

DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

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

S CENTER

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 smallscale 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

Teaching Assistant Award and Honorable Mention



TEAM 1 - BALLOON COAT TESTING MECHANISM FOR ANGIOPLASTY

Boxi Huang, Petro Lima, Rebecca Arce, Andre Gonzaga, Allison Weaver

Client: Professor Vijaya Kolachalama

Angioplasty is one of the most commonly used treatments for the biggest cause of death in the world: Coronary Artery Disease. However, the procedure can be improved for better long term results by replacing the metal stent with a drug coating on the balloon. The goal of our project is to devise a device that will simulate the interaction between the drug coated angioplasty balloon and the tissue inside of the artery. This device will output data in realtime showing how the drug coating sticks to the wall of the artery. It will be used to test different drug compounds for effectiveness. The data the sensors output will need to be processed to help us determine which drug compound works best or what could be changed for improvement. We hope that our system will provide researchers with an inexpensive, faster method of testing different drugs.



TEAM 2 - SMART BUOY

Michael Lindsay, Ian Ballou, Lina Lin Wei, Huzefa Mandviwala, Ashaki Gumbs Client: Self Defined

We are ECE Senior Design team 2, the Smart Buoy team. Our team is working to make water quality testing easier for freshwater rivers, lakes, and ponds. Currently, water testing is a labor-intensive task that requires trained judgment and trips into the water that can be hindered by the weather. To address this, our team will deliver a solar-powered mesh network of watertesting buoys with data viewable on a computer in the network. To showcase the mesh networking capabilities, we will build two buoys that can report back to the base station computer. By having the buoys be in a Digimesh self-healing network configuration, the buoy network will be easily scalable, both from a technical and from a user perspective. When a new buoy is turned on and placed in radio range of any buoy or the base station, the user will simply need to tell the base station to discover and register any new buoys. The buoys will also be cheaper and more portable than current water-monitoring solutions. They will be easier to maintain as well. Our combined solar charge circuit and buoy sleep circuitry will provide users at least 30 days of use under perfect solar conditions. Using our buoy system will be easy as well, for users only need to navigate to the web server in their browser to view comprehensible graphs and user-defined notifications about their buoy data.



TEAM 3 - CHAINSPECT

Yifei Huang, Carlos Callejas, Wei-Chu Lee, Yiwei Hua Client: Professor Michael Ruane

Our project consists in the design and development of a device capable of visually inspecting a chainsaw's chain, so as to ensure it is properly maintained and therefore safe to operate. Inspection will consist of determining target physical characteristics in the chain's cutting links through Computer Vision, such as cutting edge angle, cutting edge and rake heights. In order for our device to be compatible with a wide array of manufacturers, relevant parts, such as the bar and motor sprocket, have been designed to be easily swappable by the user. Finally, all image processing will be performed using OpenCV/CV2 libraries in a Python environment, alongside an ESP32 running C code for auxiliary functions, such as chain positioning and motor calibration.



TEAM 4 - CHESS

Andreas Papadakis, Belle Zhang, Devin Chen, Jake Thornton, Jeffrey Leong Client: Thomas DC Little

Technology moves at such a fast pace that if there are no proper use cases or adoption, it dies out quickly. The life cycle of emerging technology relies on proof of concepts that later lead to other applications, either commercial or academic. Our project seeks to design and build a hands-free, voicecontrolled robotic version of chess by utilizing emerging technologies such as augmented reality, IoT, indoor light positioning, swarm robotics and blockchain. Voice control and mixed reality innovates in the field of human-computer interaction. IoT robots change how we generate and interact with data. Our indoor positioning system sets a groundwork for future development for more advanced systems where multiple entities are identified. Finally, blockchain enhances trust and data validity that a simple excel sheet or database cannot offer. All of this is packaged in an approachable format with Chess. This encourages people of all ages to be exposed to these new technologies, spreading outreach and eventual adoption.



