with a length scale far larger than the lattice constant and strongly reconstructing the low-energy electronic bands, including flat bands near certain "magic" angles. These twist-induced effects make tBLG a versatile platform for exploring modified electronic dynamics compared to monolayers or untwisted bilayers.

Copper phthalocyanine (CuPc), a prototypical π-conjugated molecule, has been widely studied on graphite and graphene. STM and spectroscopy have detailed its adsorption geometry, molecular ordering, and interfacial electronic structure, establishing CuPc as a model for probing π–π interactions and charge transfer at organic–graphene interfaces.

In this work, we use density functional theory (DFT) to investigate CuPc adsorption on tBLG, focusing on how the twist-induced moiré environment modifies structure, energetics, band structure, and charge-density redistribution relative to untwisted bilayer graphene. We further develop an in-house structure builder capable of generating relaxed twisted bilayers from AA or AB stacking, with tunable twist angle and chirality, providing a flexible foundation for future twist-dependent adsorption and electronic-structure studies.



THESIS STUDENT
Xiang Jin

ADVISOR: PROFESSOR VIVEK GOYAL

"FPGA-Based Hardware Model for Real-Time Ion Count-Aided Microscopy (ICAM)"

Ion count-aided microscopy (ICAM) is an approach to processing the electron detector waveforms from scanning electron and helium ion microscopes that reduces the required incident particle dose, lowering the chances of damaging the specimen while maintaining better image quality compared to conventional secondary electron (SE) imaging at same dosage. Since ICAM involves collecting SE events at the detector to gain better estimates of SE yield over conventional imaging which simply integrates over detector waveforms, currently the technique is computationally limited to offline processing, after obtaining a complete scan of the specimen, preventing real-time ICAM images. The focus of this work is to design the hardware required to perform ICAM in real time, which requires fast sampling of both the SE detector waveform and the beam scan waveform (at a rate of at least 100 megasamples per second), as well as fast processing to count pulses, sample voltages, and the eventual calculation of the SE yield to obtain the grayscale values that comprise the resulting image frames. The hardware customization of field programmable gate arrays (FPGAs) may allow for a device that has the computational resources to perform ICAM on the signals in real time. This work looks into the applicability of the Eclypse Z7 board's Zynq 7020 SoC, allowing real-time DSP in the FPGA fabric and allowing for offloading preprocessed data via USB to a host PC, which would construct and display a grayscale microscopy image. Preliminary simulations of the FPGA on single scans of specimens yielded promising results, similar to that of ICAM performed offline. Allowing real-time ICAM reduces the likelihood of novice microscope operators from damaging the specimen while searching for an area of interest.

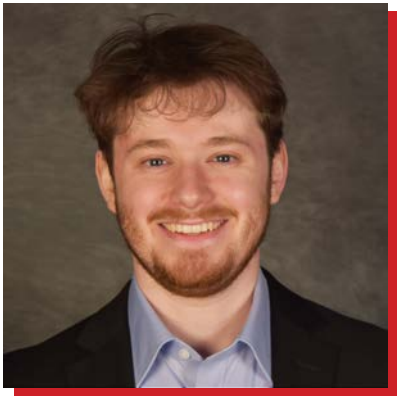
THESIS STUDENT
Lorenzo Moreira

ADVISOR: PROFESSOR RABIA YAZICIGIL

"Architectural Design And Comparative Analysis Of Floating-Point, Bfloat, And B-Posits For FFT Hardware"

The floating-point number system has been the standard for the computation of real numbers since IEEE set it as the standard in 1985. In recent years, there has been a growing interest in other representations for real numbers to improve the area, power consumption, accuracy, or speed of arithmetic hardware. The implementation of brain-float in existing architectures is a prime candidate for an optimization implemented by industry that improves hardware metrics and maintains accuracy by changing the numerical representation. A number system called Posits recently entered the scene and has drawn attention thanks to its potential accuracy benefits over floating-point. For a certain magnitude of numbers, Posits are more accurate at representing the real numbers than floating-point. However, its hardware introduces overhead due to variable-length decoding, which requires leading one and zero detectors. This oversight leads to the invention of Bounded Posits (B-Posits), which look to simplify the hardware requirements. Currently, there is no existing basis for B-Posit arithmetic outside of decode and encode blocks. This thesis implements a B-Posit adder and multiplier, however basic they may be.

