BU Department of Electrical & Computer Engineering

Friday, May 5, 2017

BU ECE

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

The ECE academic experience is guided by 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. 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 gained in the classroom 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:

Technical, communication, personal, and team skills needed for successful design in electrical and computer engineering.

Knowledge of 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 of technical information.

Understanding of team dynamics and ethical issues in design.

Experience in completing a design project for a small-scale electrical or computer system.

ECE DAY AWARDS

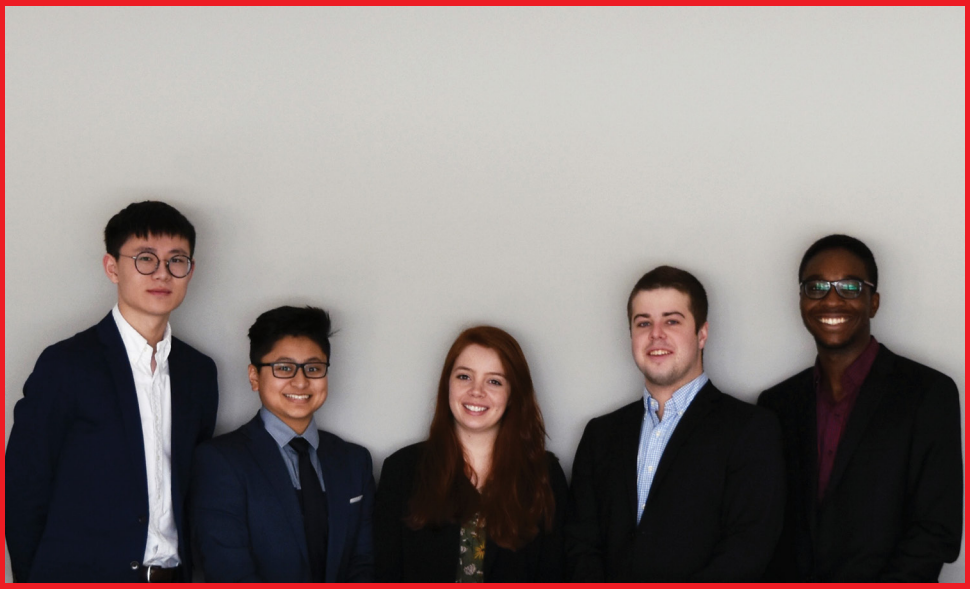
Best ECE Senior Design Project Award

Design Excellence Award

Michael F. Ruane Award for Excellence in Senior Capstone Design

Entrepreneurial Award

Space Physics Undergraduate Research Award



Team 1 | Luminesense

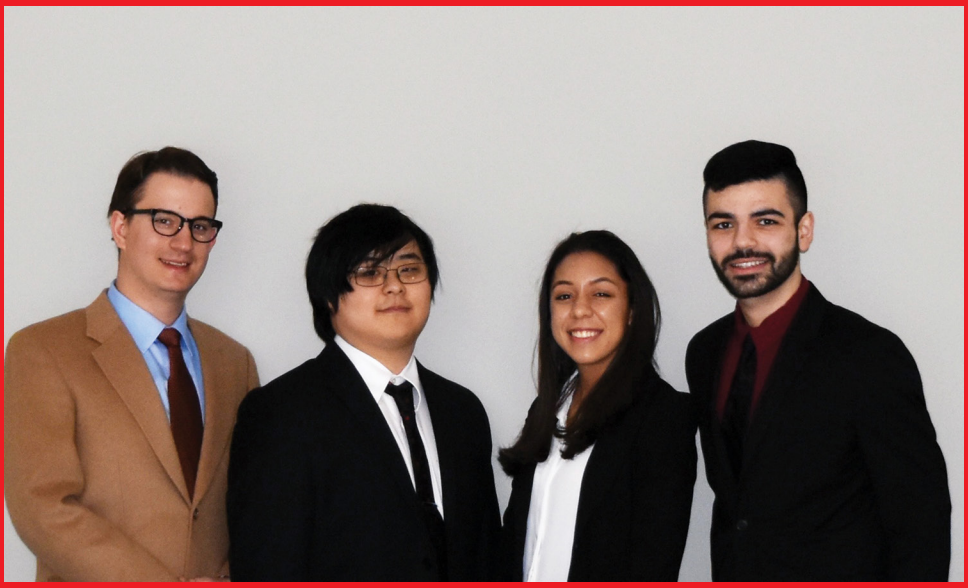
Team members: Zehua Zhao, Sneha Pradhan, Caroline Jones, Michael Haley, Tanatsigwa Hungwe | Client: Professor Thomas Little

Lighting systems have failed to take advantage of the opportunities presented by IoT technology - a world of intelligent, interconnected devices. Nowadays, consumers need a lighting system that is more dynamic, intuitive and conscious of our energy consumption. Luminesene's final deliverable is a lighting system solution that consists of a wearable transceiver, light fixtures, an IP enabled central hub, and single pixel cameras.

The system engages with the user in two different modes: “gesture mode” and “adaptive mode”. The former allows the user to actively interact with the system and explicitly change the properties of the light fixtures - their colors and brightness - by invoking gestures through the wearable. The central hub analyzes information regarding the selected lights, recognizes the gestures sent from the wearable, and updates the states of the lights. The second mode hosts a passive interaction between the user and the system. The system acts as a traditional IR sensor - turning the lights on in the presence of a user, and turning them off in the absence of a user. The single pixel cameras detect the presence of users, and relays this information to the central hub, where the lights are updated.

In the midst of all the interactions, the system's energy consumption and performance data is logged into a database and displayed on a web application. This portal grants the user access to energy usage graphs, where they can track their energy usage over periods of time. Additionally, the application gives the user remote control over the system - allowing them to change gesture preferences and issue commands to luminaires without using the wearable.

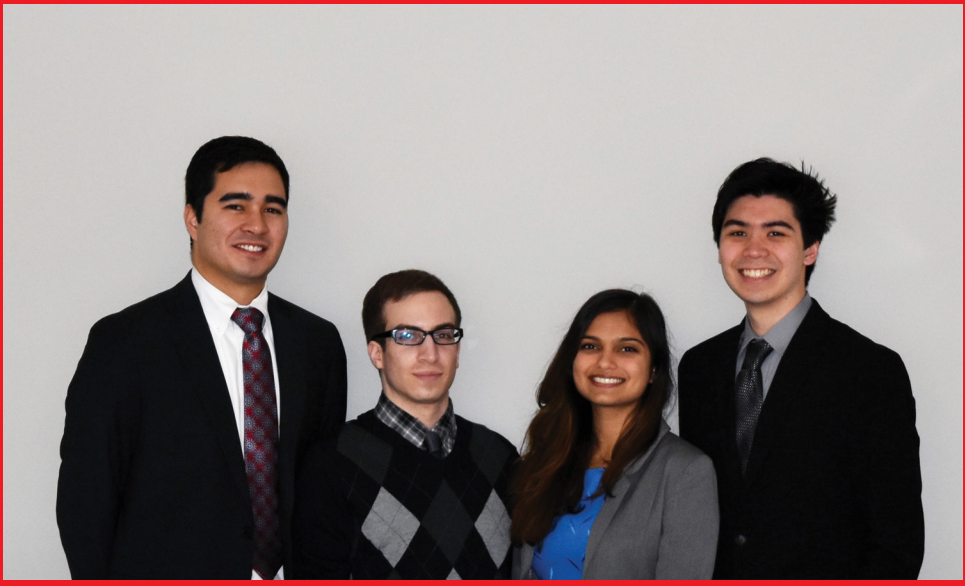
The Luminesense system features a host of capabilities: an accurate gesture recognition system, a comfortable wearable device, an intuitive gesture library, and a state of the art motion capture system that adjusts lights in real time. The project is not exceptional by virtue of its objective, but by the execution of its objective: to create a unified system of communication amongst the various components. In doing so, the system redefines the way humans interact with lights and provides a new energy efficient paradigm for smart lighting systems.