TEAM 5 - CHOREOGRAPH KINETIC ART Berk Gur, Jessica Seto, Ellen Lo, Andres Rojas, Satyajit Simhadri

Client: David Durlach

LED winches are at the top of the trend, but only widely available through grandiose trade shows and extravagant concerts and festivals. Our team is determined to make a user-friendly, portable, and affordable version for hobbyists and the maker community. The user will not be required to have prior knowledge of coding or winches. The modular LED Winch maker kit will include a winch system comprised of a stepper motor, spool, power/data cable, a microcontroller, battery, and LEDs. There will also be an extensive software library with programming examples and documentation included. As for making this happen, we've parallelized the work involved in controlling the motor, the LEDs, and physical component design for the spool and casing. Once the controls work separately we merged them to make one working winch system. The maker will provide their own smartphone that will be compatible with the provided software to control the winch. This LED Winch beautifies the dull mechanical pulley into an interactive and programmable way to experience and create art in a home setting. Our LED Winch maker kit is intended to allow people from all experience levels to build a winch system that is easy and safe, introducing the new world of choreographed artwork and inspiring with its unlimited possibilities.



TEAM 6 - COLLISION AVOIDANCE

William He, Biyao Liang, Marta Taulet Sanchez, Andrew Colletta, Jinzhi Han Client: Asher McGuffin

The rise of autonomous vehicles promises a more convenient and safe driving for smart cities. Recent developments in autonomous vehicle collision avoidance have focused mainly on the challenge of identifying objects and road lines. Although these techniques have shown great success in low-traffic environments, they are inherently limited to many of the same behaviors as human drivers. By enabling vehicles to communicate with each other, these limitations can be overcome. A decision making algorithm is necessary for vehicles to autonomously negotiate changes in traffic and avoid collisions, as well as costly slowdowns and stops. The focus of our project is this decision making algorithm, as well as a hardware and software simulation of communicating autonomous vehicles at a 1/20th scale. Using this technology, transportation surpasses the limitations of 20th century traffic model, becoming faster, more efficient, and safer.



TEAM 7 - CYBORGSAX

Tariq Ahsan, Andrew Zannetos, Raymond Liang, Qinglang Yu, Esiri Madagwa Jr. Client: Zach Lasiuk

There are currently no device available that can create both audio effects and visual effects for saxophonists. There are devices and systems for other instrumentalists such as pianists and guitarists that can accomplish these tasks, but not for saxophonists. Our client Zach, who plays the saxophone, wants to incorporate visual effects and audio effects into his live shows. The problem at hand is that there is no technology for saxophonists to have audio effects and eye-catching visual effects in their performances.

The team's final deliverable will be an attachable device that can create audio effects and visual effects given a saxophone input, and then turn that into an sonic and visual output. The attachable device will take in a saxophone audio signal into the microphone which will be attached to the saxophone process the sound in real time and output some sort of modified signal through the speaker. Simultaneously, there will be visual lighting effects coming from the LED matrices that will be attached to the exterior of the saxophone. Both the visual effects and the audio effects will be controlled with a wearable device where there will be an LCD screen and a few analogue knobs.

We will implement a microcontroller to process audio input from the saxophone and manipulate it using a library of audio effects controllable via the user interface, as well as utilizing the microcontrollers built-in FFT functionality with LED matrices to create a visual display of the audio spectrum in real time.



TEAM 8 - HEARTSCOPE

Casey Jurosawa, Evan Gonzales, Eric DeJesus, Steven Zhu, Matthew Cote Client: Sebastijan Mrak

The goal of the project is to assist at-risk populations in tracking and identifying cardiac events and overall health. The de-facto standard for monitoring cardiac health is the electrocardiogram (ECG). The primary issues with this technology are the sheer cost of medical ECGs and the limited availability of these devices outside of medical facilities. Combined with the transient nature of many cardiac disorders, it is unrealistic for the general public to get an ECG within a time-window that may only last for 10 minutes. Our objective is to modernize diagnostic cardiology and focus on three particular aspects: affordability, simplicity, and portability. With that in mind, our final deliverable will be a wearable ECG that streams data to a smartphone application via Bluetooth, which then displays data and pushes it to cloud storage. We will approach signal acquisition and filtering in the analog domain and then convert into the digital domain for portability. Much of the technology will be piggybacking on various downsizing features inherent in the Internet of Things movement and we are focusing on transferring these developments into cardiology. Our focus on affordability will drive costs down and put emphasis on system and individual efficiency. Combining this focus with an emphasis on simplicity will improve accessibility to this diagnostic tool for the general population. As a result of our efforts, we hope to be able to bring ECGs into the daily lives of those who need them.



