
BU
Senior Design Projects
2024
ECE Day Program

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

- **Best ECE Senior Design Project**
- **Design Excellence Award**
- **Michael F. Ruane Award**
  for Excellence in Senior Capstone Design
- **Entrepreneurial Award**
- **Teaching Assistant Award**

ECE DAY 2024
AGENDA

Friday, May 3, Photonics Center 9th Floor

9:00 AM	Breakfast
9:45 AM	Chair's Welcome
10:00 AM	First Demo Session
12:00 PM	Lunch Break
1:00 PM	Second Demo Session
3:00 PM	Judges Deliberate
3:30 PM	Award Ceremony

ALUMNI JUDGES

Sadie Allen
Ben Cootner
Peter Galvin
Carmen Garcia
Eugene Kolodenker
Chris Liao
Andreas Papadakis
Brad Rufleth

View the agenda on your phone:

TEAM 1 - Dryad Networks

Thomas Bowler, Rishav De, Pranet Sharma, Jueun Kang, Young-Chan Cho
Client: Dryad Networks

Abstract

Dryad Networks' project aims to improve their AI and IoT-based forest fire prevention and detection system. With wildfires contributing to global CO2 emissions and escalating climate threats, the need for more accurate and swift detection is paramount. The project aims to refine the machine learning model, deploy it at the edge and in the cloud, and collaborate with data scientists to enhance evaluation mechanisms. The focus is on early wildfire detection, aligning with engineering requirements for performance, reliability, scalability, integration, and security. Dryad Networks' system prioritizes early detection using innovative technology to aid global wildfire prevention.

TEAM 2 - Neuron Spike

Victoria Carlsten, Claire Cropper, Hao Chen, Shi Gu
Client: Vikrant Sharma, Yang Lab

Abstract

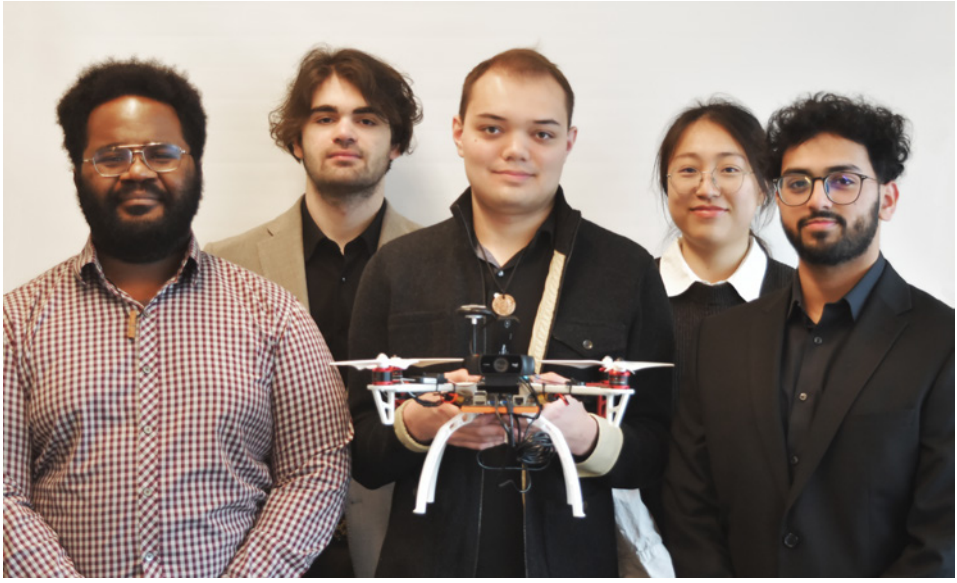
Epilepsy, a prevalent neurological disorder, impacts millions globally. Despite the array of treatments available, a significant number of patients remain non-responsive. This project involves the development of a machine learning algorithm using PCA and optimized K-means that will accurately detect and identify the brain activity, or neuron spikes, that indicate active seizure activity. The creation of an app front-end allows for the seizure activity to be visualized, for any relevant parameters to be adjusted as necessary either as a method for analysis following the collection.