Team 2 | AutoPen

Team members: Petar Ojdrovic, Dennis Your, Jeraldin Guerrero, Omar Janoudi, Wasim Khan (not pictured) | Client: Jonathan Petit and Professor David Starobinski

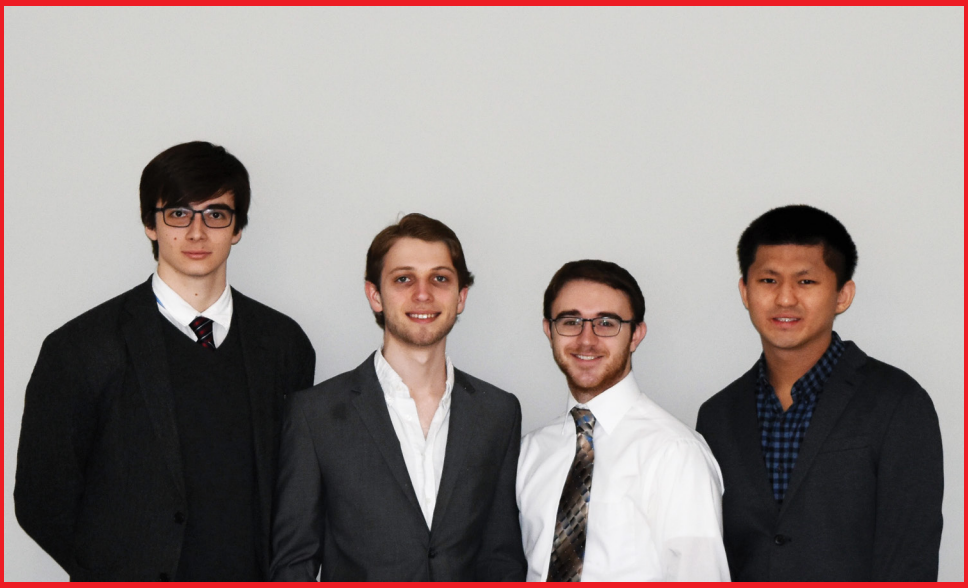
AutoPen is a software package which aims to facilitate efficient and expedient penetration testing of vehicles. As cars are becoming more and more connected, and as the number of computers and automation in a car increases, the attack surface of cars becomes larger and larger. The rapid rate of advancement makes vehicular security a daunting task for researchers, and the lack of a centralized tool repository and management system creates a significant barrier to entry. Our system aims to remedy many of these problems. By assembling much of the functionality necessary to perform effective pen-testing under one umbrella, our project makes the process of examining a car as easy as downloading the package and starting your work. All of the hassles typically associated with setting up and managing a pen-testing suite are automated, thus providing a turnkey solution. In addition, our open-source CAN sniffing and injection tools provide a similar level of functionality as expensive, proprietary platforms, with the added benefit of having built-in analysis. CAN traffic achieves security through obscurity. Thus, reverse engineering which comes as a result of effective analysis, is immensely helpful for security researchers. Based on the semester-long testing at the John A. Volpe National Transportation Systems Center, AutoPen was able to prove its use in the reverse engineering of some car systems, sniffing and interacting with SDR elements of the car, and injecting malicious CAN traffic into the vehicle's internal networks. Also provided in the software package are current tools used in the cybersecurity field for cracking Wi-Fi and Bluetooth, included for further testing penetrability in car wireless systems. This combination of tools bundled with the ease of setup is proving to be a powerful tool in the arsenal of security researchers, and will allow for finding of bugs and attack vectors in vehicle systems, ultimately resulting in safer and more secure cars.



Team 3 | DOSeye

Team members: Michael Ethier, Solomon Utain, Ami Vyas, Alexander Wang | Client: Professor Darren Roblyer

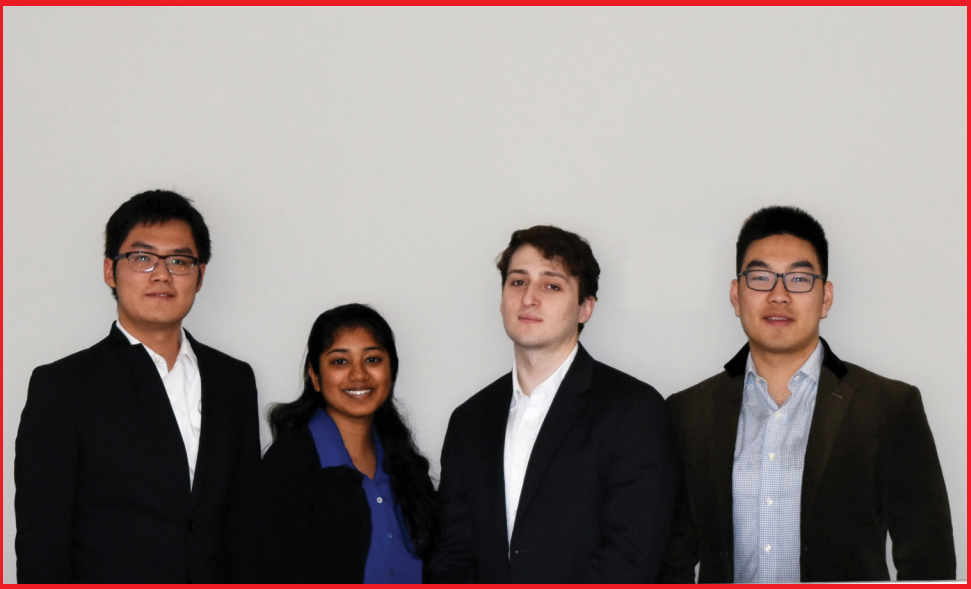
The DOSeye is an enclosed module with the capability to measure hemodynamic changes within human tissue. The measurements are taken by a laser light source and sensitive photodetector contained within our module which, when combined with diffuse optical spectroscopy technology, can be used to calculate the optical properties of a piece of tissue. The associated file tagging system can use information in the data to automatically organize the files into a searchable and user-friendly database. The DOSeye will be used as a stepping stone to eventually create a smaller probe using the same electronic components that can be used to measure the changes of a tumor during chemotherapy. Using the probe, patients and doctors will have faster feedback on the efficacy of their chemotherapy sessions.



Team 4 | SpotCheck

Team members: Daniel Andronov, Evan Bowman, Jordan McMahon, Nevin Zheng | Client: Derin Sevenler

In order to gain more information on the surface coatings used in biological assays, Professor Unlu and his research lab are currently imaging biomaterial in the form of microdots and assessing the quality of each dot. Currently, Professor Unlu's lab analyzes the results of each image individually by hand. This method has proven to be too slow and tedious and has impeded research. Our goal is to create a simple and intuitive software application that allows users to measure the quality of microdots automatically, so that research can be performed at a much more efficient rate. Our proposed solution will be a cross platform, user friendly, and flexible micro spot analysis application called SpotCheck. It will feature OpenCV backend image processing capabilities, and a Node JS frontend.