TEAM 9 - ECOBIN

Hayato Nakamura, Qianqian Guo, Aditya Wikara, Jiaqian Wu, Kevin Sinaga, Yuzi Li, Esther Huynh

Client: Benjamin Cootner

Internet-of-Things. Sustainable. Smart. Ecobin is a smart trash can that could automatically sort recyclable materials, making it an easier task in a smart home and public space. Why? Climate change has plagued news outlets and media for causing natural disasters, affecting lives of millions. In order to prevent further environmental damage, reducing garbage disposals to landfill and carbon footprint is both ethical and crucial, especially in the United States, where 230 million tons of trash are generated per year. Ecobin will serve everyone who enjoy an eco-friendly life. When a user disposes some trash, Ecobin will automatically sort it into its appropriate compartment: recyclable or non-recyclable, within seconds. The fast processing is aided by a myriad of smart sensors and up-to-date machine learning algorithm with cloud computing support. With Ecobin, recycling is no longer dreadful.



TEAM 10 - EPIC INVENTORY MANAGEMENT SYSTEM

Tianyu Zhang, Nivedita Natarajan, Siqi Wu, Daniella Vidaurreta, Andrew Barlow, Danielle Tesler, Ruiyang Shi

Client: Professor Greg Blonder

The Engineering Product and Innovation Center at Boston University has many high value tools that are available for students to check out, but there isn't an efficient system to track the tools and the students who rent them out. The goal of this project is to build upon previous year's Senior Design Project and create a hardware/software system to manage the check-out and return of these tools and instruments. Our final deliverables will generally contain two parts: a smart locker system controlled by raspberry pi and a web application linked to a database. The system should be able to verify the user's identity, to grant a user access only to authorized items, and to authenticate that the correct items are removed and returned to storage. An NFC reader would ensure that the right tools are returned to the right box because each NFC tag/tool would have a unique ID. There will be two views for the web application: an administrator view and a regular user view. The two types of users will have different access and functionalities as well. Some innovative features that are still in the research phase include an option of having a camera to keep track of the tools using image processing.



TEAM 11 - SMART EPIPEN

Waqar Haider, Priyal Verma, Naelle Zephir, Addison Ogonoski, Mohammad Ali Al-Rajjal

Client: Professor Alan Pisano

EpiPen epinephrine autoinjectors are prescribed to millions of Americans each year to treat allergen-induced anaphylaxis. After using their EpiPen, a user must contact emergency services, but may be unable to do so due to the severity of their condition or because they cannot access a phone. Additionally, EpiPens must be carried at all times, but are frequently forgotten. Our Smart EpiPen system solves both of these common issues. Our system consists of an EpiPen case that detects when the EpiPen is removed and contacts a specified support circle with the user's GPS location. The case also communicates with a wearable component that will notify the wearer if they leave their EpiPen in another room. These components are paired with a web application where the user can submit customized information such as support circle contact numbers, and where the emergency history of the case can be tracked. Our product is self-contained and does not require the user to own a cell phone.



TEAM 12 - GOOSE

Mohammad Hashem, Jacob Zweig, Roman Serov, Matthew Hormis, Marwan Sallam, Amandeep Mehat, James Coll,

Client: Professor Sheryl Grace

Over the past 30 years, the population of urban geese has exploded. Consequently, soccer field properties have been destroyed by geese and littered with feces. Our final deliverable of this project is to build a terrestrial, autonomous robot that is able to identify and chase geese off of a soccer field. This will reduce maintenance costs and ensure children can play on a feces-free field. We plan on using an Nvidia Jetson TX2 to handle the image detection and tracking. The Jetson TX2 will be connected to an Arduino shield, which will control the robot motor functionality. After conducting extensive research, we plan to add innovative features to assist in the development of our autonomous solution. Some features include our customized vision system, self-docking capabilities, and a safety mechanism to prevent against false-positive detections.



TEAM 13 - ECOHOME

Laura Morgan, Kiahna Tucker, Olivia Dorencz, Qian Zhang, Hok Yin Shum Client: Ned Utzig

Our team aims to create a solution that will allow users to store their plants outdoors during the winter without damaging the plants. The final deliverable we have devised is a greenhouse that is able to withstand cold temperatures, rain, snow, and wind all while maintaining an internal environment that allows plants to grow and thrive. To do this, we are equipping the greenhouse with various sensors to monitor the internal temperature, light, soil moisture, and humidity. A heating system will also be included in the greenhouse to keep the temperature at an acceptable level. All of the sensor data will then be sent to a web application that will allow the user to view the real-time sensor readings. The web application will also allow the user to adjust the temperature within the greenhouse. If any of the sensor readings falls above or below the suitable levels, the user will be notified. In order to guickly access the plants inside the greenhouse, an easy to open door will be built into the structure to allow the user to water plants and provide any other maintenance. The greenhouse is intended to make storing and growing plants in the winter easier for anyone that lives in a harsh winter climate.