In this thesis, we design and implement hardware architectures for floating-point, Bfloats, and B-Posit representations, and evaluate their impact on area, power, and computational accuracy. We specifically utilize a 4-point Fast Fourier Transform (FFT) to demonstrate both how one might choose a representation for a given application and to evaluate the scalability of each implementation. We note that any implementation of the FFT must be done in hardware as opposed to software, as CPUs are optimized for floating-point. Doing so allows for a fair hardware-aligned comparison, in which differences in performance, area, and power reflect the intrinsic properties of the numerical representations.



THESIS STUDENT
Nathan Strahs

ADVISOR: PROFESSOR BRIAN KULIS

"Long-Context Query-Focused Summarization with State Space Models"

This thesis explores query-focused summarization (QFS) using State Space Models (SSMs) as an alternative to attention-based architectures for long-context inputs. Unlike standard summarization, QFS requires generating summaries strictly aligned with a user query, a task that becomes computationally taxing as document length increases. Traditional transformer-based models struggle with these large contexts because the quadratic scaling of their attention mechanism creates significant bottlenecks.

To address these limitations, we evaluate whether state space sequence modeling can provide a more efficient foundation for QFS. Building on LOCOST, a prior SSM-based approach for vanilla summarization, we propose an improved SSM backbone and a new specialized architecture designed for QFS. Our results demonstrate that this approach outperforms attention-based alternatives in both memory usage and speed. Ultimately, this work establishes a more sustainable framework for the real-time questioning of massive documents, proving that attention is not needed for competitive results.

THESIS STUDENT
Rayan Syed

ADVISOR: PROFESSOR KAYHAN BATMANGHELICH

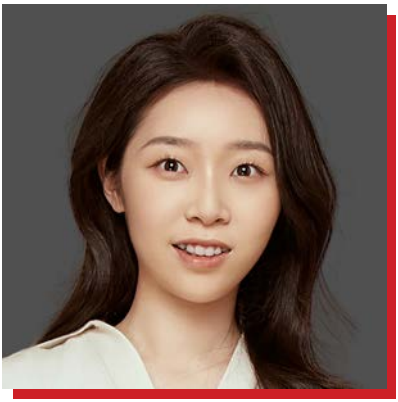
"K-FAC-Based Curvature Pruning for Out-of-Distribution Detection"

Out-of-distribution detection is essential for ensuring that machine learning models behave reliably when deployed in real-world settings. Recent work has shown that modifying pretrained models in a training-free manner can improve out-of-distribution performance. However, these approaches typically rely on simple heuristics that do not consider how different parts of the model affect its predictions.

In this work, we study whether information from the loss landscape can be used to guide these modifications. We apply a curvature-based weight editing approach and evaluate it on both vision-language models and vision-only transformer models.

We find that this approach leads to only limited improvements for vision-language models, but produces significant gains for vision-only models. These results suggest that the effectiveness of curvature-based pruning depends on how well the underlying assumptions match the model's training objective.

Overall, this work highlights both the promise and the limitations of curvature-based methods, and points to the need for better strategies when applying them to vision-language models.



THESIS STUDENT
Sitong Yan

ADVISOR: PROFESSOR BOBAK NAZER

"A Multiwavelets-based Orthogonal Time Frequency Space Modulation Scheme"

Orthogonal time frequency space (OTFS) modulation is a promising scheme for high-mobility wireless channels, but scaling it to practical large MIMO scenarios remains challenging because the two-dimensional delay-Doppler channel matrix leads to high equalization complexity. Meanwhile, the latest OTFS research based on Fourier and Walsh-Hadamard transforms suffers from a high peak-to-average power ratio (PAPR) that grows with frame number N, causing power amplifiers to operate in inefficient linear regions and increasing power consumption.

To address the PAPR challenge, we propose a multiwavelet-based OTFS (MW-OTFS) scheme that leverages the sparsity and orthogonality of multiwavelet transforms. Our simulations demonstrate that MW-OTFS achieves significantly lower PAPR with reduced complexity compared to the existing OTFS schemes, while maintaining nearly constant PAPR and BER as frame number N increases. These results indicate that MW-OTFS removes a key constraint on frame size and offers a much lower PAPR foundation for practical OTFS system design, especially for emerging higher-frequency bands where power amplifier efficiency is paramount.

THESIS STUDENT
Xiaoxiao Yang

ADVISOR: PROFESSOR ROBERT KOTIUGA

"Visualizing Algebraic Structures to Simplify Complex Problems"

This thesis explores how visualization can simplify complex algebraic structures across different domains, including atomic orbitals, prime distributions, and knot theory.