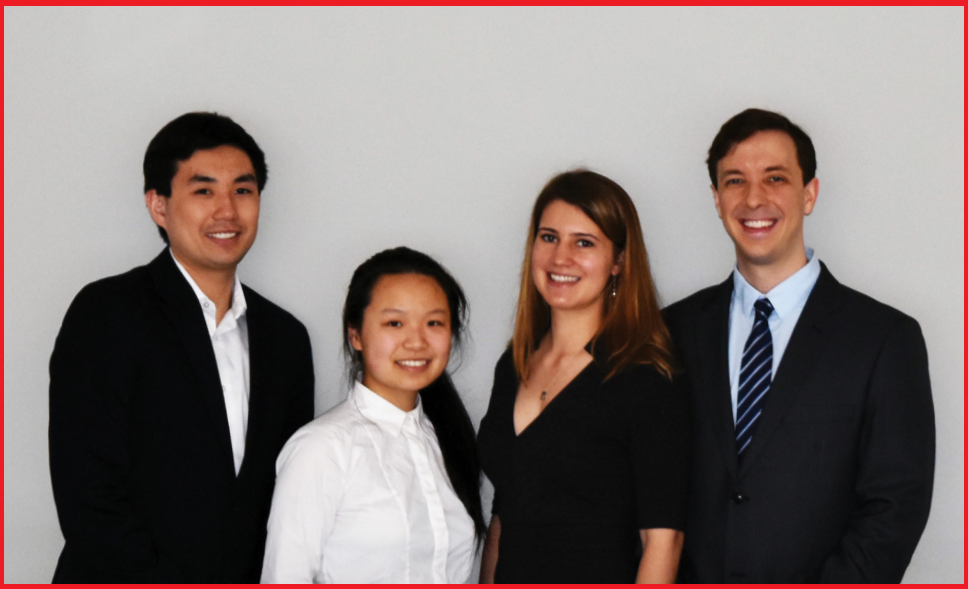


Team 5 | Aeronomy Radar

Team members: Ruixin Xu, Vithusha Thirumavalavan, Sebastian Soto, Zhechen Xu | Client: Michael Hirsch, Ph.D. and Professor Juha Vierinen (Univ. of Tromsø)

Inexpensive COTS SDR technology enables applications such as ionospheric imaging radar for $300/node. A novelty of our project is that our radar is software-based instead of hardware-based, making it 1/20th the cost of legacy radars and far faster and easier to deploy, since little external hardware is required beyond the single board Red Pitaya computer with Zynq CPU/FPGA. Out of the box frequency coverage is DC-50 MHz with dual 125 MS/s DAC/ADC, which can be translated to much shorter wavelengths (e.g. 2.4/5.8 GHz) via minimal external hardware.
Since the radar modulation and processing can be changed via software, completely different mission profiles are enabled with a mouse click. Ground-level applications include privacy-sensitive applications such as remote facility monitoring. Instead of placing several cameras around the home to monitor if someone has driven in the driveway or entered a building or house, one is able to do the same thing in a less intrusive manner via license-free radar.

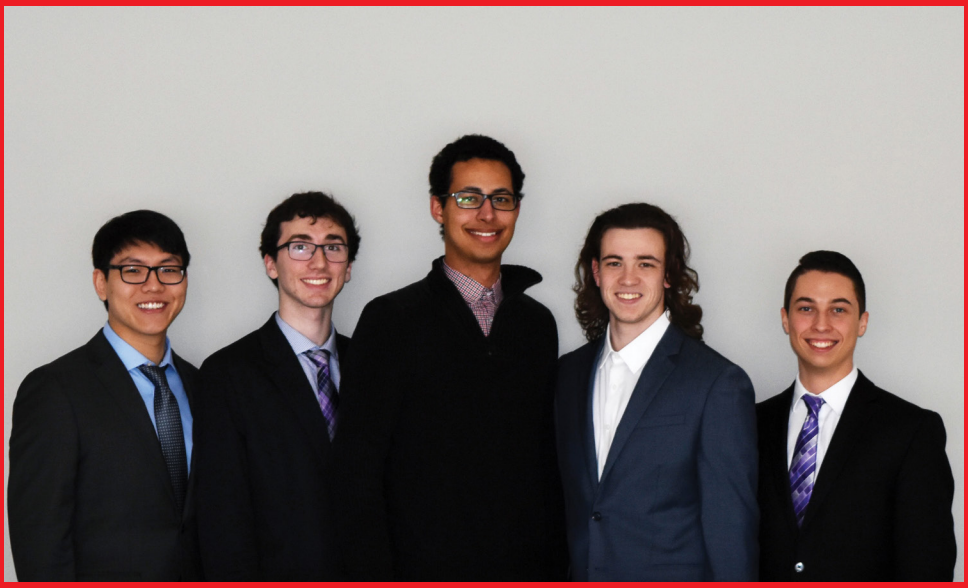
Regardless of the application, our intent is that this project helps to pave the path for other low cost open-source software-based radar projects in the spirit of the first coffee-can radar from 2006. For more information, see https://www.scivision.co/pi-radar



Team 6 | DORI: Door Opening Robotic Intelligence

Team members: Davy Huang, Jingning Zhang, Kathleen Lewis, Victor Weiss | Client: William E. Carter School and Professor Osama Alshaykh

DORI is a collaborative project between EC464 Team 6 and the William E Carter School of Boston, MA. The DORI project seeks to bring independence and autonomy to differently abled students who may not have the means to open doors on their own. Specifically, DORI is focused on bringing the ability to open doors to students who have limited capabilities and coordination in their arms and are bound to a wheelchair, through use of an advanced wheelchair attachment. The DORI attachment, with the employment of a camera, an onboard compute solution, and linear actuators and motors, is able to automatically push and pull open most conventional doors.



Team 7 | E-FIRE2

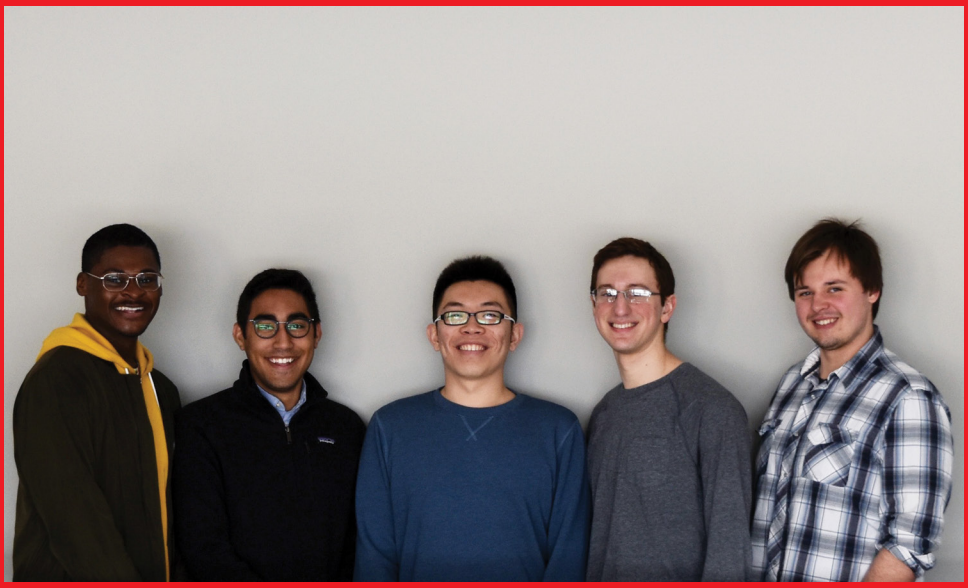
Team members: Alexander Reever Stooss, Zhaoren (John) Wang, Sami Shahin, Dylan Santos, David Barton | Client: Prof. Ted Fritz , Prof. Brian Walsh, & Prof. Ronald Knepper.

E-FIRE2 is a proof-of-concept project for a 1cm x 1cm ASIC known as MIROC2 (Multi-channel Integrated Read-Out Circuit). MIROC2 is the first integrated circuit designed to facilitate measuring electric fields in low earth orbit. Its small size along with its modularity allows for it to be an instrument in a compact, inexpensive spacecraft such as a CubeSat. Our design is focused around creating a system that houses and interacts with MIROC2 in order to provide sample electric field measurements.