TEAM 3 - EchoView.ai

Marybel Boujaoude, Jazmyn Walker, Hassan Hijazi,
Riya Deokar, Nicholas Hardy
Student-Defined Project

Abstract

The need for accessible, cost-effective, and immediate communication tools for the deaf and hard-of-hearing community is a critical issue. Current available technologies are costly, complex, and unable to be seamlessly integrated into daily life. Our solution is to introduce a revolutionary wearable device: glasses that provide real-time speech-to-text transcription. By integrating advanced technology into a discrete, everyday accessory, we will be reducing communication barriers faced by individuals who are deaf or hard of hearing. The final deliverable is a proof of concept equipped with an OLED display that will display transcribed text into the user's field of vision, an ESP32-C3 for wireless communication, and two microphones for audio capture. Additionally, we will develop an iOS-compatible mobile application that enables the user to reference past conversations and customize the displayed text based on their preferences. Our technical approach leverages continuously improvable open-source speech recognition software, a practical optical design, and an efficient microcontroller. Our end product delivers a new way for deaf and hard-of-hearing individuals to communicate, cultivating a more inclusive world where every voice and word can be heard and understood.



TEAM 4 - Pizzair, Pizza Delivery Drone

Compton Bowman, Ahmet Caliskan, Quentin Clark, Yafei Chen, Usman Jalil
Client: Spinnaker Analytics

Abstract

In response to the persistent challenges of pizza delivery, we present an innovative solution to overcome these obstacles and redefine pizza delivery. The current reliance on human drivers results in delays and cold pizzas for customers. Our solution, "Pizzair," is an AI-enabled, fully autonomous pizza delivery drone. This drone ensures fast, cost-effective, and hot pizza delivery within a 10-minute radius of a pizza restaurant. The drone is equipped with a specialized harness to securely deliver the pizza while maintaining its temperature. Pizzair's autonomous navigation system, enabled by cutting-edge machine learning techniques, ensures timely and safe delivery, even during peak demand or difficult conditions. Pizzair is intended to transform the pizza delivery industry, drastically improving customer experiences and optimizing delivery operations.

TEAM 5 - WhereTo

Erick Shimabuku Tomona, John Burke, Muhammad Ahmad Ghani,
Marta Velilla Arana, Haochen Sun
Client: Andres Papadakis

Abstract

In a modern, urban environment, it can be difficult for drivers to navigate properly, especially when it comes to finding a parking space in crowded cities. Time spent traveling in search of a spot to park can feel demoralizing as it takes a long time to locate an ideal spot and incredibly wasteful as the entire time the car continues to produce emissions. WhereTo will be a multi-platform mobile application that will be capable of solving this problem of locating viable parking. The final deliverable for WhereTo is a complete frontend and backend system capable of delivering parking regulation information to the user of a mobile application in real time. We approach designing this application with a focus in efficient algorithm design as well as a focus in utilizing artificial intelligence. When the user enters a location, the application will collect street image data from the area using Google and use it to determine the parking regulations for that region using AI object detection models as well as image text processing models. This information will be presented to the user in a comprehensive and informative manner. WhereTo's utilization of Google image data as well as AI models will allow for it to be incredibly scalable.

