ECE DAY

2022

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.

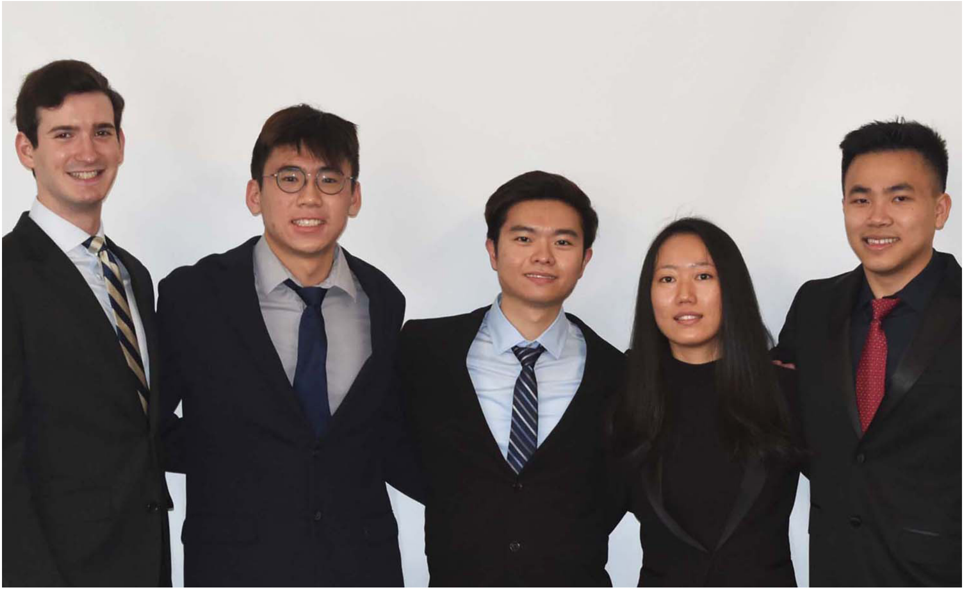
Proficiency in oral and written communication, particularly when presenting technical information.

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 Exellence Award
- Michael F. Ruane Award for Exellence in Senior Capstone Design
- Entrepreneurial Award
- Teaching Assistant Award and Honorable Mention



TEAM 1 - BOXi

Daniel Gruspier, Kenneth Chan, Yan Chen, Mella Liang, Khoa Tran
Student Self-Defined Project

Abstract

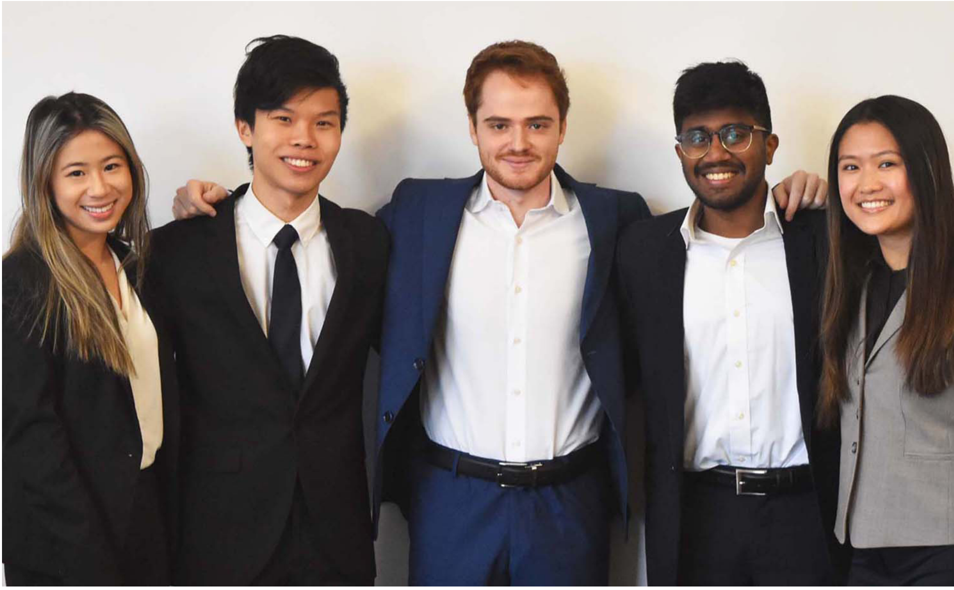
Package theft is a prominent issue that is currently not directly addressed by any product on the market. BOXi fills this niche by serving as a smart lockbox that opens only when a package is delivered and when the owner wishes to pick up a package additionally paired alongside a mobile app for real-time updates. A barcode scanner in the front of BOXi allows for delivered packages to be scanned and when verified correctly, BOXi opens up for the items to be placed inside. A weight sensor detects changes in box contents and confirms package delivery. Meanwhile, BOXi will communicate with the mobile app so the user can open BOXi with a simple flick on a phone. BOXi will add to the connectivity of the modern world extending package tracking even up to when it is at the porch.

TEAM 2 - WOOF

Daniel Shimon, Justin Lam, Rajiv Ramroop, Nafis Abeer, Chase Maivald
Student Self-Defined Project

Abstract

Woof is an ideal cross-platform social media application for dog owners. Rather than relying on individual owners to actively maintain dog friends, we propose a React Native maps interface to display locations of “friends” added by the user. To cater the application for dogs’ preferences, we require owners to purchase a dog-tag (dog-fleece due to size constraints) fitted with a GPS tracker, accelerometer, and a microphone. We are implementing a recommender system based on the owner’s dog’s interactions with other dogs wearing the tag. This recommender system will leverage the dog-tag’s proximity to other tags to start collecting audio. The collected data would be processed in the cloud before being sent back to the user as a friend suggestion. Woof is expected to deliver accurate suggestions for “friends” whenever the dog has a positive interaction with another dog. Users will be provided a profile page, instant messaging, “friends” page, interaction-history page along with a Dogmaps screen.



TEAM 3 - OPTICLE: Guiding Vision for the Visually Impaired

Nancy Zheng, Stefan Wong, Luca Guidi, Annamalai Ganesh, Jami Huang
Client: Professor Eshed Ohn-Bar

Abstract

Visual impairment impacts millions of people all over the world annually. It has a significant impact on individuals, affecting their quality of life, independence, and mobility. Current mobility aid solutions are limited in detecting off-ground obstacles, do not provide semantic information, and are not always suitable for all age groups. To address this issue, we propose Opticle, a wearable technology that detects obstacles in an outdoor environment with a depth-sensing AI camera and alerts users when any immediate obstacle is detected with haptic feedback and auditory output. The user will wear a chest mount with a camera in the center, a wrist mount with a linear resonant actuator, and bone conducting headphones. Our hope is to provide a solution that allows visually impaired individuals to feel more confident mapping their environments and maintaining their independence when navigating outdoor areas.