We will deliver 3 printed circuit boards. The first board houses MIROC2 (the IC which makes this all possible) as well as its bias power and interfaces with two other boards. Another board attaches to an external diode detector array and provides bias resistors and power to that array. The final board houses the FPGA and connects to MIROC2's board to provide instructions and receive and process data. We will also deliver a collimator, which will enable us to direct electrons at the detector diodes, which will then send a signal to MIROC2 and the FPGA. This system will demonstrate that MIROC2 works as intended and can be applied to measuring electron energies, and thus also for measuring electric fields in space.

We use detector diodes to absorb high energy electrons. After an electron hit, the diodes, when properly biased, draw some current to ground which causes a temporary charge flow. MIROC2 takes this charge flow as input and amplifies and shapes the pulse as a voltage pulse. The FPGA makes decisions regarding which of MIROC2's on board Analog to Digital Converters (ADCs) should handle this, and then converts this input into a serial output. This information, as well as a trigger pulse telling which diode was hit, is passed to the FPGA, which stores the data and passes it to a GUI.

MIROC2 is a custom IC and does something entirely unique in reading pulses from solid state devices designed to measure electron energies. Its ability to work with a radioactive source instead of an electron gun, which draws much more power, is critical to making the system as low power as possible. The PCB's being designed are custom and unique and will power MIROC2 as well as control the necessary signals end-to-end.

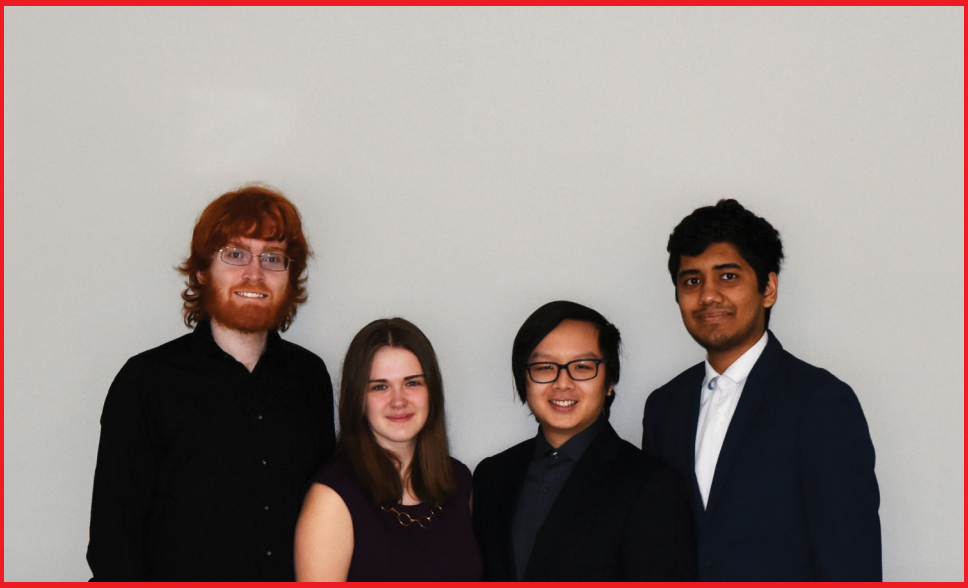


Team 8 | Groove Gloves

Team members: Fritz Jolivain, Darryl L. Johnson, Yi Liu, Brett Moretzky, Richard Nesbit
Client: Pauline Pisano

There are approximately 1 million deaf people in the United States and 70 million worldwide. While they may not be able to experience sound and music in the traditional sense, there have been cases where people with significant hearing impairments have been able to interpret sound through the sense of touch. Evelyn Glennie, a popular solo percussionist, has been profoundly deaf since the age of twelve yet has still been able to produce music through her sense of touch rather than hearing.

The Groove Gloves seek to provide a similar experience to others in the deaf and hard of hearing community. Groove Gloves will be comfortable gloves that allow the user to experience a faithful interpretation of sound and music through vibrations on their fingertips. The device will support both music playback from a personal device and ambient sounds as an audio source. The gloves will be battery powered in order to make the experience portable.



Team 9 | Vulcan Microfluidics

Team members: Shane McCormack, Alexandra Nero, Julian Trinh, Anish Asthana
Client: Professor Douglas Densmore

Project Vulcan is aiming to reduce the cost and time-consumption of biological experiments by automating the design, execution, and data collection processes through the CIDAR lab's low cost "Fluigi flow" microfluidics. Compatible with Neptune, a streamlined system for designing microfluidic devices, Vulcan will provide a microfluidic system that is backed by custom, parameterized hardware to add the ability to carry out laboratory experiments. Our final deliverable includes two modular hardware primitives (PCR and Droplet Characterization) that will communicate with our peripheral manager software. The added peripheral manager will include a graphical user interface in order to allows users to properly control the modules and customize experiments. This project will also expand upon the customer's current software to include the ability to create a microfluidic device with these integrated hardware primitives. All components of our design will be constructed using low cost materials and programmed using open source software to increase affordability and encourage other engineers to improve upon our project.

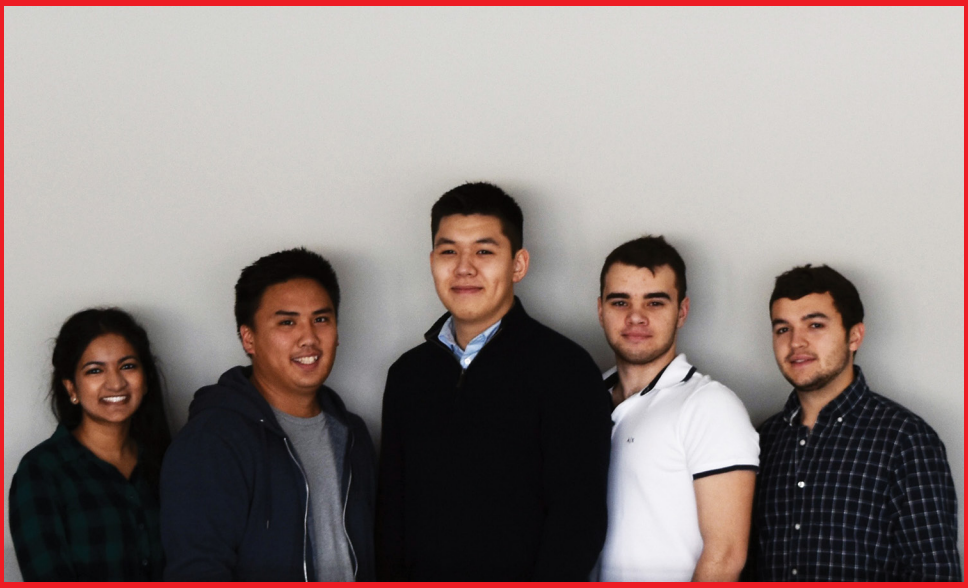
Team 10 | NMR in a Coffee Cup

Team members: Nicholas Brusco, Arnab Gogoi, Xingda Chen, Jean Dega, Asad Ashraf
Client: Schlumberger

Traditional NMR machines use a significant amount of energy and in most cases are immobile and prohibitively expensive. When samples at an oil site need to be tested they are sent back to labs. Waiting for results can hold up progress and negatively affect productivity. A portable device which would allow testing on site with immediate overview results on an oil sample would be highly beneficial to petroleum companies as it would save valuable time, capital investment and increase efficiency. It also has the potential to help petroleum companies get knowledge of the oil in the vicinity more quickly and therefore protect the environment from unnecessary drilling ventures.
Our client would like to have a prototype of an NMR spectroscope inside an actual coffee cup that can successfully conduct and obtain results for NMR spectroscopy on water so that he can demonstrate the device's usefulness as a miniature portable NMR to Schlumberger.

To realize this goal we plan to spit the NMR into its three main portions: the actual NMR consisting of a coil and magnet; the PCB to analyze the sample; and a rechargeable battery unit to power the device. We aim to minimize both the space and power required by each of the components in order to minimize the overall cup size. In order to do so, we'd have to cut and stack the PCBs in a way inside the cup so that it takes the least space without getting interference from the NMR component. We'd also have to fine tune the number of coils and the distribution of the coiling in order to optimize the magnetic pulse delivered to the sample.