TEAM 6 - AI-Enhanced Pharmacy Procurement

Houssain Ababou, Joel Akerman Dayan, Manuel Segimon,
Bora Bulut, Zaiyan Muhammad
Client: Beth Israel Deaconess Medical Center Pharmacy

Abstract

The nature of the problem at hand revolves around the client's manual and time-consuming drug procurement processes, characterized by the need for constant evaluation of alternatives based on price, quantity, and packaging. Additionally, the criticality of specific drugs necessitates a precise and timely restocking strategy. Our final deliverable aims to address these challenges comprehensively through an AI-driven procurement solution. This solution comprises a three-tiered technical approach: continuous stock monitoring and replenishment based on live feed analysis, intelligent recommendations for alternative drug replacements drawn from the pharmacy's database, and the development of a user-friendly interface based on client feedback. The proposed model offers innovative features such as dynamic stock monitoring, intelligent alternative recommendations prioritized by cost, dosage preference, and packaging, and a user-centric interface tailored to streamline the buyer's decision-making process. This solution is poised to significantly optimize the client's drug procurement workflow, ensuring efficiency, accuracy, and responsiveness to critical drug restocking requirements.

TEAM 7 - MuseumMate, AR Museum

Yangyang Zhang, Ananth Sanjay, Kwadwo Osafo, Kai Imery, John Culley
Client: Professor Thomas Little

Abstract

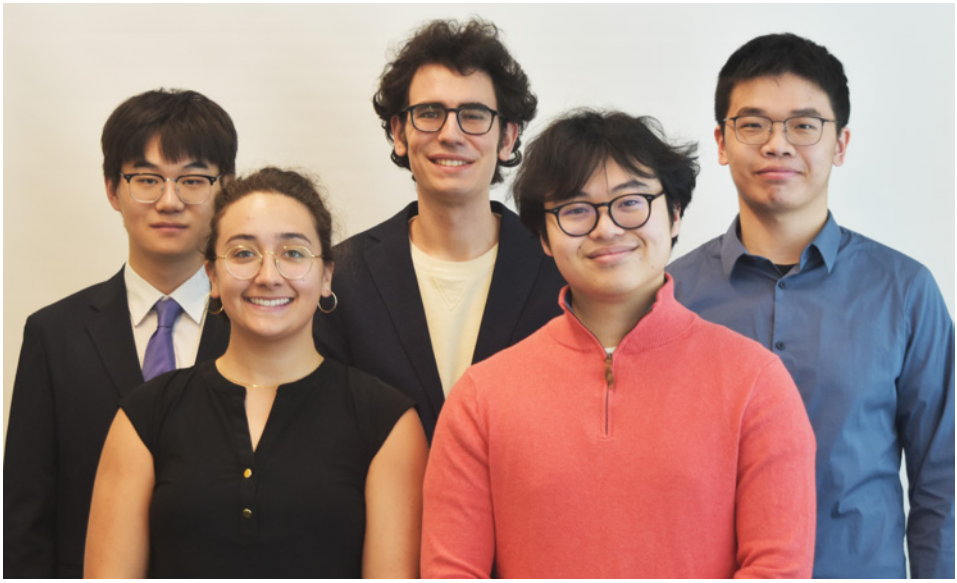
The MuseumMate project aims to revolutionize the museum experience by integrating advanced technology to enhance visitor engagement and accessibility. Leveraging a collaboration with Boston-area museums, the project introduces a mobile application that combines indoor navigation, augmented multimedia information, and real-time congestion management. This system utilizes Ultra-Wideband (UWB) technology for precise location tracking and RFID for interactive content delivery, facilitating a seamless integration of virtual and physical tour elements. Central to the project's success is the diverse and collaborative team, comprising individuals from five different countries, bringing together a wide range of technical skills and perspectives. This diversity has been instrumental in the innovative development and application of technology, such as the integration of ChatGPT for enriched exhibit curation. We are set to offer a dynamic and accessible museum visit, enhancing the educational and cultural experience for all visitors.

