
BU
ECE
DAY
program
Senior Design Projects
2023

Department of Electrical and Computer Engineering

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

The ECE academic experience incorporates guidance from respected faculty members, cutting-edge facilities, a diverse student body and an emphasis on university-wide interdisciplinary research. After establishing a strong engineering theory foundation, students enhance their understanding by developing technical skills. ECE seniors graduate with experience in mobile cloud computing with security, intelligent computation and data science, image and optical science, nanotechnology and bioengineering.

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

SENIOR DESIGN

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

The technical, communication, individual and teamwork skill-building needed for successful design work in electrical and computer engineering.

Knowledge of and experience working with specifications and standards, information collection, design strategies, modeling, computer-aided design, optimization, system design, failure, reliability and human factors.

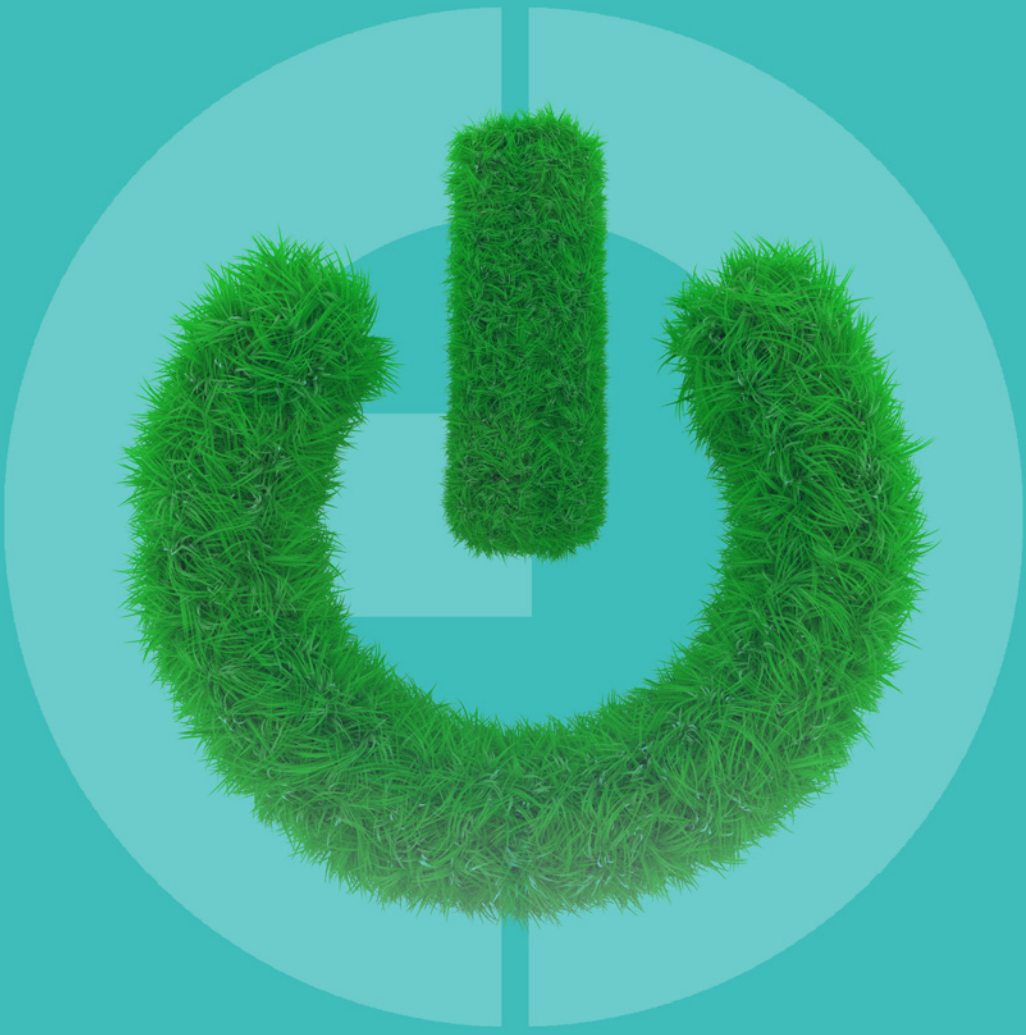
Proficiency in oral and written communication, particularly when presenting technical information.