We've been working on multiple aspects of the device that need "optimization" to make a traditionally large NMR system fit into the size of a cup. We've worked on:
- Cutting up a single-board PCB and stacking it in a way that it fits in a small space and is not affected by the electromagnetic portion of the NMR system.
- Creating a miniature NMR system by:
- Finding a magnet with just enough magnetic field strength to enable accurate spectroscopy but not impede the device's portability.
- Coiling a wire inside the [hollow] magnet evenly to provide an evenly distributed electric field.
- Finding ways to introduce a sample into the device and allow easy cleaning to enable multiple quick uses.
- Coming up with a way that components could easily be removed and replaced due to damage or component failure from a top opening as the device would be implemented into an actual coffee cup.



Team 11 | Occusense

Team members: Krystal Kallarackal, Miguel Cepeda, Yerkebulan Nurkatov, Artem Bidnichenko, Alex Bleda | Client: Professor Prakash Ishwar and Professor Janusz Konrad

Current HVAC (Heating Ventilation & Air Conditioning) systems account for 20% to 35% of a building's energy usage. However, they are not responsive or adjustable to the number of people in a room. Air ventilation, by itself, accounts for 7-10% of a building's energy consumption leaving a large opportunity to save on commercial building energy costs. According to the National Grid, efficient HVAC systems are able to save building energy consumption by up to 10%. We aim to create a real-time, accurate and reliable sensor system that determines the occupancy of a room. This system will utilize thermal sensing technology combined with a detection algorithm to track the number of people entering and exiting a doorway. The occupancy data will be pushed and stored to a database housed in a website where the client will be able to view real-time and historical data for a specified room. Finally, this data will be utilized to adjust the room's ventilation system to cater to the number of people occupying the room, lowering building energy consumption and costs.

Team 12 | Open-Source Cytometry Platform (OSCP)

Team members: Tooba Athar, Gregory Starr, Connor Drummond, Christopher Delucia
Client: Howard Shapiro, MD PC and Michael Hirsch, Ph.D.

In resource-poor countries, the process of diagnosing patients with life-threatening diseases can be expensive and time-consuming, and the technology needed to diagnose patients is often unavailable to health care providers. According to the WHO, the P. falciparum strain of malaria is one of the leading causes of mortality in the developing1 world, and many patients do not have access to rapid diagnosis.

Cytometry is the technique of counting and measuring cells for analysis and is commonly used to diagnose many diseases. Advances in multiparameter flow cytometry over the past two decades have allowed for improved outcomes for patients and have allowed physicians to make quicker, more accurate diagnoses in many countries around the world. The high cost and large size of these cytometers prohibits their use in many parts of the world, particularly in rural or low-income areas. Our proposed solution to these problems is a low-cost, portable blood analysis device. With a constraint of $2000, the development of this open-source/open-hardware platform will give clinicians and researchers around the world the ability to access and build upon this technology, allowing them to identify the most fatal strains of infectious diseases and effectively diagnose their patients.

The final deliverable includes both the device itself as well as the documentation necessary for engineers and medical technicians to recreate the device and add to its functionality. The optical system will consist of a scientific-grade camera, lens filters, and high-powered LEDs to excite fluorescent dye in the blood sample. The fluorescent dye binds to A-T pairs within DNA. The human cells and malarial cells are then distinguishable, as they contain different concentrations of A-T pairs. The diagnosis algorithm will quantitatively analyze the relative intensities of illuminated organisms within the blood sample and compare the results to known intensities in a control sample. By comparing the relative intensities to known values, the presence of malaria can be determined.

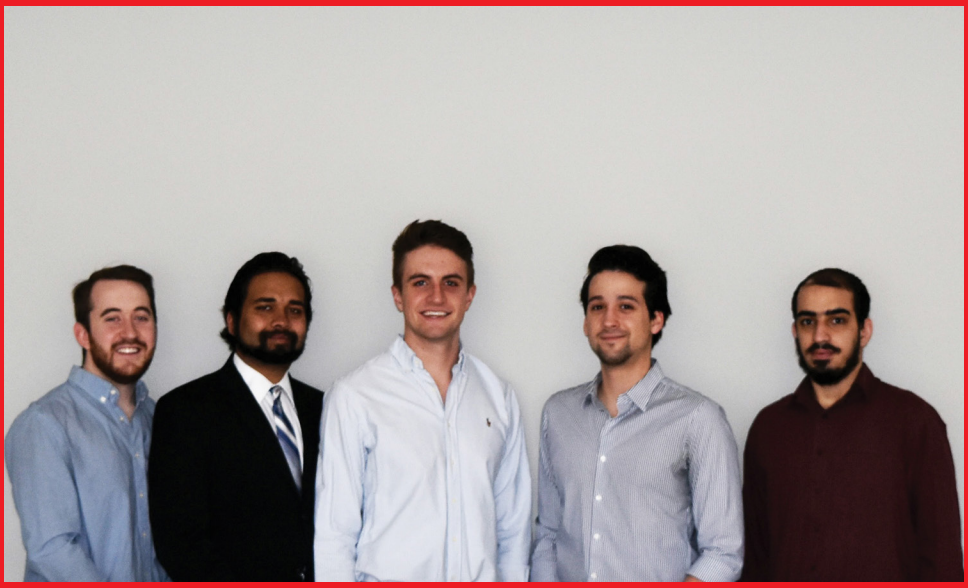
1 "Fact Sheet about Malaria." World Health Organization. World Health Organization, Apr. 2016. Web. 11 Dec. 2016.

Team 13 | Ventana

Team members: Johan Ospina, Allison Durkan, Edwin Fitzpatrick, Santiago Beltran, Tess Gauthier | Client: George Matthews, Microsoft Garage

Technology in the home is hard to use. In modern homes, internet connected devices surround people, from smart TVs to wireless speakers. Controlling these different devices means using multiple clunky and inconsistent applications across various types of devices, making the experience miserable. Using Microsoft HoloLens, the team created Ventana, an open source platform to find, connect, track, and control these existing internet connected devices.

The three main elements of Ventana include the platform that allows these internet connected devices to speak to the HoloLens, a multi-faceted method for tracking device position, and an application for the HoloLens that allows the mixed reality headset to control these devices. Ventana allows people to intuitively interact with internet connected devices in the home through simple, customizable holographic controllers.



Team 14 | EmergenTree: Prediction of Toppling Trees During Storms

Team members: Brian Soares, Sparsh Kumar, Ethan Wayda, Nicholas Boukis, Alan Yazbeck | Client: Dr. Ousama M. A'Amar

In the past year alone, falling trees have cost US property owners over $1 billion in damages. Over 100 people in the US are killed each year by falling trees, and falling tree damage is the most common cause for automobile insurance claims. Even though there are so many problems which stem from falling trees, there is no available preemptive solution to predict and prevent a tree from falling.

Emergen Tree aims to alleviate the financial and physical risk associated with falling trees and tree branches.

Our product consists of an integrated system of sensors that aims to accurately predict whether a tree is at risk of falling using a combination of algorithms, meteorological information, embedded hardware, and wireless communication devices.

Team 15 | GooseBye

Team members: Nicholas Dargi, Sharar Arzuk Rahman, Nadya Rojas, Kishan Patel, David Asbjornsson | Client: Professor Sheryl Grace

Geese have become a nuisance for many schools and districts. Populations of Canadian geese are skyrocketing and as a result green areas for communities here in Boston and throughout the northeast are being ruined. Traditional techniques for geese removal involve stationary scarecrows and trained dogs. No solution currently is autonomous and efficient. We aim to solve that issue.