By employing harmonic polynomials, primorial-based sieves, and algebraic invariants, we study structures ranging from concrete to highly abstract settings. The resulting visual representations reveal patterns that are not apparent in traditional representations, demonstrating that visualization can serve as a useful tool for understanding and simplifying abstract mathematical structures.

SENIOR DESIGN FACULTY

THOMAS LITTLE Professor

Prof. Little received the BS in BME from RPI, the MS and PhD from Syracuse University in EE and CE, respectively. Prior to graduate school, Little developed microprocessor-based systems for automation, PBX call routing, and oceanographic instrumentation. His early work at BU incudes modeling and design of distributed media delivery including online movie streaming. In 1994 he co-founded a startup for video streaming which pivoted to interactive-media and technology-based consulting. In 2004 he returned to BU full-time pursuing research in mobile computing and sensor networking. From 2008-2019 he was Associate Director of the NSF Smart Lighting Center where his research included high-speed light-based communication and networked systems. Little is co-inventor on patents spanning human activity recognition, laser-based positioning, occupancy sensing, optical modulation, and beam steering for multiple access. Most recently he has been involved with developing systems for air quality instrumentation, indoor positioning, and collaborative AR/VR.

OSAMA ALSHAYKH Lecturer & Asst. Research Professor

Dr. Alshaykh is CEO of NxTec. He was CTO of Packetvideo corporation, Scientist at Rockwell and Visiting Researcher at UC, Berkeley. Osama received a PhD in ECE from Georgia Institute of Technology in 1996. Osama received a Fulbright Scholarship and served as associate editor for IEEE Transactions on Circuits and Systems, Video Technology. He served as consultant, board member and advisor for several companies and groups. Dr. Alshaykh serves as co-instructor of the capstone Senior Design course.

RYAN LAGOY Adjunct Professor

Ryan Lagoy is an Adjunct Professor at BU and Director of Hardware, Systems, and Manufacturing Engineering at Starry, Inc. He previously held research and engineering roles at BAE Systems and has contributed to neuroscience and RF systems research at BU. Ryan earned his MS in EE from UMass Amherst and his BS from BU. He is an inventor on multiple RF technology patents and has lectured on affordable internet technologies. Ryan has served in leadership roles within IEEE and has been recognized with numerous industry and academic honors for his contributions to engineering innovation and education, including the Michael F. Ruane Award for Excellence in Senior Capstone. Ryan advises Senior Design teams on hardware architecture, RF systems, and product realization, shepherding prototypes from concept to field testing.

TEACHING ASSISTANTS

ZIXIONG CHEN GST

Zixiong Chen is a PhD student in computer engineering at BU. She received her MS in Computer Engineering and a BS in Physics from UCSB. ***Areas covered:*** *AI/ML, robotics, computer vision and imaging, signal processing and communications, high performance computing, software.*

FALLON MCBRIEN GST

Fallon McBrien is a PhD student in Sabrina Neuman's Robomorphic Computing Lab focusing on robotics, specifically collision geometry and motion planning. She's interested in design, controls, and software. She received her BS in MechE (Aerospace Conc)at Boston University. ***Areas covered:*** *Sensing and measurement, cybersecurity, data science, AI/ML, computer vision and imaging, mobile computing and apps, signal processing and communications, systems and control, embedded systems, software.*

ZIPEI WU GST

Zipei Wu is a PhD student in Electrical Engineering at BU. His research focuses on deep brain imaging using multiphoton microscopy to study brain mechanisms. Beyond his studies, I love photography and traveling the world. He received his BEng from Shenzhen University, China. ***Areas covered:*** *Bioelectronics, AI/ML, photonics and optics, circuits signal processing and communications.*

ALUMNI JUDGES

BEN COOTNER

After graduating from BU, Ben Cootner began his career as an iOS developer at a startup called LevelUp, building whitelabel apps for local restaurants. He stayed through its acquisitions by Grubhub and now Wonder, where He works as a Staff Engineer. He's contributed to major areas of the Grubhub app, including pickup and app launch, led integrations with partners like Instacart and Rokt, helped develop their Super Bowl promotion, and attended Apple workshops, including WWDC. These days, he's working on a new AI-powered app while continuing to focus on reliable, user-facing features and guiding key architecture decisions.