An understanding of team dynamics and ethical issues in design.

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

ECE DAY AWARDS

- Best ECE Senior Design Project
- Design Excellence Award
- Michael F. Ruane Award for Excellence in Senior Capstone Design
- Entrepreneurial Award
- Undergraduate Outstanding Research Award
- Teaching Assistant Award and Honorable Mention



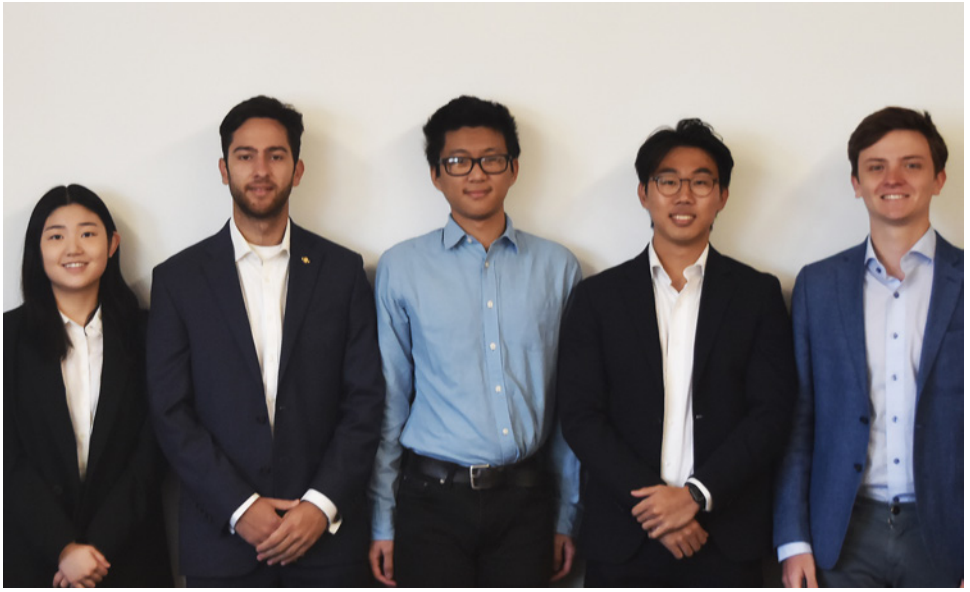
Get the agenda on your phone!

AGENDA

9:00 AM	BREAKFAST
9:45 AM	WELCOME FROM CHAIR
10:00 AM	FIRST DEMO SESSION
12:00 PM	LUNCH BREAK
1:00 PM	SECOND DEMO SESSION
3:00 PM	JUDGES DELIBERATE DESSERTS AND SNACKS SERVED
3:30 PM	AWARD CEREMONY