TEAM 8 - OBSIDAS, On-Board Sound Intensity Data Acquisition System

Aurojit Chakraborty, Daniel Cardosi, Muhammed Abdalla,
Joseph Lucatorto, Javier Gonzalez Santamaria
Client: Volpe National Transportation Systems Center

Abstract

There is an ever-growing body of evidence that demonstrates the negative effects of noise pollution: not only does it harm local wildlife near major roadways, but it is also linked to health issues such as tinnitus, hearing loss, and heart disease. Automobile traffic is a major driver of noise pollution, yet the current sound-measurement tools used by the U.S. Department of Transportation's Volpe Center consist in outdated and cumbersome programs. The software to be developed, requested by Volpe, aims to make their road-acoustics research more streamlined and scalable by interfacing with an external microphone array to perform fully automated measurements of tire-pavement noise via the On-Board Sound Intensity (OBSI) method. The software will be a LabVIEW executable that leverages a C++ subroutine for all computations on sound data.



TEAM 9 - Alzlife, Alzheimer's Disease Therapy

Yuri Zhang, Emily Lampat, Christopher Brake, Khang Le, Ruohui Huang
Client: Dr. Andrey Vyshedskiy, AlzLife

Abstract

Alzheimer's Disease a ects more than 6 million Americans to date, where 1 in 3 seniors die from either Alzheimer's or another form of dementia. Current treatments are inconvenient and inaccessible due to patients' hesitation to reach out early, as well as Primary Care Provider (PCP) lack of resources in diagnosing. To help healthcare professionals and neuroscientists in their e ort of treating and alleviating the issues of inaccessibility to Alzheimer's treatment, we propose a noninvasive sensory stimulation therapy that exposes patients to 40Hz light, where a LED panel can be attached at the back of any individual's smartphone and have it display white bright light that flickers at a rate of 40Hz. By having patients exposed to this light, it will promote cells and fluids important for various brain waste-clearance mechanisms that are important in eliminating debris and plaques known to cause Alzheimer's.

TEAM 10 - Fridge Buddy

Jeffrey Chen, Andres Garcia, Trevor Chan, Cole Wentzel
Student-Defined Project

Abstract

Food waste is a significant issue in the United States, with a substantial portion occurring as a result of groceries spoiling in households. Despite efforts to combat this problem, many individuals struggle to effectively manage their perishable items, leading to unnecessary waste, financial losses, and negative environmental effects. Moreover, while some consumers turn to smart fridges for assistance, these appliances are often prohibitively expensive for many households. Additionally, standalone grocery-tracking apps, while available, are often inconvenient to use and lack the comprehensive features needed to efficiently manage food inventory. Fridge Buddy fills this gap by providing an affordable and user-friendly solution that seamlessly integrates into existing refrigerators. Fridge Buddy is a touchscreen device that easily mounts onto refrigerators (magnetically or via adhesives) as well as a mobile application that tracks item inventory, alerts users of expiration dates, and offers suggestions for optimal utilization of items. Its interface enables users to conveniently view, add, remove, and update items, with text and image recognition to streamline the input process. Additionally, a recipe suggestion feature assists users in making the most of their existing items Furthermore, a cloud backend synchronizes data across devices, ensuring that user data is always up-to-date. By economically transforming traditional refrigerators into smart appliances, Fridge Buddy empowers users to better manage food at home, reduce food waste, and save money on groceries.

TEAM 11 - MOSS Wheelchair

Sebastian Gangemi, Aya Kassem, Maha Noor, Norbert Malik
Client: Professor Osama AlShaykh

Abstract

Around 1% of the world's population needs wheelchairs, but a basic wheelchair cannot meet everyone's needs and expectations. Therefore, we are proposing to build a Modular Open Source Smart (MOSS) Wheelchair in which engineers will be able to create modules for a user's wheelchair as needed. For our project, we will implement three modules while also creating an open-source website for easy access to our modules.
The first module introduces a 3D-printed robotic arm implemented with servo motors for precision in movement and manipulation. The second module features navigation, where we employ computer vision. This algorithm facilitates advanced real-time object detection and recognition, allowing the wheelchair to navigate its environment intelligently.
The third module tackles obstacle detection and avoidance, utilizing the outputs of computer vision to intricately control the motors and electronics responsible for wheel movement and robotic arm functionality. Using computer vision will allow our wheelchair system to gain an enhanced ability to interpret its surroundings, offering users a more sophisticated and adaptive mobility solution. Through this comprehensive approach, we aim to redefine wheelchair capabilities and foster inclusivity while providing users with customizable, state-of-the-art mobility solutions.