Our final deliverable will consist of a nearly autonomous geese removal system. GooseBye will have a corresponding mobile application for the user to set field constraints and other settings. Once this mission created by the user is sent to our system, the drone will be able to perform sweeps periodically to remove geese from a given field or green space.

Our technical approach consists of a DJI Phantom 3 Drone that will be nearly autonomous (user intervention necessary for battery swaps), a pole-mounted camera to survey the field (saves the drone from being active constantly), a weatherproof and secure hangar to dock the drone, a raspberry pi to interface the components of our system, and a iOS application to interface with the user. These five components will let a user create a mission, with variables including field dimensions and sweep activity. This mission will then be sent the mission to the raspberry pi, where the processing will be handled. Once the situation calls for a sweep (based on data gathered from the pole-mounted camera), the hangar will open, and the drone will begin its sweep. After the geese have dissipated, it will return and the hangar will close. The pole-mounted camera will continue to survey the field. This data will be processed by the raspberry pi to determine when another sweep is necessary.

Our technical approach has certain innovative features to solve challenging problems we faced creating a system that could successfully remove geese. First, we decided to use an aerial drone rather than a terrestrial one to challenge geese in both land and nearby water. To use that battery of the drone as sparingly as possible, we added a pole-mounted camera to gather feedback and survey the field, rather than have the drone leave the hangar and check for geese using its native camera.

Team 16 | Running Safety

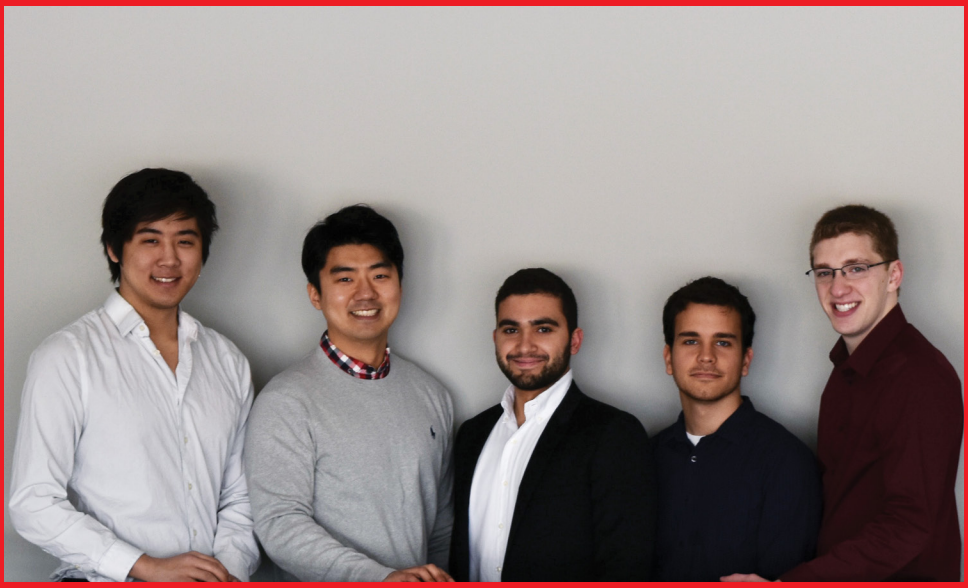
Team members: Rosy Chen, Alexandra Miller-Browne, Christopher Considine, Inna Turshudzhyan, Nikita Gawande | Client: Isabel Pisano

Not every runner who goes out for a run comes home safely. And the truth is that they are never 100% safe from people or from cars, regardless of the time of day, their age or even gender. Accidents happen. Last year, between the months of July and November, there were at least five people who were killed while going on a run. Vanessa Marcotte, 27, was killed in August 2016 during an afternoon jog half a mile from her mother's home. In another incident Karina Vetrano, 30, was strangled while going on 5pm jog. She was found 15 feet from the running path. It is incidents like these that are the problem and are what inspired our customer to conceptualize this project.

Our goal is to alleviate this problem and save lives by developing a comfortable and concealable device, targeted towards both male and female runners that will reassure them of their safety as they continue on their path to wellness and success.

This device, which we have decided to call Guardian, will be able to send text messages, make calls, and locate a runner geographically, in order to send out notifications to their emergency contacts and/or 911. Our final deliverable will be a device that is stored inside an armband for discreteness and easy access. The device will be triggered through button activation. Our system is one PCB board that is compact and small with a waterproof encasement. In conjunction with this device, a web application will be made for runners to allow their emergency contacts to get their coordinates in real-time and the mobile application will allow users to edit the list of their emergency contacts and plan their running route of the day.

Guardian is different from all the products offered in the market right now because our device is more sophisticated; it has both a web application and mobile application component to it. It is also discrete so that assailants will not be able to immediately locate or identify the device if found. Additionally, even though our main focus is to target runners, Guardian can be used for other activities such as walking or driving. Because of its size and portability, it can easily be taken out of the armband and placed into a pocket.



Team 17 | FridgeView

Team members: Jackson Hsu, Deok Kwon Kim, Cyril Saade, Kevin Kasper, Ben Cootner
Client: Ryan Lagoy

In an age of app based grocery shopping and near instant food delivery people still have the problem of forgetting the contents of their fridge when they're not at home. This causes two major problems: consumers buying something that they already had, and not buying something because they thought they already had it. Buying redundant items results in a waste of money, and having to make a second trip back to store results in a waste of time.

The overall objective of FridgeView is to solve the problem of consumers not having reliable and remote access to information regarding their fridge's inventory through use of Computer Vision, IoT, and mobile applications. To solve this problem our device will be portable, affordable, scalable, and reliable. Our final deliverable will consist of a Central Hub, a Sensor Cube, a Camera Cube, and a mobile application. The Sensor Cube will record temperature and humidity allowing for better monitoring on how exactly temperature and humidity effects the food inside their fridge. The Camera Cube will take photos of the inside of the fridge. Finally, the Central Hub will also take photos, communicate with the other modules via B.L.E, and send all of the collected data to our database on the cloud. The mobile application will be the main user interface for our consumers to view all of this information. Our system takes advantage of the use state-of-the-art-image processing API to try and classify all items that are inside the fridge. Therefore, this enables our product to offer recipe suggestions, suggest expected expiration dates, and automate grocery shopping.

Team 18 | Rok bands

Team members: Doug Roeper, Yogeshwor JB Rana, Shikha Taori, Abraham Cohen, Nicholas Maresco | Student Defined Project

Physical fitness is an important part of leading a healthy life. However, it can be difficult for beginners to develop and learn an exercise plan to achieve their goals. This project aims to solve three main problems beginners face when starting to work out:

- Creating an exercise routine
- Learning new exercises
- Performing exercises correctly and safely

Our system consists of three main parts: a smart wristband, a smart weightlifting belt, and a companion mobile application. The wristband and belt allow the system to collect information about the user's movements while he or she works out. Each device is equipped with sensors (e.g. accelerometer and gyroscope), a microcontroller, and wireless hardware to connect to the user's mobile device. During a workout, the devices relay information back to the companion application for analysis. The companion application runs on the user's mobile device and is the main interface for the user. When the user opens the application, he or she is brought to a home page displaying past workout history and other metrics. From the home page, the user can begin their exercise routine for the day. If the user is unfamiliar with a particular exercise, he or she can learn how to do each exercise by viewing video tutorials and reading step-by-step guides. While the user is working out, the system analyzes the user's movements to count reps and provide realtime feedback on his or her form. This feedback helps to ensure the user is working out correctly and safely.