TEAM 4 - OverEar: Sound Localization Device

Guillermo Ao, Benjamin Li, Jonathan Ngo, Hannah Gold
Student Self-Defined Project

Abstract

OverEar is a device that aims to solve the Cocktail Party Problem, a phenomenon where certain people, due to a hearing or neurological impairment, are not able to focus on someone talking to them in a gathering of other people —a Cocktail party, for example. To fulfill our obligations as societal engineers we have created an embedded system that will perform sound segregation in real-time, allowing users to focus their concentration on the sound-oriented in front of them. Our device processes sound input from two microphones and runs the data through a custom sound-localization algorithm. Sound can be outputted in the form of non-intrusive in-ear plugs or BlueTooth earbuds, depending on the user's preference. Our innovative project combines a two-microphone approach with real-time audio processing.

TEAM 5 - Klavis

Elizabeth Diamond, Alex Jedrey, Isaac Fluhr-Chapman,
Talha Kamran, Amir Emad Adly Riad

Student Self-Defined Project

Abstract

Entering buildings, rooms and dorms have a list of security risks and inconveniences. Current solutions for school security risks involve physical student ID cards and keys being stolen, lost, replicated, etc. The creation of student ID cards is also a source of plastic waste in the environment. Our project Klavis allows for hassle-free entry and greater security for your community. In a modern world, authenticating yourself into a building using a smartphone virtual card is convenient and eradicates the need of carrying physical student IDs or keys. Our project provides administrators with ACS software that allows them to grasp a clear understanding of who enters a building through logs, delegated access and power to add or remove access privileges with ease. When contacting VTAP, a company that produces NFC card reader hardware, we were shown great interest as they have never seen NFC cards being used for student access to buildings. We have innovatively crafted a solution that makes the ACS receive the virtual card ID from the VTAP NFC sensor and automatically checks if the student has access privileges. Now with Klavis and our partnered company,VTAP, a single tap allows doors to open for you.

TEAM 6 - Deeper: The Mental Health Connector for Mental Health Consumers & Loved Ones

Daniel Li, Byron Mitchell, Nicole Kwon, Haoxuan Li
Student Self-Defined Project

Abstract

The nature of the problem is that there is miscommunication and misunderstanding between mental health consumers and loved ones. To bridge this unaddressed gap, deeper will be focused on connecting these specific groups. As a final deliverable, this project will be tested out on college students in hopes of achieving a >75% accuracy with the machine learning algorithm behind the journal and be a fully fleshed-out mobile application that is deployed on Google Play and Apple's App Store. The proposed technical approach behind deeper involves undergoing the agile practice of planning out sprints through Jira and completing individual tasks while simultaneously collaborating and working on code with Github. With this application, the aim is once again not necessarily to build new connections or provide mental health services, as there are existing platforms that provide these functionalities; rather, an innovative feature comes from this unique value proposition of strengthening the connections within the community that the user already has through the multitude of functionalities behind the application.

TEAM 7 - Amadeus

James Wasson, Dev Bhatia, Samantha Au, Ryuichi Ohhata, Brandon DeSiata
Student Self-Defined Project

Abstract

Amadeus is a mobile application designed for musicians to connect and self-promote. The application will allow users to create a profile in order to showcase themselves playing, tether those profiles to a musical group, and network with other musicians. These individuals and groups can communicate with others and promote events to their network. The ultimate result of this project will be a shippable mobile application with profiles, direct messaging, and a hyper-local map that registered users can add entries to.

TEAM 8 - Noise Hub

Benjamin Brewer, Ibrahim Chand, Alexander Prior, Allen Zou
Student Self-Defined Project

Abstract

The problem NoiseHub aims to solve is one all college students experience: finding a suitable study space on campus can be challenging and consume precious time better spent studying. NoiseHub intends to improve efficiency in students' search for study spaces by providing accurate and real-time information on study spaces across campus. This information includes room temperature, noise levels, and an estimate of current occupancy.

As a final deliverable, the NoiseHub team will present a fully functioning sensor suite and companion app which is tailored to each individual user. Users will be able to specify room aspects they find important, and the suggested study spaces will be filtered based on the users preferences.

TEAM 9 - Aerobatics Black Box

Radhey K. Patel, Xinyu Liu, Darcy Meyer, Pai Liu, Wenjun Ma
Client: Dr. Kenneth D. Sebesta, CyPi Ltd.

Abstract

Aerobatic performances are very different from ordinary flying tasks. General pilots use scientific methods to avoid risks during training, while aerobatic pilots take the initiative to face risks and use their lives to challenge the limits of aircraft performance and flying skills. In the field of aerobatics, there is no limit to the exploration of pilots' flying skills. In different aerobatics, the aircraft's flight status, altitude, speed, direction, and overload parameters change drastically. The pilot must understand the changes in motion parameters, and control the aircraft to move on a predetermined trajectory in a timely and accurate manner. During competition training, ordinary avionics cannot record and replay 3D demonstrations of flight training, and pilots cannot make precise movement adjustments. In order to help pilots to understand the status of the aircraft, our Aerobatic Black Box will address these issues by delivering a hardware part which contains AHRS, INS, GPS and a camera to collect pilot input, and a software part which allows pilot replay 3D demonstration of flight training, and also provides pilot input corresponding to every maneuver. Aerobatic Black Box is specially designed for introductory aerobatics pilots and aerobatics training. This system will allow pilots to observe different angles of flight attitude for the next flight adjustment, and also solves the lack of digital AHRS in some aircraft, maneuver log and greatly reduces the difficulty of aerobatics training.

TEAM 10 - Shazamboni: Backyard Ice Resurfacer

Yanni Pang, Bryan Jaimes, Katharina Golder, Robert Ling
Client: Alan Pisano Jr.