TEAM 14- IOT NMAP

Mohammed Uddin, Spencer Liu, Christina Chimienti, Seung Hee Lee, Byoungsul Lee

Client: Professor David Starobinski

Our goal is to create a network scanning tool that uses a software defined radio (SDR) to listen to communications being transmitted by IoT devices via various networking protocols. We will be detecting the presence of IoT devices by sweeping for network communication and classifying them through their unique waveform signatures and frequency ranges. Additionally, we will be decoding the packets captured by the SDR with the tools such as GNU Radio in order to enumerate IoT devices and also to determine their manufacturer. We will be listening to 3 popular IoT networking protocols (Wifi,BLE and Zigbee) in a single software platform and displaying the results in a graphical user interface so that the client can use the program with ease.



TEAM 15- RIVERSONDE

Anthony Byrne, Victor Ly, Nikunj Khetan, Adian Mikulic, Andy Whitman

Client: MA Department of Conservation and Recreation, Charles River Watershed Association

Humans have relied on fresh and saltwater rivers for transportation, clean drinking water, irrigation, and food since the earliest recorded history. Compared to oceans and other large bodies of water, however, rivers are significantly understudied, especially with respect to the effects of climate change. In an effort to close this research gap, we have set out to develop the RiverSonde, a low-profile underwater sensor suite that enables inexpensive remote collection of water quality data from rivers and streams. We've designed RiverSonde to be hydroelectrically-powered by a river's natural current, making it deployable in low-sunlight areas, and mesh-networkingready, meaning a multiple-sonde network can be deployed to take remote measurements even in areas without cellular coverage. By implementing sensors and electronics that are typically only found in \$3000+ laboratory probes while still keeping RiverSonde's base cost under \$500, we hope to give budget-constrained research and regulatory agencies a powerful new tool to help preserve our rivers for generations to come.



TEAM 16 - MICROGRID DEMO

Brian Dyer, Gabrielle Abad, Allison Leung, Kyle Motoshige Client: Malay Mazumder

As the need for renewable energy becomes clearer than ever, so does the need for student engineers to have a comprehensive understanding of the systems that implement them. Microgrids may become a key part of a renewable energy future due to the ease with which they are able to integrate green energy sources like wind and solar. To give students direct experience with all the complexities of a specifically solar PV powered microgrid, we are building a fully functional, interactive microgrid system model for Professor Malay Mazumder's EC/MS 573 Solar Energy System's class. This will involve us breaking down all the different functioning systems within a microgrid and replicating them on a small scale. A demonstration will accompany the introduction of the microgrid model to the EC/MS 573 class's lab, upon which students will be able to interact and interpret directly the way energy is generated and distributed in a solar powered microgrid system.



TEAM 17 - NEUTRON

Sergei Posnov, Calvin Rose, Allen Qu, Mohamed Al Junaidy, Nehemiah Dureus Client: Analytical Space Inc.

Neutron is a flexible, solar powered gateway device between IoT devices and a satellite network. Sensors in remote areas that do not have internet access will often be unable to store all of the data that they collect. Neutron is a device that can autonomously collect data from these sensors via Bluetooth Low Energy and store it before uploading the data to a satellite with a radio. A technician can also inspect the data

in Neutron by connecting to a temporary WiFi LAN. Neutron is power constrained, so the data collection occurs on a low-powered ESP32 chip, while a more powerful processor will be used to run the GUI interface and drive the satellite radio.



TEAM 18 - ARScope

Jon Washington , Emma Howard, Karanraj Chauhan, Ghazal Randhawa, Hanchen Zhang Client: Justin Lee

Pathologists spend every day on the job making predictions, and determining the futures of patients. They work hard to do their jobs well, but the margin for error is small, and they have no assistance in determining areas of interest currently. Our final deliverable will be two designs and bills of materials for an augmented reality microscope, as well as a physical version of the device itself, and its software. One desian and bill of materials will below cost, for a hobby version of the device. The other design and bill of materials will be of higher cost, and is intended for use in a professional setting. The approach involves a device that fits between the head and body of any infinity corrected microscope. It uses a beamsplitter at its center that allows a camera to see the slide under the microscope, and the user to see a mask projected over the slide. The display and the camera are attached to a PC, and the user must run a Python script in order for a model to predict areas of interest for onion mitosis and output a mask. Between the beamsplitter and the camera, as well as the beamsplitter and the display, lenses are used to focus and magnify both the slide and the display, respectively.