TEAM 12 - Hazard Harbinger

Abdulaziz Almailam, Noah Cherry, Timothy Borunov, Julia Hua
Student-Defined Project (SICK Competition Entry)

Abstract

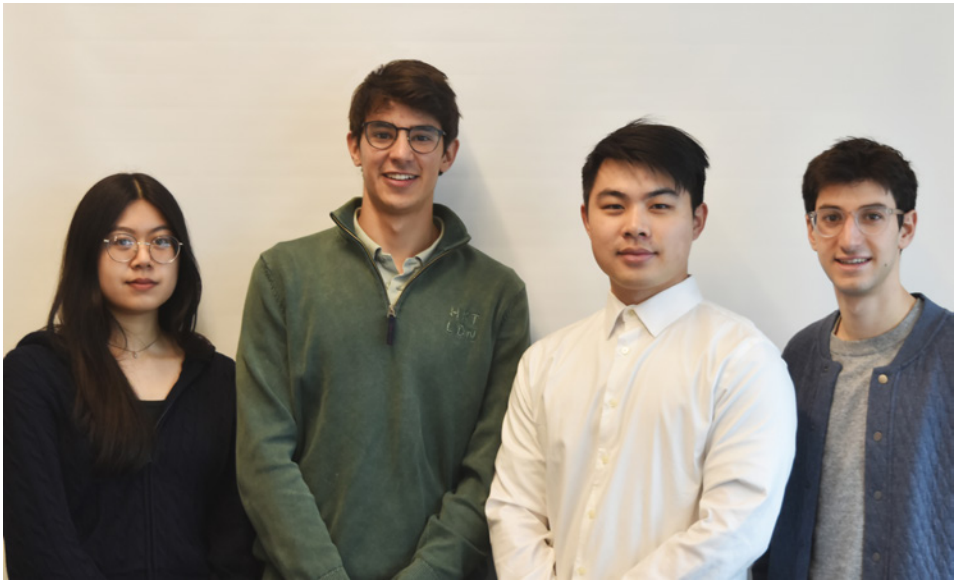
Wildfires are major environmental disasters with far-reaching consequences on the environment and human mortality. A common practice to prevent wildfires is prescribed burning, which requires thorough planning. To aid these burn plans, we propose a novel system that integrates an airborne LiDAR system and deployable sensor nodes. This system will result in a 3D fuel map and relevant environmental data.

TEAM 13 - VIAD Optics, Visually Impaired Assistive Device

Axel Toro Vega, Leanorine Lorenzana-Garcia, Zachary Dion Tan,
Ruben Carbajal, Jose Batile
Student-Defined Project

Abstract

The project seeks to address the pressing challenges faced by the visually impaired community and presents VIAD's progress towards an innovative solution. The visually impaired community, numbering over 2.2 billion globally, endure daily challenges beyond vision loss. In the United States, where over 7 million individuals are visually impaired, affordable and effective solutions are imperative. An affordable solution becomes more vital in terms of regional differences; the prevalence of vision impairment in low- and middle-income areas is estimated to be 4 times higher than in high-income areas. VIAD's proposed device utilizes LIDAR and advanced machine learning to enhance object recognition, enabling users to identify potential threats. Powered by a rechargeable battery, this system employs haptic feedback and sound alerts, customizable to user preferences. The goal is to eliminate the barriers that visually impaired individuals encounter in obtaining help and simplify the process, fostering independence and improving their overall quality of life.



TEAM 14 - Scan It! Pack It!