Abstract

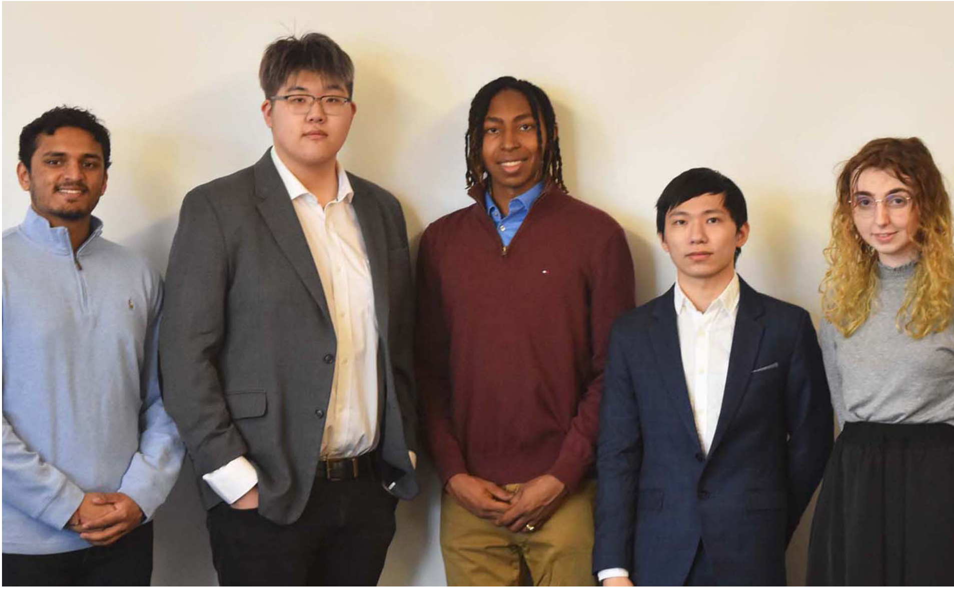
Backyard ice rinks are gaining popularity. Especially due to the effects of Covid-19, families are building skating rinks in their backyards for kids to practice skating, develop hockey skills, and simply to have fun. These same rinks often contain imperfections such as cracks, pit holes, and chipping, and existing products to maintain the surface of the ice are often expensive, inefficient, too large, and require an extensive amount of manual work. We propose to deliver an affordable and compact semi-autonomous backyard ice resurfacer that will be remote-controlled via a mobile device application. We will create this device by using a Raspberry Pi computer to control the various working components of the machine and connect the device to the user interface via the Raspberry Pi's Bluetooth and WiFi. The machine will consist of hardware components including distance detecting sensors for object avoidance, motors to control and steer the wheels, and a camera for assisted user vision. These processes will be implemented through Python and Django software downloaded to the Raspberry Pi along with Flutter Framework and Dart programming language used to develop the cross-platform application: the Shaz App. There are currently no remote-controlled ice resurfacers on the market for at-home use.

TEAM 11 - Bee Sense

Asbel Fontanez, Brian Mahabir, Pratima Vaidyanathan, Ivan Isakov
Client: Natan Rodzin

Abstract

Every year bees have had an increasing mortality issue. This issue arises from both environmental changes and unwanted intruders. To fix this, there needs to exist a system that is able to help beekeepers monitor their hives and be informed if there are any urgent issues. Team 11, Bee Sense, brings forth the following system solution. The system will include sensor boards, scales, and a Raspberry Pi. The sensor board will house a temperature sensor, a humidity sensor, an air quality sensor, a microphone, an IR camera, a real time clock, and some type of on board storage. The sensor board will also be able to transmit data to the Raspberry Pi using LoRa. The scale will be able to take weight measurements from the hive and send it to the Raspberry Pi using LoRa. The Raspberry Pi will convert all this information into CSV files asked for by the client.



TEAM 12 - Beyond Air Tapping

Nirmal Patel, Hin Lui Shum, Michael Washington,
Chen-Yu Chang, Willow McFarlin

Client: rtangent

Abstract

Sharing something professional or fun to others becomes a trend of people's daily routine in workplaces and at home. Demonstration of models, documents shows limited information on a 2D scale on a flat platform. Those models are also not portable to further view, making it hard to visualize. To be more specific when conveying ideas or prototypes, we propose to create a system with a baton and IOS device accompanying the IOS app. The solution supports multiparty through an XR application which projects AR objects anchoring to batons. The QR code will be constantly scanned through the IOS app that is worn in a headset with stereoscopic view. Whenever the QR code changes, the model will also change, including the size, dimensions, and contents. The authenticated users are also allowed to upload new models to the baton via wifi using node.js. The innovation of our system is that we have our IMU system in our baton so that when the QR code is scanned and the model is displayed, when the IOS device is moved to another position, the 3D model will not move. However, when we move the baton, the 3D model will move along with the baton, which interacts with the baton. This technology helps increase the sense of reality and we can also move the baton to have a more detailed view in a specific position.

TEAM 13 - Misbehavior Detection System for Cellular Vehicle to Everything Technologies

Julia Zeng, Max Ellsworth, Sam Krasnoff,
Michael Aliberti, Jason Inirio, Yixiu Zhu
Client: Professor David Starobinski and Stefan Gvozdenovic

Abstract

Cellular Vehicle to Everything Technology (C-V2X) enables cars and IOT devices with an LTE connection to broadcast positional information so that vehicles can perceive their surroundings without line of sight and avoid potential accidents. Before it is widely adopted, however, its reliability and security must be verified. To this end, we are modeling over-the-air C-V2X communication using software defined radios and leveraging machine learning to detect anomalous behavior. By running tests both with and without a jammer present and collecting data from agents involved, we will train a machine learning algorithm to determine when denial of service attacks are occurring on the network. The ultimate goal of this project is to provide insight into the strengths and vulnerabilities of the Vehicle to Everything protocol.