BEN DUONG

Ben Duong began his journey at VMware (now Broadcom) as a college intern, and has grown with the company ever since. His career has spanned the distributed cloud management landscape from IAM and virtualized networking to IaaS. He now leads a team dedicated to VCF (VMware Cloud Foundation) multitenancy, where he builds the role-based access control (RBAC) software powering private clouds.

MARISSA GLASSBROOK

Marissa Glassbrook is Assistant Vice President, Climate Change Resilience at Sun Life, where she leads enterprise-wide climate strategy and risk management, including transition planning, decarbonization roadmaps, and emissions measurement across global insurance and asset management businesses. She previously held leadership roles at National Grid, advancing sustainability strategy, performance management, and clean energy transition initiatives. Marissa began her career as an electrical engineer in transmission planning and holds a BS in Electrical Engineering from Boston University and an MBA from Harvard Business School.

EUGENE KOLODENKER

Eugene Kolodenker is a security engineering leader who pairs hands-on technical depth with a track record of building and guiding high-performing teams.

He earned his BS in Electrical Engineering from Boston University in 2012 and began his career at AMD, contributing to the design verification of the PlayStation 4. He later joined MITRE, where he led cybersecurity projects for government customers while completing his MS in Computer Engineering, also at Boston University.

Today, Eugene is at Lookout, where he translates cutting-edge research into real-world protection for millions of mobile devices worldwide. He is recognized for bridging deep technical research with product, engineering, and threat intelligence teams to deliver security outcomes at scale.

STANLEY NGUYEN

Stanley Nguyen is currently an Electrical Engineer at RTX, working on test development solutions for air traffic radar CCAs, where he focuses on designing and improving test systems and automation. He graduated from Boston University and is currently pursuing my Master's in Electrical and Computer Engineering at Johns Hopkins University. His interests are increasingly centered around circuit design and SW, particularly in bridging the gap between hardware and software systems. BU's engineering program gave him a strong foundation in both theory and practical problem-solving that helped him reach this point in his career.

ANDREAS PAPADAKIS

After graduating from Boston University in 2019 with a Bachelor in Computer Engineering, I started working as a Software Engineer at Talon Aerolytics. Initially, I did a lot of research in 3D Modeling from Photogrammetry (SFM), specifically in the field of Tower Communications and Civil Sites. After producing Pipelines to create 3D Models from Drone Imagery, grab any 3D Measurements of Objects of Interest, and automatic Inventory Analysis, Talon Aerolytics has also moved into the domain of Utility Pole Infrastructure and Automatic Pole Loading Analysis.

ALUMNI JUDGES

RYAN ROSENBERGER

Ryan Rosenberger graduated from BU with a B.S. in Electrical Engineering in 2022, followed by a M.S. in Electrical and Computer Engineering in 2023. He now works in Boston as a Senior Project Electrical Engineer at Lutron Electronics Co. He designs and develops smart LED light sources for both residential and commercial applications.

BRADLEY RUFLETH

Bradley Rufleth has over 20 years of experience working at GE Aerospace. His background is in military engine control systems for turboshaft and turbojet applications. In his free time he enjoys sailing, snowboarding, traveling, and attending men's and women's hockey games.

CHRISTIAN SO

Since graduating from BU ECE, Christian So has joined Boston Dynamics as a Machine Learning Software Engineer, where he develops ML stacks for next-generation robotic platforms and industrial applications. Beyond the lab, Christian is dedicated to empowering the next generation of young inventors, serving as a sponsor for the BU Hacks High School Hackathon. His commitment to service extends beyond tech; he frequently volunteers at local Boston events to foster community and help bring projects to life. Christian is honored to return as an ECE Day judge, leveraging his robotics industry experience to celebrate the accomplishments of this year's teams.

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THANK YOU, CLIENTS

Thanks to all who challenged the seniors with their real-world engineering needs, and encouraged their student team as they worked to solve them.

THANK YOU, ALUMNI JUDGES

Special thanks to our ECE Alumni judges, who took time from their busy schedules to be here with us today.

THANK YOU, ECE & ENG STAFF

ECE Staff have worked countless hours to support the year-round needs of the Senior Design class, as well as to coordinate ECE Day itself. Thank you all.

and finally, THANK YOU, STUDENTS

Thanks to all the seniors for the months of hard work and dedication put into these projects, from the day you walked into the first session of EC463 at the start of the Fall semester.