ALUMNI JUDGES

BEN COOTNER
RYAN LAGOY
CARMEN GARCIA
ANDREAS PAPADAKIS
EUGENE KOLODENKER
CHRISTOPHER LIAO
SADIE ALLEN
PETER GALVIN

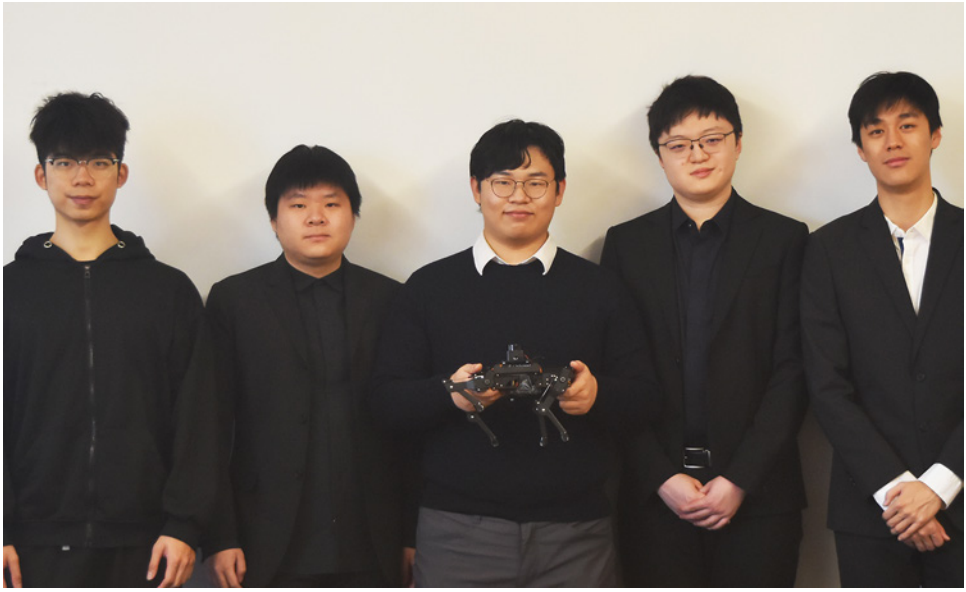


TEAM 1 - Parallel Battery Management Evaluation Board

Sunwoo Park, Harry Katsaros, David Liu, Eric Cho, Antonio Alonso
Client: Analog Devices, Inc.

Abstract

Our senior design project involves designing and fabricating a small-scale enclosure capable of showcasing the parallel battery management functionality of the MAX17330 chip: a proprietary fuel gauge with integrated battery charging and protection. Through our smart charging structure, we aim to create a product that can efficiently showcase Analog Devices, Inc.'s (ADI) battery management ICs on a single platform and display the increased longevity of batteries when placed within this system. With more and more companies becoming reliant on technology with multiple independent batteries within a single product, the need for parallel battery management has skyrocketed as of late. Our product will address these needs while also helping reduce the growing issue of electronic waste caused by battery misuse. Our final deliverable will require a technical approach that will include careful examination of each ICs datasheet, extensive research into complex circuit structures, design and development of a 3D printed enclosure, and the employment of Inter-Integraged Circuit (I2C) protocols via MicroPython. The innovative aspect of our final product is that we will be interconnecting custom hardware and software to achieve new functionality in an already existing ADI product. Our final product will take in power via a type-C USB programmable power supply (PPS), go through a type-C power delivery controller (MAX 77958), followed by a switched capacitor (MAX77932) as a form of voltage division. Then, the system will divide between two MAX17330 chips, each charging or discharging its own battery. The overall unit will be controlled by a microcontroller which will communicate with an LCD. On this LCD, we will display valuable information read from the MAX17330's registers such as the batteries' respective states-of-charge and the charging or discharging currents. ADI will use our product at trade shows to show potential clients the versatility and efficiency of the MAX17330 in a parallel battery management system.



TEAM 2 - Autonomous Legged Robot

Yichen Wang, Yihe Bi, Xiteng Yao, Bowen Ma, Shun Zhang
Client Name: Professor Eshed Ohn-Bar

Abstract

According to the World Health Organization, at least 2.2 billion people globally have near or distance vision impairments. Walking in unfamiliar environments can be challenging for these individuals. Traditional solutions include probing canes and specially-trained guide dogs, but both have limitations. These solutions cannot provide navigation to visually impaired people, and guide dogs can be expensive. In public spaces such as hospitals, schools, and malls, direction signs are typically hung on the ceiling and do not provide touch or sound interaction. As a result, it can be difficult for visually impaired people to navigate to the correct location. To help them move around more easily, our autonomous legged robot will act as an indoor guide. It will be able to lead users to specific locations, such as an office room or a specific aisle. Our legged robot will navigate through routes, avoid obstacles, and provide voice feedback about obstacles and location information along the way.

TEAM 3 - Black Women M.D. Network

Front: Mya Turner, Paige Deveau
Back: Abhinoor Singh, Vinay Metlapalli, Akhil Sehgal

Client: Black Women M.D. Network

Abstract

Introducing the Black Women MD Network (https://blackwomenmdnetwork.com), an innovative and empowering platform designed specifically for Black women doctors to connect, collaborate, and grow professionally. Our mission is to create an inclusive, supportive, and inspiring environment that fosters meaningful connections and opportunities for Black women physicians.