TEAM 19 - PEOPLE ++

Nabeel Younis, Leonard Gunawan, Mckenzie Cheung, Ferris Armstrong, David Gomez Client: Janusz Konrad

People++ is an on-premises, privacy preserving data collection network that provides insightful and well catalogued data for future research projects around the field of people counting. We have collaborated with our client, Professor Janusz Konrad, in his ARPA-E sponsored research to come up with an architecture that will enable him to develop machine learning algorithms to guess room occupancies in order to feed back this data to HVAC systems and modulate them more ecologically. Our network features door mounted thermal sensors to collect data, panoramic cameras for ground-truthing data, server computers that host the API and database, and a visualization tool to query data and monitor the network live. People++ is highly modular and can be deployed in any room with power-over-ethernet (PoE) networking with minimal overhead in terms of installation time and config file changes.



TEAM 20 - ROBOTIC ARM

William Chang, Brian Koh, Shivni Singh, Yangdi Li, Mahdiul Chowdhury Client: Prof Osama Alshaykh/Carter School

Modern technology provides many solutions for handicapped individuals like side ramps and automated doors, allowing individuals to avoid stairs and get to their desired destinations. For instance, many buildings in the BU campus have automatic handicapped functionality for doors. But what if any individual has no control of their arms to physically open doors or push buttons?

The goal of this project is to engineer an autonomous robotic arm that can be mounted on an electric wheelchair to open doors for users with severe handicapped disabilities. The arm should have the functionality to open major door types, taking into account the position of the door handle or type of door. In the case of using elevators, the arm should also have the precise functionality to push buttons. The design needs to have a simple and interactive user interface to allow users to navigate and control the robotic arm with ease. Besides the robotic arm itself, the project consists of two other main features: a React Native mobile phone application for voice recognition and processing and a camera for image processing. Users will send voice commands to the mobile application through the phone's microphone, giving commands to the system such as opening doors or pressing buttons. After recognizing and processing the user's voice input, the application then forwards it to the main system that is integrated with the camera and robotic arm. The Intel Realsense D435 camera, with good coloring and depth sensing capability, will detect the position of the button/doorknob and its surrounding dimensions using a python script with OpenCV library and related models. Along with the user's voice command, this information will be used to determine the destination and action of the robotic arm. The arm will then use them to navigate itself to the destination (button or doorknob) and perform the action. A C++ script will be executed to control the rotation of each joint and finger to realize the movement.



TEAM 21 - ROGUEDRONE

Roberto Garcia Plata, Adam Sapp, Gene Grinberg, Lucas Soffer, Joaquin Giorgi Client: Self Defined

Drone security is an emerging field as drone technology increases; safety concerns drive the need for innovative solutions. We propose a drone that will catch another drone out of the sky and remove it from the area. We will modify an existing drone using computer vision to track a target drone, creating a pathing algorithm that will allow us to autonomously fly towards said drone, and use a claw system to catch the target.



TEAM 22 - RUNNING SAFETY Cong Han, Thomas Cimino, Yajing Lai, Payton Hauck, Zexing Gao Client: Professor Alan Pisano

Running Safety Plus is a safety device used by runners or joggers of all ages that will be useful for emergency situations of any type. Comfortably concealed and durable enough to fulfill all of its functions, our device will track GPS coordinates, heart rate, the running force, and contact an emergency contact if needed. Our device consists of both a shoe insert and chest strap to help avoid false positives and provide more accurate detection of emergencies. Using a GPS, sim card, and Bluetooth functionalities, the device is programmed through a web application which is where preferences are set and data is stored.



TEAM 23 - SONOS

Zachary Safran, Lin Ma, Biagio DeSimone, Zhunan Shuai, Thomas Cheng Client - Sonos

Sonos is a company that creates whole home wireless sound systems and has decided to partner with Team 23 on a Senior Design project. Sonos sound systems focus on high quality audio and simplicity, allowing for users to easily control anything from a single speaker to groups of speakers all from a single application. A drawback to the current system, is that playback and music selection is locked down to a single device. If the device owner wants to allow others to control the music selection, they must give their personal device to others. This clearly has security and usability limitations, which has inspired the project proposed to Team 23 for ECE Senior Design.