TEAM 14 - AR Agents

Wooyoung Cho, Heran Haile, Wenting Yu, Yuwen Cai, Yasmin Jamal Almousa
Client: William E. Carter School, Boston Public Schools

Abstract

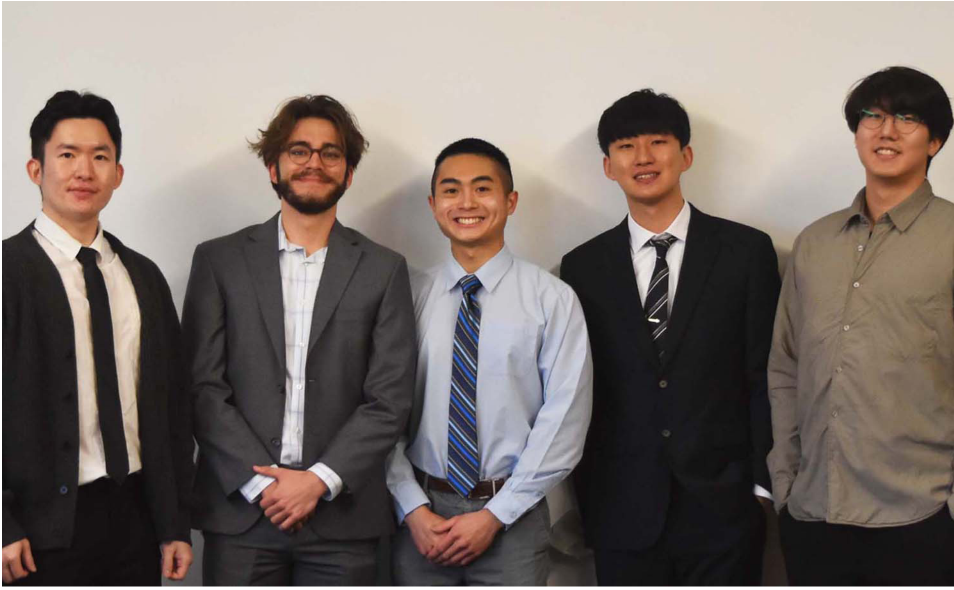
Children born with developmental disabilities can have difficulty with speech and language acquisition at an early age. Recent research has found that AR-enhanced learning can be an effective solution for the ongoing speech acquisition problem in these children. We will be using BoardWorks certified symbols and words, which the students are familiar with, to create an iOS application that performs image recognition and outputs the corresponding AR videos using ARKit. The videos will include audio recordings of a speaker enunciating the words in English and Spanish. The symbols will be printed on A4 paper, showing one symbol per page to ensure clarity. They will also be available for download and reprint whenever necessary. Printable card systems allow user flexibility and can be replaced in case of damage or loss. Users with disabilities will also be able to use a head/hand switch to control the buttons within the app, making the experience more interactive.

TEAM 15 - OCR and Data Entry App

Eric Benfaida, Jerry Neequaye, Patricia Luis, Zixuan Shu, Zhe Tu
Client: The Suffolk County District Attorney's Office

Abstract

The Suffolk County District Attorney's office has several formats of paper form that are used on almost every single case. These forms are in paper form and not digitized. Thus those are not easily searchable nor can be used for district wide data analysis and other aggregate analysis. The OCR and data entry app is a cross-platform app that can be used as a foundation for automated case file data entry. The foundational goal of the app for now, is to be able to fetch data from a few specific handwritten and typed out forms, while being able to share those files with other permitted users.



TEAM 16 - Drone 5G Network Performance Modeling: Sky Seer

Do Hun Ji, Peter Wallace, Ryan Mondonedo, Jung In Chang, Jong Whee Jeon
Client: Timothy Geraghty

Abstract

As commercial implementations of aerial drone fleets become more prevalent, there is an increasing need for beyond line of sight (LOS), autonomous operations. These would rely on communications networks, such as 5G, and would require minimal latency for precise control. Currently, there is minimal understanding of whether 5G network connectivity can support drone operations at altitudes of up to 400 feet above ground level, which is the airspace allotted to drones. To obtain a better understanding, this project will model 5G network performance at such altitudes. We propose the installation of a 5G cellphone on a quadcopter drone. The cellphone will conduct network speed tests and push the results to a cloud database. The collected data will then be used to produce the final deliverable, which will be a machine learning model of 5G network performance at the various altitudes.

TEAM 17 - Aerial 5G Network Modeling

Taehyon Paik, Stanley Zhang, Yuan Chi Chung, Talbot Taylor, Minseok Sakong
Client: Timothy Geraghty, AT&T Labs

Abstract

Mobile network operators are in the process of building out their 5G networks to support an ever-growing range of applications. The impact of these emerging capabilities is wide ranging and will have major impacts on many aspects of AT&T's business and infrastructure. Using our Aerial 5G android application based off of the Ookla Speedtest SDK, we have collected 5G connection data and built a machine learning model that is predictive of 5G speeds in different locations and conditions. For clarity, the collected data and predicted results are visualized using geolocation maps. This allows users of the application to further examine 5G networks and predict connection speeds in urban environments. The current machine learning model accounts for geographic location, altitude, connection source location, and predicts latency and upload/download speeds for these conditions.

TEAM 18 - Electric City

Linglong Le, Michelle Imogu, Erbyn Bonilla, Stephanie Cuterez, Henry Chong
Client: Marissa Petersile, National Grid

Abstract

As countries and institutions start pushing to replace fossil fuel driven vehicles with zero emission vehicles such as electric cars, there will inevitably be skepticism and doubt expressed towards this change. These doubts have a variety of sources, whether it be a lack of familiarity with how electric vehicles work, or a belief that electric vehicles cannot operate as well as gas powered vehicles. To combat these sources of doubt, this project will create a small-scale model of a transportation grid completely powered by electric vehicles. There will be multiple small vehicles, which will display mileage and battery charge remaining in the model, capable of driving around and then linking up with provided charging stations to recharge. This will show the operation cycle of electric vehicles, providing a clear demonstration of the process of charging, driving, then recharging the vehicles. A set of controllers will also be provided for user interaction with the model, allowing people to come up and drive the vehicles around. Charging stations attached to solar panels as well as outlet power will be provided and attached into a model made up of custom created roads and accompanying decorations, to create a realistic transportation system based on these vehicles.

TEAM 19 - Five Razors

Tao Zhang, Marcel Aubry, Chenyuan Zhou, Olivier Chen, Ren Jian Lim
Client: Procter & Gamble

Abstract

Many thousands of annotated images are required to train a deep learning machine vision system to detect defects. Generating a large and representative image dataset manually is not practical, especially since some defects are difficult to produce naturally at high frequency. Therefore, this project will instead generate simulated images using CAD models and rendering software. This will include 3D scanning and converting of real-world defective parts into 3D CAD representations, writing macros in the CAD software to automatically generate randomized defects using the originally scanned part as a template to seed subsequent virtual defective parts, and then using these models to generate a multitude of photorealistic images each with uniquely different defects. Our final deliverable includes full alteration power of the virtual defective part through the use of an interactive GUI.