Team 19 | Smart Pet Food Dispenser

Team members: Anderson Vanegas, Tom Burke, Erika Schwartz, Ryan Lader, Tim Qin
Client: Fabio Malangone

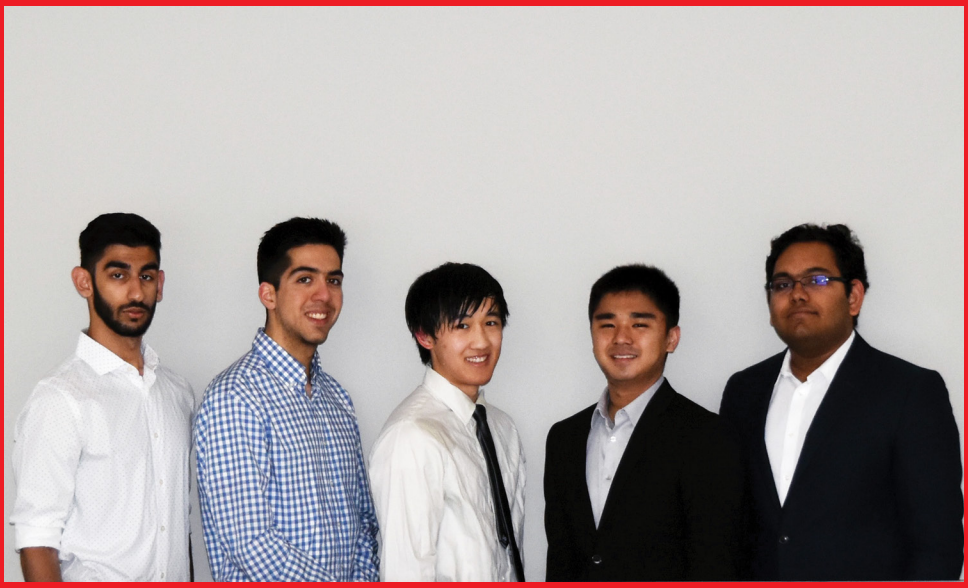
It is all too often that pets are not given proper diets and develop conditions from them. We seek to create a Smart Pet Food Dispenser called H-Pet that uses data analytics and machine learning to optimize a pet's consumption habits. The product will require internet connectivity to store/analyze data, an integrated camera to allow the owner to interact with their pet during feeding time, a scale via an embedded system to monitor the amount of food the pet consumes, and an RFID chip to store important information about the pet. The end result will be an internet-enabled device capable of automatically dispensing a healthy amount of food at predefined, pet-specific time intervals.

Team 20 | Sweet City

Team members: Steven Li, Jessica Cadreau, Jennifer Fong, Makenna Hart, Cameron Graves | Client: May Moy

Currently, many individuals are unaware of the importance of clean energy technologies. As of right now, our primary energy source is fossil fuel. However, due to greenhouse gas emissions, a decreasing amount of resources, and a declining cost efficiency, fossil fuels are negatively impacting the planet. Our goal is to increase awareness on this issue through interactive demonstrations. The final deliverable will consist of solar, wind, energy efficiency, and smart grid modules. These four modules are encompassed in an interactive educational exhibit modeled around the city of Boston. The overall exhibit will serve to educate individuals on energy technologies as well as National Grid's Smart Grid pilot program. This is accomplished through displaying power generation and consumption values on LCD screens.

Each module approaches clean energy or energy efficiency differently. The solar and wind modules generate power and drive visual loads. The power generated will also be displayed on an LCD screen so users are able to easily understand the concepts of power generation. The energy efficiency module will compare power consumption for LEDs and incandescent light bulbs. The power consumed will also help the user determine the efficiency of both. Power saved by using LEDs, shown on an LCD screen, will be used to drive a separate visual load. The Smart Grid module will depict National Grid's Smart Grid pilot program. This will simulate a blackout and show the quick response. The response time will then be displayed on an LCD screen. A second screen will display details of the entire city's energy generation and consumption. A Raspberry Pi 3 will be used to measure all data. Once the data is acquired, it will be sent to the module displays.



Team 21 | Sync Cycle

Team members: Sameer Qureshi, Moises Rodriguez, David Tran, Gavin Hiroe, Vinay Krishnan | Client: National Grid

National Grid's Sustainability Hub needs a new experience for customers who want to learn about energy-efficient and environmentally friendly alternatives to gas-powered motor vehicles. Replacing their simple electric bicycles, Sync Cycle will be the integrated, informative solution designed to fit with the theme of educating National Grid customers through interaction. The Sync Cycle will be equipped with a pedal-assisting electric motor, an on-board data collection system, and a companion application which users can use to navigate the area and view the environmental and financial impact that their ride makes as opposed to the same trip in a gas-powered passenger vehicle.

Team 22 | TIDEMARK

Team members: Zachary Lasiuk, Anna Stuhlmacher, Rebecca Wolf, Samuel Beaulieu, Alex Vahid | Student Defined Project

Have you ever tried to focus on breathing or controlling your heart rate? Consciously controlling automatic bodily functions requires constant attention, making everyday tasks much more difficult. This is the core problem type 1 diabetics face every day: controlling their blood glucose levels—typically automated by the pancreas—while going about life as normal. With the amount of information, discipline, and attention required to stay in safe ranges of blood glucose levels, it is no wonder type 1 diabetics see a loss of over ten years of life expectancy on average—a direct result of either too low or too high blood glucose levels (outside 80-130 mg glucose/dl blood).

Currently diabetics monitor their diabetes with a wide range of different devices and apps, requiring constant switching between management tools throughout the day. Because of this, two-thirds of type 1 diabetics in America are not meeting target blood glucose levels. The lack of effective technology directly affecting millions of lives is unacceptable to us.

We aim to keep type 1 diabetics within the safe ranges of blood glucose by (1) Improving type 1 diabetic's ability to self-medicate and (2) Preventing hypoglycemic and hyperglycemic events (extremely low and high blood glucose levels, respectively) through a low-cost, open-loop system. To accomplish this we created an easy-to-use iPhone application.

In our application, data collection is automated by connecting to frequently used devices tracking data affecting future blood glucose levels (past blood glucose levels, insulin injections, physical activity, and carb intake), relieving the burden of constant manual data entry. Visualizing the data could not be easier with an interactive graph displaying relevant information at a glance, with the option to view current and past trends to see what worked to stay in a safe blood glucose range and what did not. Included in the graph is a narrow range of projected blood glucose levels an hour into the future, allowing users to take preventative measures if an extreme value is anticipated.

Our project, T1DEMARK, is an extremely powerful yet simple way for type 1 diabetics to make more informed decisions, prevent extreme swings in blood glucose, and lead healthier lives.

Team 23 | Satellite Tracking for LEO

Team members: Joshua Klein, Zachary Chapasko, Amber Baurley, Joseph Beaupre, Kyle Hughes | Client: Dr. Timothy Yarnall, MIT Lincoln Lab

Tracking satellites in low earth orbit (LEO) is a challenging problem. Traditional telescope mounts (called altitude-azimuth, or alt-az mounts) fail to adequately track satellites in LEO because they both degrade in tracking quality when pointing nearly overhead and have a blind spot directly overhead. This project is focused on building a telescope mount that can properly track satellites in LEO without degradation or blind spots when pointing overhead. A secondary goal of the project, which is built into the requirements of Senior Design, is to build the telescope mount relatively cheaply (at a cost of around $2,000).

To accomplish the project goals an altitude-altitude (or alt-alt) mount will be built. An alt-alt mount rotates the axes of rotation of the alt-az mount by 90°, eliminating the blind spot and degradation overhead. Alt-alt mounts have two blind spots/degradation areas, but these are located on the horizon where they will not impact LEO satellite tracking. For the final deliverable an alt-alt mount will be machined and will come complete with an electromechanical control system. Users will be able to interface with the mount using a graphical user interface where they can input TLE (two-line element set, a type of dataset that describes the orbit of a satellite) and GPS data.