As a digital platform akin to LinkedIn, Black Women MD Network offers a membership-based service where users can sign up and gain access to an extensive network of like-minded professionals. The site asks its members to pay tiered-based dues to support the organization. Members can explore a diverse range of profiles, interact with other Black women doctors, and discover potential collaborations, mentorship opportunities, or job openings.

At Black Women MD Network, we believe in the power of representation and unity. Our platform acknowledges and creates a space for Black women doctors to network and excel in the medical field, while encouraging and uplifting one another to reach their full potential. By fostering a sense of belonging and providing invaluable resources, we aim to bridge the gaps in representation and create a thriving community of Black women doctors.

TEAM 4 - Brain 4CE

Brendan Shortall, Mitchell Gilmore, Dayanna De La Torres,
Jonathan Mikalov, Alexander Johnson

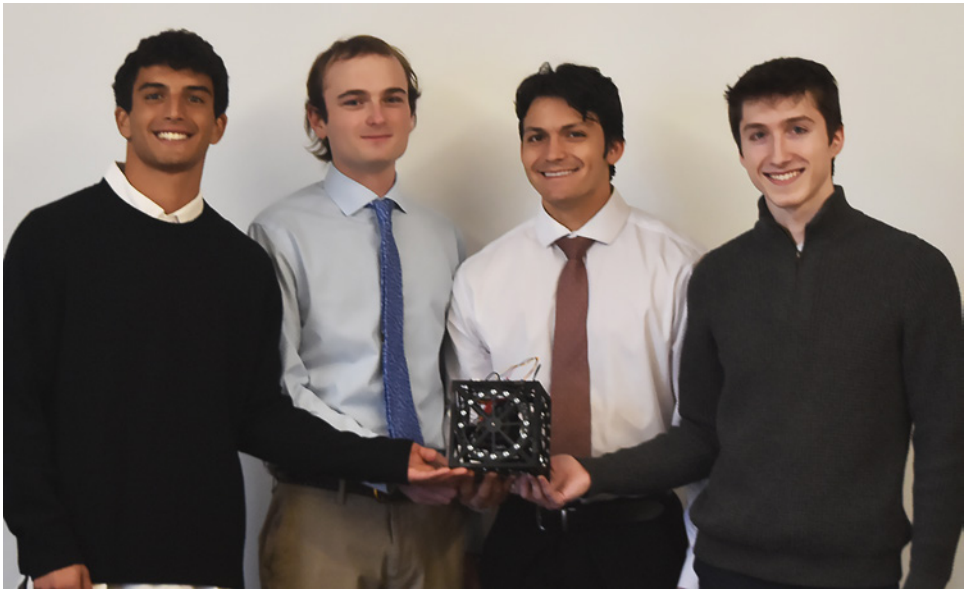
Student Self-Defined Project

Abstract

The ability to manipulate objects using only your mind is no longer a far-fetched idea. While It may sound like something out of science fiction, our team is turning this into a reality. We've created a headset that utilizes Electroencephalogram (EEG) sensors to quickly and accurately record a user's neural activity. Our state-of-the-art deep learning algorithm then decodes these signals into predefined motor imagery tasks.

This breakthrough technology is integrated with a computer game that provides the user with an environment to navigate using their mind. With the Brain 4CE headset, users can perform four different actions: rotating clockwise, rotating counterclockwise, moving forward, and moving backward. Each action corresponds to a physical motion that the user imagines themselves doing.

Our team was inspired to develop this project by our desire to bridge the digital divide for those who are physically disabled. With the Brain 4CE headset, users will be able to operate a computer, a wheelchair, and virtually anything else using nothing but their thoughts! The possibilities are endless, and we're excited to see what the future holds.