TEAM 20 - SwingOn

Hanlin Mai, Yoel Beyene, Jessica Martinez Marquez, Tingru Lian
Client: Professor Martin Herbordt

Abstract

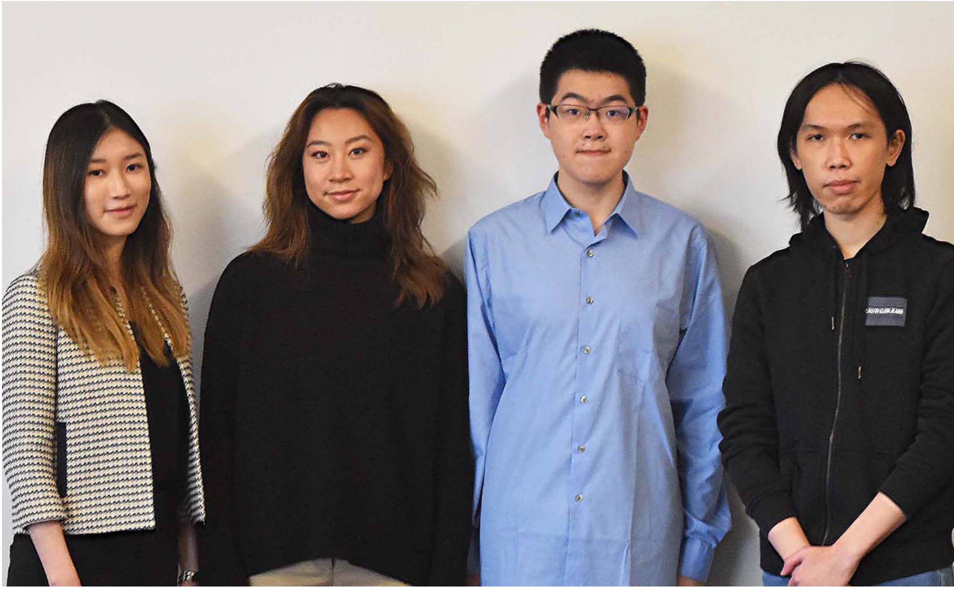
Golf is a difficult sport, especially without proper or personalized training, which leads to many potential golfers to be turned away. Most golf swing training aids focus on the trajectory of the golf ball. Although these aids are helpful, they cannot help users improve their balance and consistency. SwingOn aims to give users a way to improve their swing in ways that other training aids fail to do. Using a smartphone app that tracks the motion of the user, golfers can analyze their swing in real time. Additionally, users can upload videos of their golf swing from their Photo Library app or Files app to get analyzed videos with feedback. The SwingOn app uses pre-trained models to analyze and draw the user's body points. These points are used to compute the user's centroid and measure their balance. Instant feedback will also be provided after analysis to give the user better insight into improving their swing in the future. The SwingOn app will focus on the user's balance and consistency—the two most important mechanics of a great golf swing. SwingOn was created to make golf more accessible for people of all backgrounds and experience levels.

TEAM 21 - H-Pet

Shaivya Gupta, Tony Faller, Briana Zhao, Mohnish Sandi
Client: Fabio Malangone and Carmine Malangone

Abstract

Today, many pet parents have extremely busy schedules and are forced to be away from their pet for prolonged periods of time. During that time away, they worry about their pets missing their regular feeding times. H-Pet aims to alleviate this concern by providing a smart & automatic pet feeder and an accompanying mobile application that allows parents to schedule feeding times and see detailed feeding information. H-Pet leverages RFID technology to identify which pet is currently at the feeder, and it utilizes an attached food bowl with an integrated scale to track each pet's consumption at each feeding. Furthermore, through the accompanying mobile application, H-Pet is able to provide comprehensive health profiles that will allow devoted pet parents to better monitor and care for their pet. H-Pet is an innovative solution that allows parents to never miss a feeding time and track their pets' health to make the best decisions for their care.



TEAM 22 - HOMEdash: Heartbeat of Mother Earth Dashboard

Ashley Chong, Haocun Wang, Zhangchi Lu, Zhiyuan Liu
Client: Veronica Anderson, Born Global Foundation

Abstract

Information in the form of charts, 2D tables and statistics that fall under the umbrella of the United Nations 2030 17 Sustainable Development Goals (SDGs) is not readily available in a user-friendly and significantly user-friendly format. Maps are a means of interactive storytelling that can help display data of the UN SDGs as geographic information system (GIS) layers. As such, HOMEdash (which stands for Heartbeat Of Mother Earth dashboard) is a cross-platform application that displays real-time data streams about sustainable development on a 3D globe which users can interact with. Interactions like turning layers on and off, enabling time to see changes, and perform simple analyses to identify patterns will create a more powerful experience. The application should highlight the UN 2030 Sustainable Development Goals (SDGs) and provide access to widgets which display humanity's progress toward the goals. The user interface is made through Javascript API, with a back-end component using ArcPy and Python3 API, as well as sustainability prediction features using machine learning frameworks with Kaggle and PyTorch accordingly, and a user-end database with AWS services.

TEAM 23 - HYP Batteries

Daniel Kao, Yu-Sheng Chen, Ismaeel Alalawi, Spencer Piligian, Steven Wang
Client: Dr. Kenneth D. Sebesta

Abstract

Batteries for small aircraft propulsion are a niche market, eGliders in particular, because their power needs are unlike anything else. As a result, there are no cheap commercial off-the-shelf battery packs that are lightweight enough, with performance similar to rocket launch for an eGlider. Our hybrid-chemistry battery pack design aims to fill this gap by combining two batteries, with two different discharge characteristics. These two cell chemistries can achieve a variable-max discharge rate, allowing us to design a smaller battery pack, while fulfilling power requirements throughout the launch. This pack setup will help gliders achieve a safe flight through the use of electric power, and as a result will minimize the risk of mechanical failure on our client's conventional mechanical engines, whose vibration causes other parts of the craft to wear out and increases the chance of failure.