Daniellia Sumigar, Juan Carlos Vecino de Haro, Tristen Liu, Ramy Attie Khafif
Client: Benni Trachtenberg

Abstract

Container and packaging material waste poses issues for resource management and sustainability. Shipping companies, storage industries, and ordinary people alike face the difficult task of finding optimal packaging. To address these issues, Scan It! Pack it! will be a user-friendly iOS mobile application that can automatically detect object and container dimensions and generate an optimal packaging schematic. The application will utilize LiDAR sensing to perform dimension detection, cloud technology for data processing, and machine learning models to identify optimal packaging accurately. It will encourage proper packaging methods to reduce waste and ensure the safety of goods when transported.

TEAM 15 - SOL, Bi-Facial Solar Plant

Alexa Wiencek, Oluwaseun Soyannwo, Majid Almuhaideb,
Rahat Mahmood, Steven Cheng

Client: Professor Malay Mazumder

Abstract

Off-grid solar plants, solar power plants that work independently from the grid, are among them most promising solutions to rising alternative energy demand. Our system integrates bi-facial solar modules with moving reflectors, which capture sunlight on both sides for enhanced efficiency, requiring a specialized management approach to optimize positioning and energy capture. Furthermore, these systems require an energy-storage element, usually a LiPo or SLA battery, and need additional safety considerations. Our client contracted us to develop a solar plant remote-monitoring and control system that keeps track of key metrics in various parts of the plant, while ensuring precise and robust control of the bi-facial module system for optimized off-grid solar power performance. Our remote monitoring solution incorporates a web application that streamlines all of our plant-monitoring features. Our overall technical approach involves the iteration of monitoring and control systems on a small-scale solar plant model, with the goal to provide our client with a robust, flexible system that can be easily adapted to full-scale configurations.

TEAM 16 - C-SLAM

Zhaowen Gu, Lydia Jacobs-Skolik, Lucia Martinez Ruiz, Xinglin He, Robert D'Antonio
Client: The Charles Stark Draper Laboratory

Abstract

Since the current methods for precise underwater navigation are either insufficient in terms of accuracy or environmentally unfriendly, C-SLAM aims to address the critical issue of underwater localization for Uncrewed Underwater Vehicles (UUVs) undertaking seabed surveys. To improve the accuracy of navigation and overall operational efficiency, we'll use Simultaneous Localization and Mapping (SLAM) techniques, which can achieve precise localization by looking at matching landmarks and Inertial Navigation System (INS) measurements from sonar data. While processing these sonar data, C-SLAM will adjust position estimation errors through loop corrections and pose-graph optimization methods. As a result, it can generate a detailed 2D/3D visual representation of the vehicle's trajectory in the seafloor environment. Considering the importance of exploring the seafloor for scientific research, resource identification, and environmental monitoring, it is essential to track the accurate trajectory of UUVs, and our final deliverable, C-SLAM, is dedicated to tackle this issue.

TEAM 17 - Virtual Fitting Room

Mayank Yadav, Killian McShane, Aryaman Gupta, Ahmed Benmensour, Aryan Gupta
Student-Defined Project

Abstract

The digital revolution has significantly transformed the retail industry, propelling a shift towards online shopping. However, when customers shop online, they are unable to try on their clothes before purchasing them. As a result, they are uncertain about just how the clothes fit, look, and feel, and they return clothes at high rates, rates that incur substantial financial and environmental costs. Moreover, traditional online catalogs and size charts do not clearly depict how a particular clothing item would conform to an individual's unique physique. Our project, VFiT, aims to empower customers to address this gap by providing an application for users to try on clothes using a personalized 3D model so that they can purchase confidently and sustainably.