TEAM 5 - Space Motor

Seifallah Nabil Abdelhamid Ahmed Ibrahim, Peter Crary, Diego Corona, Nick Palladino
Client: Infineon Technologies

Abstract

Our project is a brushless DC motor controller that demonstrates radiation-hardened power semiconductor devices. The controller's power components are Infineon MOSFETs and gate drivers, and it can be programmed using the VESC Project's VESC Tool. Customizable features include commutation method (e.g., trapezoidal and sinusoidal), feedback method (e.g., back-EMF, hall-effect sensors, and encoders), input and output voltage and current limits (for protection and torque control), board and motor temperature monitoring, and more. The VESC Tool can also be used to monitor in real time the motor speed, board and motor current and temperature, and log both input and phase currents for efficiency testing. We built a system that demonstrates three of our motor controllers in a space application. The system is a self-contained 15-cubic centimeter cube with reaction wheels mounted on three of its faces, that can balance on an edge and its vertex. It uses the reaction wheels and an accelerometer and gyroscope sensor to orient and balance itself. The 3D-printed body of the cube and its cost-optimized motor controllers make it the ideal system for demonstrating power devices at conferences and trade shows. One motor and controller can be used to demonstrate device efficiency, while the balancing cube is an application demonstration.

TEAM 6 - Smart Gym

Richard Che, Carlton Knox, Arturo Garcia Ovalles, Benjamin Marin Canseco
Student Self-Defined Project

Abstract

There is a steep learning curve for people who want to start an exercise regime, particularly with regard to strength and resistance training. Lacking proper guidance when beginning strength training can lead to developing long-term improper exercise form, reducing exercise effectiveness and increasing the risk of injury. It thus becomes critical that individuals learn proper exercise form and receive automatic, continuous, and immediate feedback throughout their training. There is currently a gap in this type of training assistance that Smart Gym is designed to bridge. Our approach uses physical accelerometer, magnetometer and gyroscope sensors positioned on the body to map the body's posture and form during motion, which is then analyzed in real time to determine form correctness. The final deliverable incorporates these sensors into a comprehensive smart exercise system. Users will attach the sensors to their body and in combination with a mobile application, they will be able to exercise while obtaining feedback about their form. In addition, some other features of the app include storing a history of the user's performance and providing different workout options. Alternative products that offer form feedback typically use camera vision mounted on a stationary device, which can generally only be installed and used in home gyms. The Smart Gym system provides a portable solution for users who wish to receive form feedback in any fitness environment.

TEAM 7 - “Take” Notifier

Brandon Swain, Daniel Paganelli, Connor Greenwood, Kira Milgrim, Ethan Klein

Student Self-Defined Project

Abstract

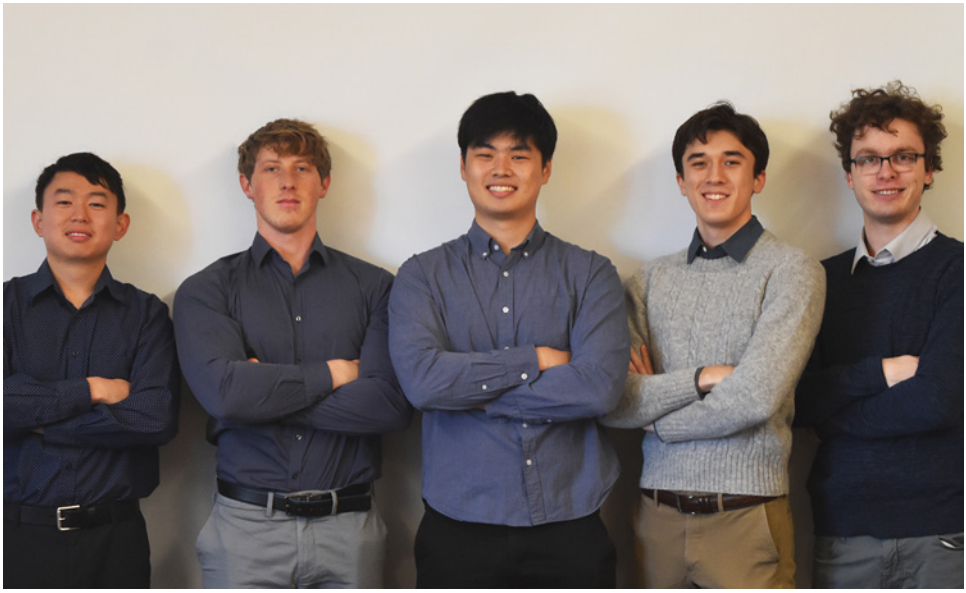
Outdoor rock climbing is an inherently dangerous sport, requiring a climber and their belayer to work together to navigate difficult or unpredictable terrain. Clear communication between the climber and their belayer is critical to safety, as the belayer must be able to hear and respond to simple commands from the climber to help them avoid dangerous situations. These commands are often relayed vocally, but environmental and personal factors can inhibit this communication. To combat this issue we propose a new device, the “Take” notifier, which provides hands-free transmission of commands from the climber to the belayer and notifies the belayer of such commands non-audibly. The “Take” notifier is designed to be portable and durable enough to withstand rough handling outdoors. This device provides an improved alternative to climbing communication devices and methods, helping to lower risk where verbal communication is not possible.