TEAM 24 - FLEXTEND

Jack Halberian, Thomas Scrivanich, Carmen Hurtado Garcia,
Sohaib Ansari, Murat Sencan

Client: David Cronin, Fabio Malangone, Carmine Malangone

Abstract

The knee is one of the most injury-prone joints in the body. Frequently, these injuries require surgery and physical therapy alongside constant monitoring that is necessary for rehabilitation and recovery. Current monitoring systems are costly and do not provide flexibility for the individual. FLEXTEND is an at-home, self-administered, electro-mechanical device that will measure the flexion and extension of the knee in degrees and track results for the users. FLEXTEND will provide a cost-efficient and accommodating option for active adults, the elderly, and any others with pre existing knee conditions. Featuring a cross-platform mobile application and on-device screen, our product will be user-friendly, interactive, and customizable to the user's goals for recovery.

TEAM 25 - REALM

David Cocero Quintilla, Jaskaran Gahunia,
Suzelle Mejia, Jean Marc Achkar, Daniel Cabrera
Client: Andrew Vargas, Nicholas Musella, and Varshith Anilkumar

Abstract

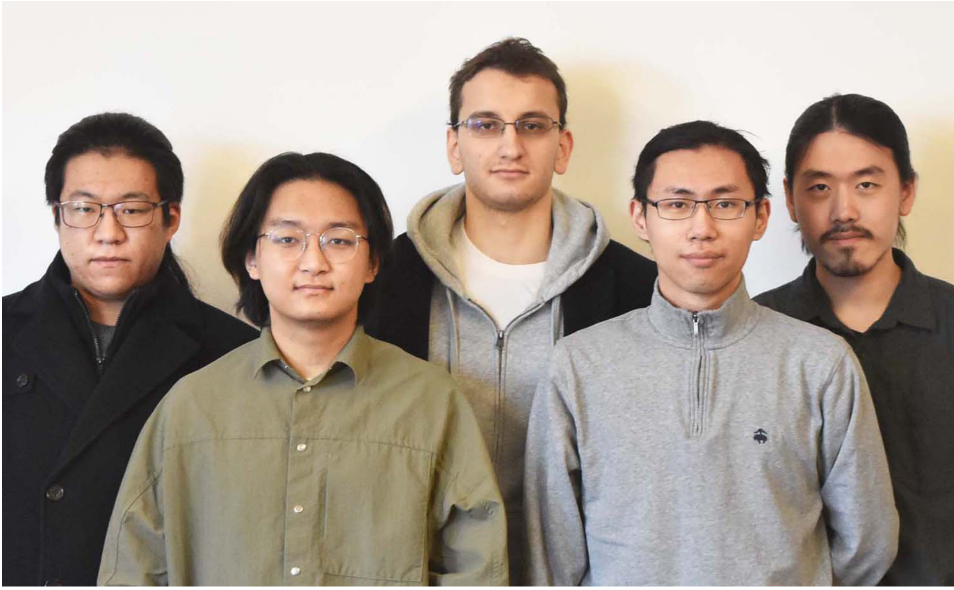
While agencies provide leads and comparative analysis tools, independent realtors largely rely on social media, word of mouth, and cold-calling to find their own leads. This, however, is not always effective and certainly inefficient. We aim to deliver a cross-platform real estate app aimed at independent realtors to provide them with (1) automated comparative analysis, (2) “farm” delineation through a map interface, and (3) general organizational tools that ultimately improve their efficiency and yield a higher return on successful leads. Backend powered by Google Firebase and Google Maps API, frontend done in React Native framework, and comparative analysis in the form of a machine learning algorithm for estimating the current value of a given home.

TEAM 26 - RFSoC for RF Environment Monitoring

Jaime Mohedano Aragon, Isaac Yamnitsky, Yana Galina, KaKit Wong
Client: MIT Haystack Observatory

Abstract

The radio frequency (RF) spectrum is becoming increasingly congested, making high-fidelity measurements in the geospace and radio astronomy communities difficult. This congestion results in the need for RF interference mitigation techniques, and mitigation techniques require the use of RF spectrum monitoring tools. We plan to create an interactive Web application which will use a variety of RF sources to display the RF spectrum, efficiently parse and store data. Our main focus is on the application of the Xilinx Radio Frequency System-on-Chip device to RF spectrum monitoring, as well as other techniques of interest to current interference mitigation research. We will also handle previously recorded data.



TEAM 27 - Beaverly

Chenliang Wang, Wangyi Chen, Dmitry Zimin, Siyang Zhang, Yuxuan Luo
Client: Professor Janusz L. Konrad, Jordana Muroff

Abstract

Extreme room clutter is often a manifestation of mental health disorders and causes a dangerous living environment such as fire and hygiene hazards. Thus, Clutter Image Rating (CIR) has been developed to combat dangerous environments and help diagnose residents with hoarding. The client has developed an algorithm that produces a CIRs, which they want to deploy to the Boston Housing Authority (BHA) in the form of a mobile Application. Additionally, the usage of the algorithm by the BHA will provide additional images to further train the algorithm.

Our team's solution is to build a cross-platform mobile and tablet application supported by our server, database and web portal to manage users' data. We chose Flutter + SpringBoot + MySQL as our technical stack to complete this system. The process of developing the application is split into four main tasks: frontend (App), server, database + web portal and algorithm. The combined tasks will fullfill the client's request for a convenient CIR phone app, image database and an algorithm with improved accuracy.

TEAM 28 - SITA: Speech Indirect Therapy for Autism

John Wilkins, Samantha Puterman, Anika Sharma,
Harleen Chaudhary, Dabin Jang
Client: Dr. Andrey Vyshedskiy

Abstract

Due to historical and ongoing discrimination, specialized healthcare for people with autism spectrum disorder (ASD) has been systematically underdeveloped. Specifically, for non-verbal children with ASD, effective and consistent practice is critical to the success of speech therapy. Speech therapists, however, currently lack sufficient resources to ensure that such practice occurs outside of scheduled sessions. To fill this void, we present SITA (Speech Indirect Therapy for Autism), a cross-platform app for therapists to create and assign personalized speech exercises for children to practice at home. SITA allows therapists to record custom videos of themselves correctly pronouncing words that are then sent to the child's device for future practice. During such practice, an algorithm evaluates and scores the child's attempts, rewarding audible and accurate pronunciations with playtime through simple built-in games. Ultimately, SITA aims to help speech therapists increase their efficacy and efficiency by providing an effective tool for speech practice.