Team 23 has been tasked with creating a new form of controller for Sonos' unique wireless home sound systems. While developing our solution, we decided this new controller will focus on collaborative control of music selection. Our product will be a combination of a web application, portable controller with LCD screen and NFC tags. The owner of the system will be able to synchronize their Spotify account to the controller in a secure administrator page. Guest users will be able to edit the administrator's current playlist by searching for songs with Spotify's API and adding them chronologically to the admin's playlist after the current playing song. NFC tags and QR codes will be implemented to allow users to quickly access the web application without the need to download and install any third party software.

Our solution allows Sonos users to easily configure their music controls for guest use, without any worries of passing around their personal devices. This new, more collaborative control system can give guests the individual freedom to queue music they want all without stopping the party.



TEAM 24 - BILI-HUT Zimo Wang, Amanda Fung, June Hua, Phillip Teng Client: Little Sparrows Technologies

Millions of infants worldwide are affected by neonatal jaundice, a medical condition that can be treated with blue light phototherapy. In the US, approximately 100K phototherapy treatments are administered at a cost of \$500M to the healthcare system. In developing countries, the situation is dire. More than 6M infants lack access to phototherapy each year, leading to >100K preventable deaths. A portable phototherapy device gives the baby's parents the opportunity to treat jaundice at home. Bili-hut is a phototherapy treatment device that offers a portable solution for this market. Our project involves creating the smartest phototherapy device on the market by adding additional features to the Bili-hut while maintaining the existing collapsible and slim structure. The updated Bili-hut will have a RGB LED status indicator that offers an overview of the device's status. Our web application will also feature a live stream of the baby and performs various innovative computer vision algorithms that allow the device to track heart rate, blindfold detection, baby presence, and bilirubin levels in near real time through a single camera. This data will all be made accessible through the webapp to the healthcare providers and parents. Cumulatively, these features allow the treatment of neonatal jaundice to take place in the comfort of the patient's own homes and lighten the burden of care as achieving the goal in making it the smartest phototherapy device around.



TEAM 25 - VULCAN Pablo Ferreyra, Nicholas Arnold, Rachel Manzelli, Soon Sung Hong, Isa Mustafa Client: Student-Defined Project

Vulcan IoT is a cheap, low-power consumption IoT device which monitors humidity, temperature, and soil dryness to preemptively detect when and where the next wildfire will occur. By integrating machine learning algorithms, trained on 50 years of fire-inducing weather patterns, we analyze the IoT data via AWS and assess the danger of the current weather conditions in real time to notify responsible agencies so that they can contain the wildfires.





THESIS STUDENT ALECIA GRIFFIN ADVISOR: PROFESSOR SELIM UNLU

Adapting Interferometric Reflectance Imaging Sensor to Microwell Plates

There is a growing need for disease diagnostics as new epidemics emerge. Optical biosensing is a useful tool for non-invasive monitoring of DNA-DNA binding, DNA- protein binding, and protein-protein binding. Having a label-free and quantitative method for disease diagnostics eliminates the need for tagging with fluorescent labels or using additional probes, saving time and resources. The objective of this thesis is to design and implement a high-throughput and multiplexed platform for detection and analysis of biological nanoparticles (BNP) and binding kinetics based on the Interferometric Reflectance Imaging Sensor (IRIS) technology. The IRIS is a dual-modality instrument. The lowmagnification IRIS is a simple, robust, and inexpensive biosensing platform developed by the Ünlü lab at Boston University that has demonstrated real-time detection and quantification of protein-protein binding, DNA-protein binding, and DNA-DNA hybridization with high sensitivity and reproducibility. The high-magnification Single-Particle IRIS (SP-IRIS) has the capability to detect individual nanoparticles, as the reflected light from a layered substrate and the scattered light from the nanoparticle interferes. The goal for the next iteration of IRIS is to incorporate a microwell plate that holds the sample, allowing for BNP characterization and binding kinetics, as well as compatibility with current experimental procedures and instrumentation. Having the capability to scan and image each of the wells individually would greatly improve time and efficiency, and allow for more tests to be performed at similar temperature and humidity conditions

THESIS STUDENT YEN PHAM

ADVISOR: PROFESSOR ALEXANDER SERGIENKO

Linear Optics for Secure Quantum Key Distribution

As technology is shifting from classical base to quantum base, classical cryptography is gradually becoming obsolete while quantum cryptography is gaining better recognition due to its ultimate protection against hackers that is governed by quantum physic laws. The purpose of this project is to design a new quantum cryptography system using linear optical devices, a three-port that is developed by BU Quantum Communication and Measurement Lab. Compared to BB84 protocol, which is the most familiar quantum key distribution protocol, our system is expected to achieve higher chance of detecting an eavesdropper by producing more quantum states.