TEAM 8 - Drone Automation

Nengneng Yu, Qintian Huang, Chengze Zheng, Lixing Shen
Student Self-Defined Project

Abstract

This project implements an automation system for a drone that enables it to automatically take off, detect and track an object in flight, and land. The project employs the PixyCam2, a compact vision sensor that uses color-based object recognition to identify and track objects, for object detection. The PixyCam2 is mounted on the drone and transmits data to the onboard RaspberryPi, which processes the data and generates control commands to adjust the flight path of the drone in real time. Using the PX4 flight controller, a custom system was developed to control the drone's flight path. The PX4 flight controller is an open-source autopilot system that offers a dependable and modifiable platform for controlling the flight parameters of the drone. The system was designed to receive data from the PixyCam2 and adjust the position, altitude, and velocity of the drone accordingly.

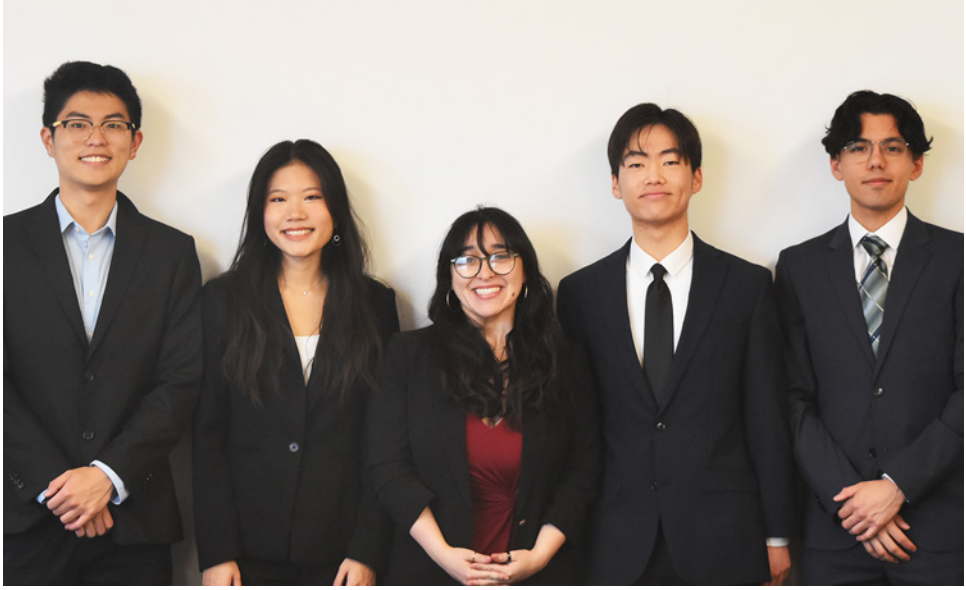


TEAM 9 - Torque Vectoring

Alex Zhou, Nick Marchuk, Jonathan Ye, Will Krska, Giacomo Coraluppi
Client: Terrier Motorsports