TEAM 29 - ClearSol: A Self-Cleaning Solar Power System

Ryan Rosenberger, Anthony Saab, Zachary Capone,
Julian Leguizamon, Fabio Ricardo

Client: Dr. Malay Mazumder

Abstract

ClearSol is a stand-alone solar photovoltaic power system that utilizes supercapacitor energy storage. This system powers an Electrodynamic Screen (EDS) that allows for automatic dust-mitigation using electrostatic interactions in the case where dust accumulates on the surface of the panel. The aim of the project is to be a proof of concept for the implementation of supercapacitors as energy storage in a PV system with an EDS and a potential external load.

TEAM 30 - Smart Grid

Jonas Escobar and Aidan McCall
Client: Professor Alan Pisano

Abstract

Initially built by a previous senior design team, The Smart Grid Test Facility is an educational tool for engineering students, facilitating in-class experiments, demonstrations, and active learning. After several years, we are restoring the model in order to make it functional for a professor to easily set up and use in class through a user interface and testing procedures that we design. The interface will analyze and display recorded data, allowing a class to develop a mathematical understanding of the processes happening physically on the model. Ultimately, this project will help students learn about the power grid and how it reacts to various arrangements of generators, loads, wiring networks, and sensors.

TEAM 31 - EcoSwitch

Keven DeOliveira, Michelle Thevenin, Jiawei Liao,
Michael Harkess, Samarah Uriarte
Client: Harsha Ogoti

Abstract

Manually controlled FCUs (fan coil units) in BU brownstone dorms lead to rooms becoming uncomfortable warm. As a result, students either turn off their heating unit or open a window in order to obtain a more comfortable temperature. These methods of achieving such conditions is either inconvenient to the student or a waste of energy. To this problem, we propose Ecoswitch, a system consisting of smart devices networked with online portals to allow students and administrators to remotely monitor and adjust the temperatures of these rooms. The smart device is an autonomous FCU dial mount that will manually adjust FCU settings based on local weather and user input. Room temperature data and user information will also be stored within a database, which can be queried for and displayed to users to monitor FCU performance. EcoSwitch is designed for the management of BU's campus life and will establish applications that can help Boston University achieve its Zero Waste goals while increasing student quality of life.

TEAM 32 - VETCON BADGE

Julian Pagett, Derek Barbosa, John Kircher, Carlos Ortiz, Ryan Sullivan
Client: VETCON - Michael R. Jones

Abstract

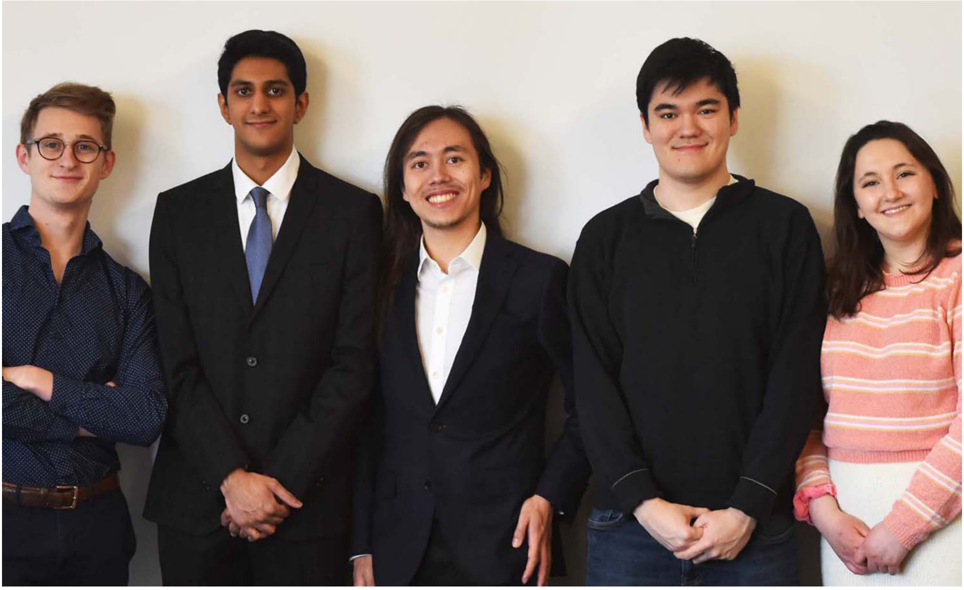
Our clients, VETCON, need a unique, func-tional, and production-ready badge for DefCon 30 which will take place in August 2022. Our team will be creating the prototype along with a bill of mate-rials needed to produce each badge, a user manual for assembly and operation of the badge, as well as a mass badge production process. Our team will use the TI MSP430 microcontroller as a framework for the badge. We will create custom hardware, software, and a distinct aesthetic appearance to create a unique user experience.

TEAM 33 - NanoPack for NanoView

Joseph Walsh, Devin Bidstrup, Paul Stephen Hutchinson Maltaghati,
Justin Melville, George Kent-Scheller
Client: NanoView Biosciences

Abstract

As NanoView Biosciences expands and offers its services to more customers, it will need to ramp up the production of its signature product, an imaging device which is used to characterize biological molecules. This device requires treated silicon chips that allow the company to analyze different biological samples. The current development process for these chips includes a step where a lab technician must use tweezers to manually move chips from the internal carrier called a traveler into their packaging for shipping called clamshells. This is both labor-intensive and error-prone. Our proposed solution is an automatic packaging device that is 10 times faster than human-packing and resistant to error when placing chips. This will comprise both a packing machine and an accompanying software package to control the machine. The machine will be a CNC-style device able to perform x-y-z motion with a tweezer actuator at the end of the arm to pick up the chip. From the software program, one will be able to start the packing, monitor its status in real-time, detect errors, and terminate it if need be.



TEAM 34 - PUCKFish

Will Aracri, Ammar Hussain, Peter Ha, Alex Necakov, Victoria Thomas
Client: Andy Whitman and Anthony Byrne of Fathom Fishing

Abstract

The lobster fishing industry is a historic practice that has largely remained unchanged since its emergence in the mid 1800s, with traps placed along predetermined routes. This dead reckoning leads fishermen to place numerous extraneous traps throughout the ocean in areas unlikely to house lobsters. These have a significant environmental impact on other marine life such as the endangered North American Right Whale, a species where fishing gear entanglement is the leading cause of unnatural death. Due to these environmental concerns, fishermen are regulatorily limited in the number of traps they can place. PUCKFish solves this by providing low cost, rugged instrumentation to fisheries. This device puts the tools for data acquisition and analysis in the hands of trappers, with data-backed decisions about where to place lobster traps truly optimizing fishing hauls. We will be producing three PUCKFish data collection devices each recording six key metrics relevant to lobster activity on the seafloor. PUCKFish will be the first business-grade all-in-one data collection and analysis suite specifically for lobster fishermen. Its low cost and ability to collect the six metrics most critical to locating and tracking lobsters will revolutionize the lobster fishing industry.