ANIRUDH SRIRAM THESIS STUDENT ADVISOR: PROFESSOR LEV LEVITIN

Deadlock and Livelock Prevention in Computer Communication Networks

Wormhole routing is used in high-performance routing in multicomputer interconnection networks. One of the predominant issues with wormhole routing is that messages are prone to deadlocks where messages may wait for each other in a cyclic manner. I will be designing & implementing software for two new tree-free algorithms, namely the Edge Deletion Algorithm (EDA) & the Simple Cycle Breaking Algorithm (SCB), for deadlock and livelock prevention in such networks. The EDA & SCB algorithms work on the physical layer of communication networks, and proactively prevent deadlocks, so making sure the deadlocks never occur. Hence the routing in the network, with these algorithms applied, becomes deadlock and livelock free. These algorithms in turn have a critical effect on network performance. The EDA & the SCB algorithms are expected to dramatically outperform competing algorithms in the following parameters: the reduction of average prohibited turns, reduction in average increase of distance in network, & reduction in average increase of saturation load. I will be using R to implement the two algorithms, as well as three other competing algorithms to get results on the above parameters. I will also be simulating the algorithms on real-time computer communication networks, to get results on the message delivery times for networks using the different algorithms. The implication of this research is that communication networks employing the widely used wormhole routing technique will be deadlock-free, while keeping the message delivery times between different nodes (e.g. computers, workstations, wireless local area network access points etc.) lower than previously possible for networks using other deadlockprevention algorithms.



THESIS STUDENT VIJAY THAKKAR

ADVISOR: PROFESSOR RICHARD WEST

Android OS on x86 For A Mixed Criticality Processing Domain

Traditionally, vehicle control systems have comprised of many dozens of microprocessors that control the car via relays and communicate with each other over a Control Area Network. Modern cars have orders or magnitude more data processing requirements, and these needs are only going to grow with the advent of self driving cars. Thus, consolidation of the processing platform is critical for future scalability.

This project aims to make progress towards consolidation of real time control systems and CAN processing with information and entertainment systems onto a single chip. To set the grounds we discuss our motivations for picking a single multicore x86 processor, followed by the design decisions behind picking Android OS as the info-tainment host. Finally, we conclude with the software modifications necessary to enable Android to function in a mixed criticality processing domain.



THESIS STUDENT TRISHITA TIWARI

ADVISOR: PROFESSOR ARI TRACHTENBERG

Abusing New HTTP Headers for Fun and Profit

We present various ways to abuse new HTTP headers. Specifically, we show how they can be leveraged to scan ports blacklisted by browsers, probe firewalled hosts, trigger false positive anomalies on Intrusion Detection Systems and mount Distributed Denial of Service attacks. We also show how they can be abused for user tracking on various levels--at the network layer by Internet Service Providers (ISPs), and at the application layer for first and third party websites (where we bypass some third-party tracking protections). We also demonstrate how headers can also be used by ISPs that passively sniff network traffic to deduce whether clients have visited particular websites before, even if the traffic is encrypted and prior visits happened on a different network. Our attacks work, to varying extents, on different browsers. Finally, we conclude with mitigations to prevent such abuse of these headers and hope that this work will help browser vendors implement more secure versions.

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 fulltime 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 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.



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



GOLSANA GHAEMI

Golsana is a second year PhD student working with Professor Krieger on distributed systems and cloud computing. She loves reading books and also playing tennis and baking in her free time.



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TEACHING ASSISTANTS



DEVIN BEAULIEU

Devin R. Beaulieu works at MIT Lincoln Laboratory and is a BU PhD student under Dr. Bifano. His research is in adaptive optics and novel microscopy techniques.



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THANK YOU, CLIENTS

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.

THANK YOU, STUDENTS

Finally, thanks to all the seniors—who did the work over the approximately 240 days since they first arrived in EC463.