To make the alt-alt mount pieces of aluminum stock must be machined and fit together. Motors and encoders will be housed within the mount and will be used to move the mount along its two axes of rotation. A Raspberry Pi 3 will feed instructions to the motors and receive feedback from the encoders, and altogether these three components will become a closed-loop control system. The control system will be further refined by adding an imager to the base of the telescope. The imager will create an image feed that can be manipulated using image processing and then used to assist the telescope-pointing control system. The graphical user interface will be implemented on the Raspberry Pi and will allow the user to supply the necessary information to start the tracking process.

The real innovative feature of the project is the use of the alt-alt coordinate system. Alt-az mounts and other widely commercially available mounts are unsuitable for tracking objects in
LEO as they pass directly or nearly directly overhead. Conversely, the alt-alt coordinate system of the mount is optimal for tracking objects in LEO because they solve the hole at the zenith.

Team 24 | Trivia Throw Toy (3T)

Team members: Jacob Dansey, Changshuo Fu, Christine Low, Neil Sanghrajka, Urvashi Mohnani | Client: Eugene Kolodenker

The Trivia Throw Toy is a ball-shaped toy that speaks in a clear voice a trivia fact that has been intelligently parsed from Internet sources upon detecting it's been thrown or shaken. The device aims to fill the void in conversation by providing engaging topics of discussion. The user will have the ability to hear facts by category and also up vote/down vote facts to enhance other user's experience. A mobile application will be used as the interface for picking categories and voting. An accelerometer is used within the toy to detect motion. Upon detection, a fact is pulled from the proper categories cache and spoken aloud through a speaker. If the cache is near empty, a call to a cloud server is made to pull more facts in. The server handles the parsing of Wikipedia and identifies proper facts through natural language processing.

Team 25 | V2V

Team members: Eddy Luo, Lingxiu Ge, Yihao Hu, Hannah Herbert, John Knollmeyer | Client: Professor Thomas Little and Dr. Jessica Morrison

Vehicle-to-Vehicle Communication, is an optical-link based communication system for autonomous vehicles. Our design is proposed as an alternative to radio-frequency (RF) based CDMA communications, which suffer from interference in congested environments. The system will provide transceiver units to be mounted on vehicles and static base stations, capable of transmitting and receiving information using low power lasers and photodiodes. These transceiver units can then communicate with one another by first establishing the optical link, and then maintaining it using a complex tracking algorithm to steer the laser beams.

Senior Thesis | Anomaly Detection in Transportation Networks Using Machine Learning Techniques

Athanasios Tsiligkaridis | Advisor: Professor Ioannis Paschalidis

Most large cities throughout the world exhibit traffic congestion; Boston is a perfect example of this reality. Congestion can be characterized by both usual traffic jams (due to morning/evening commutes) and unusual jams (due to ac- cidents, inclement road conditions, etc.); these unusual jams must be identified so that they do not hinder other adjacent roads. The goal is to identify these unusual jams and report them in order to ultimately build smart and efficient cities.

As a senior thesis project, I will design an anomaly detection system and ap- ply it to real traffic jam data provided by the City of Boston. For this endeavor, a dataset containing traffic jam points will be used. A subset of the dataset will be used for creating anomaly-free baseline models for a set of time intervals de- fined over different seasons, days, and hours. All jams will become parametrized into a 4D feature space; clustering methods will be used to measure jam per- sistence in each time interval and discard the jams that do not appear often. With defined models, new traffic jams can be compared and classified as either anomalous or non-anomalous.

Lab: Network Optimization and Control Laboratory Thesis Advisor: Professor Ioannis Paschalidis

Senior Thesis | Ultrafast Thulium/Holmium co-doped Fiber Laser with Semiconductor and Graphene Based Saturable Absorbers

Junjie Zeng | Advisor: Professor Michelle Sander

For advanced applications including micromachining and microfabrication, ultrafast pulses are preferred due to several reasons such as short optical pulse duration and high peak power. To build an ultrafast laser system, a saturable absorber is one of the most important components, as it induces mode-locking operation and stabilizes the pulses both temporally and spectrally. Semiconductor saturable absorbers which are traditionally used in soliton mode-locking, can have high fabrication expenses. New frontiers of pulsing dynamics can be explored in mode-locked fiber laser systems utilizing graphene based saturable absorbers, as they have attractive features for ultrafast pulsing such as a short recovery time, broad spectral operation range and a high damage threshold. This thesis project presents a Tm/Ho co-doped fiber laser that generates femtosecond pulses with a semiconductor saturable absorber mirror and graphene; higher harmonic mode-locking states and vector soliton have also been investigated. Detailed characterization of the output pulses generated from the laser demonstrates novel features, including repetition rate tunability, wavelength tunability and high pulse energy, which overall reveals its potential for wide range of applications.

Senior Thesis | Design and Characterization of a Compact Ultrafast Tm/ Ho co-doped Fiber Laser Emitting in the 2 μm Region

Panagis Dimitrios Samolis | Advisor: Professor Michelle Sander

The following thesis presents the design process and characterization steps of an efficient soliton mode locked Tm/Ho co doped fiber laser. The emission wavelength is centered near 2 μm which is known as the “eye-safe” region and which also has many applications varying from LIDAR systems to spectroscopy, medicine and telecommunications. The generation of femtosecond pulses is achieved by a passive mode-locking technique that requires the use of a semiconductor based saturable absorber. The exploration of novel pulsing states is also explored, including higher harmonic generation as well as the study of the laser's vector soliton nature.

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 and Assistant Research Professor

Osama 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 Fulbright Scholarship and served as associate editor for IEEE Transactions on Circuits and Systems, Video Technology. He served as a consultant, board member and advisor for several companies and groups.

GRADUATE TEACHING ASSISTANTS

Michael Hirsch

Senior TA

President, SciVision, Inc.

Dr. Hirsch consults and advises companies and institutions in remote sensing systems, rapidly going from ideation to Series A, market or deployment. He fuses real-time heterogeneous networks of GPS, radar and optical sensors, breaking through legacy spatiotemporal sensing limits.

Fulya Kanik

Fulya is a second-year Ph.D. candidate in Electrical Engineering. Her current research in the Optical Characterization and Nanophotonics Laboratory focuses on development of interferometric biosensors as sensitive, rapid diagnostic tools. She received a B.Sc. and a M.Sc. in Chemistry and Biotechnology from METU, Turkey and a M.Sc. in Biomedical Engineering from UMass Lowell.

Mina Nazari

Mina Nazari is a PhD candidate in Electrical Engineering, researching on a photonic virus Inactivation technique with no collateral damage. She received her M.S. degree in electrical engineering from Tarbiat Modares University, Iran, and worked on optical devices based on non-Hermitian platforms.

Jinyuan Zhao

Jinyuan Zhao is a second year PhD student in Electrical and Computer Engineering. He received his B.S. degree from Tsinghua University. His research interest is light transport analysis model for a multi-source, multi-sensor, privacy-preserving indoor localization and action recognition system.

Three additional Teaching Assistants supported the course during the Fall 2016 semester: Jiawei Chen, Asher McGuffin and Mounika Vutukuru.

THANK YOU!

Thank you, Clients

Senior Design could not happen without the volunteer participation of our many customers. Thanks to all who suggested problems, encouraged their student team and challenged the seniors with their real-word engineering needs.

Thank you, Alumni Judges

Special thanks to ECE Alumni, who took time from their schedule to be with us today.

Thank you, ECE & ENG Staff

ECE Staff worked countless hours to support the year-round needs of the senior design projects, and to coordinate the culmination event, ECE day. The staff ordered parts, installed software, arranged cost reimbursements, helped with travel arrangements, managed gifts given to projects, found vendors and services, and provided direct help with PCB design and assembly. The events of ECE Day were organized in the fall and many hours went into planning the rooms, equipment, awards, and luncheon for the seniors.

Thank you, Students

Finally, thanks to all the seniors—who did the work over the approximately 240 days since they first arrived in EC463. Good luck and congratulations from the ECE faculty!


ECE DAY 2017