TEAM 18 - Langolio

Johnson Yang, Kristie Gong, Eric Xie, Kawsar Ahmed, Jakub Zolkos
Client: Isabel Allen

Abstract

In foreign language education, countless students traverse the corridors of middle school, high school, and college without ever engaging in meaningful dialogue with native speakers of their target language. This deficiency often arises from the reluctance of language instructors to participate in pen pal programs due to the arduous task of identifying suitable partner classes abroad and concerns regarding the unmonitored nature of student interactions. To tackle this challenge head-on, we propose a novel solution in the form of an application tailored to facilitate structured and supervised language exchanges between classrooms across borders. By providing educators with a streamlined platform, our initiative aims to forge connections between students from diverse cultural backgrounds, fostering immersive and controlled language learning experiences in a digital environment. Through this innovative approach, we seek to revolutionize the landscape of foreign language education, bridging the divide between learners and native speakers while ensuring a secure and enriching learning journey for all participants.

TEAM 19 - Integrated Laser and Electronics

Raphael Mok, Mateus Toppin, Tian Huang, Viet Nguyen, Ian Lee
Client: Professor Chen Yang

Abstract

The model to be developed will be a function generator which will be able to generate square waves for the purpose of activating a nanosecond pulsing laser to stimulate neurons. The generator will be based on a smaller microcontroller such as an Arduino or Raspberry Pi, which will make it significantly cheaper, smaller, and more sturdy for shipping and general use in labs and physicians' offices than current models. Along with the physical function generator, we will be creating software for ease of programming the laser, which will also serve a dual purpose of collecting real-time data. If time permits, an application for a phone will also be created which can be programmed to allow for repeated signal generation by patients.

SENIOR DESIGN FACULTY

ALAN PISANO Associate Professor of the Practice

Dr. Alan Pisano received a Ph.D. in electrical engineering from Northeastern University in 1974. He retired from General Electric in January 2010 after a 39-year career there in both Power Systems and most recently Aircraft Engines. There, he was responsible for numerous advanced controls technology programs and held a variety of managerial positions including Manager of Turboshaft/Turboprop Controls and Manager of Advanced Controls Technology and Planning. After retiring from GE as a Department Staff Engineer, he was appointed to the full-time faculty in the ECE Department at Boston University as Associate Professor of the Practice. He is currently the lead professor and course coordinator of the capstone Senior Design course in ECE and also regularly teaches courses in control systems and electric energy.

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 Ph.D. in Electrical and Computer Engineering 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.

MICHAEL HIRSCH Research Scientist

Michael's research focus includes remote sensing and scientific computing. Michael's work connects first-principles space physics and aeronomy models in real-world applications of AI / ML algorithms from edge sensors to HPC. His research helps enable the GNSS receivers in smartphones to serve as a space weather detection network, including the 2024 solar eclipse.

TEACHING ASSISTANTS

AYMAN ABDELHAKEEM GST

Ayman Abdelhakeem is a PhD student at Boston University from Benha University, Egypt, focusing on optical engineering and signal processing. His groundbreaking work on the PS_OCT system at Massachusetts General Hospital promises transformative insights into brain tissue visualization, positioning him as a rising star in academia and research.

MEGHAN LEMAY GST

Meghan LeMay Is fifth-year PhD student working with Dr. Joshua Semeter. Her research focuses on using GPS as a diagnostic for space weather.

TORNIKE SHUBITIDZE GST

Tornike Shubitidze is a third-year PhD student working in Professor Luca Dal Negro's lab on nonlinear nanophotonic structures and aperiodic optical systems for optical device applications.

TEACHING ASSISTANTS

TING XIE GST

Ting Xie is a second-year PhD student working with Professor Irving Bigio on neuron-degenerative disease by using Birefringence Microscope. She received her Master's degree in optical engineering from Zhejiang University in China. She loves reading books and also playing tennis in her free time.

STUDENT SUPPORT

FAIRUZ ABUSHGARAH Laboratory Assistant

Fairuz Abushgarah is a second-year undergraduate student majoring in Electrical and Computer Engineering. Intrigued by the quantum mechanical perspective of technology, she intends to dedicate herself to pursuing scientific discovery through electrical research. Aside from her academic focus, she casually runs a personal art account and writes spoken word poetry.

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 schedule 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.

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