TEAM 35 - RoboSaw: The Collaborative Wood Stock Cutting Robot

Peter Siegel, Pavel Gromov, Teo Waalberg, Dylan Derose
Student Self-Defined Project

Abstract

Interaction with equipment including circular saws, miter saws, and table saws accounts for a large portion of the risks facing construction workers at the jobsite. RoboSaw is a robot miter saw designed to eliminate the repetitive, time-consuming and potentially dangerous task of manually cutting wood stock by working collaboratively with a construction worker to complete a project. RoboSaw can cut wood based on a preset cut list or at intervals marked with pencil, enabling the construction worker to focus entirely on structure assembly. By automating the processing of wood stock at the jobsite, RoboSaw can improve construction speeds, eliminate the risks of injury, and reduce operating costs for employers and other stakeholders.

THESIS STUDENT JOHN MIKULSKIS

ADVISOR: PROFESSOR RICHARD WEST

Autonomous Vehicle Twin HIL Simulator

Abstract

We are working on creating a Hardware in the Loop (HIL) simulation testbed for autonomous vehicle research to help achieve conditional automation (level 3 autonomy) with open-source self-driving car software such as OpenPilot. Level 3 autonomy implies that a human is required to drive the vehicle, but the advanced driver-assistance system (ADAS) can take control of the steering, braking, and throttle when the environment demands it. We plan to do this by simulating a vehicle in software that communicates with a system which has a scaled down car that collects real world sensor data. We plan to use this sensor data to have real time corrections and testing with a direct feedback loop to and from the software simulation.

THESIS STUDENT
LAITH SHAMIEH

ADVISOR: PROFESSOR AJAY JOSHI

Embedding Nanoantennas in IC Chips Using Machine Learning

Abstract

With the continuous push towards scaling of Integrated Circuits (ICs), production costs have been correspondingly increasing, leading more and more companies to outsource the fabrication of IC chips. Consequently, there is a growing concern about the security of such chips. In particular, the IC chip becomes vulnerable to Hardware Trojan (HT) insertion during the fabrication process. Moreover, these HTs cannot be easily detected using traditional electrical methods. My project will embed optical nanoantennas in each standard cell such that each cell has a unique optical signature. To add an HT, one will need to move or replace standard cells which would change the optical signature of the design. This malicious modification can then be detected using backside optical imaging. Manually inserting nanoantennas inside each one of the hundreds of gates in a library is very time-consuming. To avoid this, my project focuses on developing a Reinforcement Learning (RL)-based design of the standard cells with nanoantennas. I am exploring two approaches: one approach where we start with a standard cell layout and insert the nanoantenna inside the standard cell, and the second approach where we start with a nanoantenna and then design the standard cell around the nanoantenna.

THESIS STUDENT
ESTHER YE

ADVISOR: PROFESSOR RICHARD BROWER

Quantum Computing: the Sine-Gordon Model as a Qubit Chain

Abstract

Quantum computing has demonstrated the potential to surpass classical computers in solving difficult computational tasks. One such category of tasks which it lends itself to is the computation of lattice gauge theories (LGT). In this project, we demonstrate a scheme for implementing the lattice sine-Gordon (sG) model on a quantum computer. We numerically simulate the discretization of the sG-model and then utilize Qiskit to generate quantum circuit models and compare the results of those circuits to the exact solution.

THESIS STUDENT LIFU ZHANG

ADVISOR: PROFESSOR IOANNIS PASCHALIDIS

NOC Clock

Abstract

Early detection of cognitive impairment not only allows better care for patients but also enables the selection of better candidates to participate in drug clinical trials and increases the likelihood that some of these trials would yield drugs which can make a difference. My research group led by prof. Paschalidis has been studying ways to predict cognitive impairment using non-invasive approach such as clock drawing test. As deliverable, my team would like to develop a web application for patients to submit a clock drawing and demographic information that can predict subjects' cognitive impairment status using deep learning methods.

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 Adjunct Professor

Michael's research focus is in geospace remote sensing, using GPS, megawatt radars and synchronized high-speed cameras to characterize and model the space weather environment.

Michael's work connects first-principles physics models to real-world applications of AI / ML algorithms from endpoint to HPC. Michael's research helps enable the GPS receivers in smartphones to serve as a space weather detection network.

Michael teaches software engineering at the graduate level, generalizing his experience building a patent portfolio to techniques every engineer can benefit from.

TEACHING ASSISTANTS

JEFFREY ALIDO

Jeffrey is a 2nd year Ph.D. candidate working with Professor Lei Tian on computational imaging. He is passionate about jazz music and basketball, and is learning how to sew fashionable clothes for his friends and for himself.

SHASHWATH BHARADWAJ

Shashwath is a 2nd year Ph.D. student in Professor Vivek Goyal's group, working on single photon imaging systems. Prior to this, he received an MScin Energy and Material Sciences from INRS-EMT, Canada, and a BE in Computer Science Engineering from PES University, India.

MUHAMMAD WALEED KHALID

Waleed is a second-year Ph.D. student under Professor Abdoulaye Ndao and is currently working on metasurfaces and light-matter interaction. He loves playing cricket and cooking in his free time.

TEACHING ASSISTANTS

CK PAW U

CK is a third year BU Ph.D. student in Professor Walsh's Space Physics and Technology lab. They work on LEXI, an x-ray telescope that will observe the interaction of the solar wind with the earth's magnetic field from the surface of the moon.

CHATHURA RAJAPAKSHA

Chathura is a second-year Ph.D. student working with Professor Joshi on computer architecture and hardware security. He loves traveling and watching movies in his free time.

BINGYING ZHAO

Bingying is a second-year Ph.D. student working with Professor Jerome Mertz on Multi-Z microscopy. She receved a BS from Sun Yat-Sen University and an MS from Karisruhe Institute of Technology.

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 hard work and dedication put into these projects every day, from the day they walked in to EC463 at the start of the Fall semester.

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