Abstract

As motorsports categories are turning towards electric vehicles, teams are developing new strategies to reduce lap times. One such strategy is to develop a torque vectoring system to independently control two rear wheels of the vehicle to improve cornering performance and driver control. The final deliverable will be a fully functional torque vectoring system that can be integrated with the tractive system of the car as well as user-friendly documentation to assist clients with implementing the torque vectoring system onto the car. The proposed technical approach is to design a PID controller to track the yaw rate of the rear wheel-driven vehicle. To do so, a 2-degree of freedom (DOF) linear model and a 7-DOF nonlinear model will be designed. The developed controller will be embedded to an onboard microcontroller on the vehicle to control the independent motor inverters. To maintain robustness of the hardware, a Controller Area Network (CAN) interface will be developed so that the motors can maintain a given torque difference from the controller. The main innovative feature of the project is to independently control how much power goes to each of the rear wheels rather than giving the same power to both to improve speed and control. Additionally, a large focus has been placed on user-serviceability so it can easily be adapted to any future vehicle. Finally, the developed system will be easily implemented to existing vehicles as our software will be properly parameterized and a utilization/ implementation guide will be communicated through documentation.



TEAM 10 - Intuitive Computer-Human Interface (ICHI)

Ronald Huang, Grace Kim, Jeanette Villanueva, Ande Chen, Henry Galindo
Student Self-Defined Project

Abstract

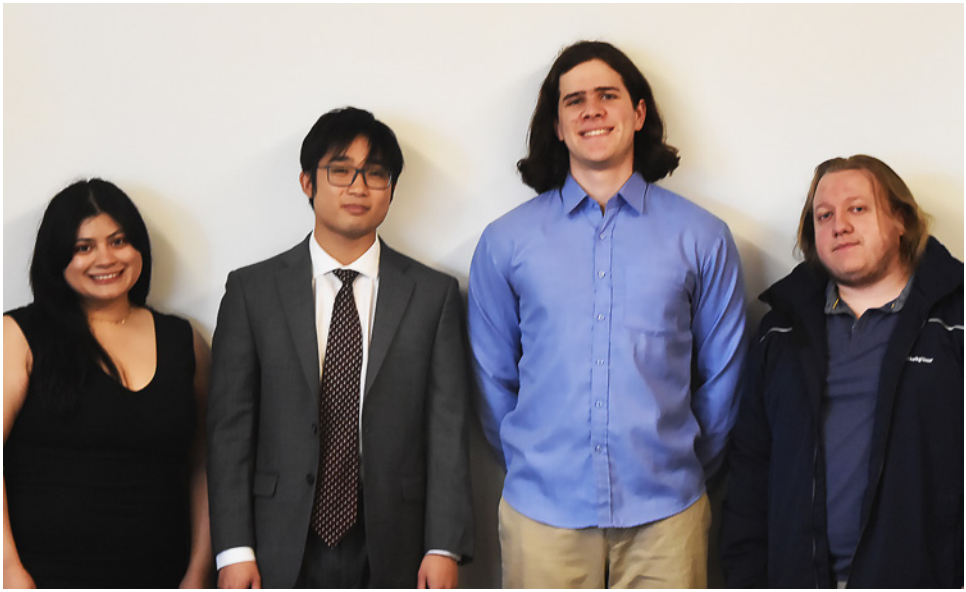
Computer literacy is gradually becoming a prerequisite for participation in this technology driven world. It is imperative that as many people as possible learn this skill. However, traditional mouse and keyboard input can prove to be difficult or impossible to use for individuals who suffer from illnesses that hinder their fine motor skills. Our product, ICHI, utilizes a combination of the Tobii Eye Tracker 5 and speech-to-text as a more intuitive and accessible method of working with a computer. The product will incorporate all of the same functionalities as a computer mouse in an ambidextrous handheld controller in addition to a built-in microphone for speech-to-text functions. Further, this product will be demonstrated in a Unity Game environment, where the eye tracker will be used to focus the cursor on specific objects and a text box to show speech to text.

TEAM 11 - Aerobatics Black Box

Qi Luo, Maxwell Bakalos, Yanbo Zhu, Eli Carroll
Client: Dr. Kenneth Sebesta

Abstract

Aerobatic pilots have trouble visualizing their routines from a viewer's perspective and figuring out which actions they perform result in a successful flight. Our team's solution is an in-flight recording system. After a flight, the pilot can watch the recording back to learn what inputs caused which outputs and improve their abilities. This project was proposed by our client, Dr. Kenneth Sebesta, who flies an aerobatic plane himself! In order to record the flight, we need to know the plane's position and orientation, as well as the pilot's inputs and the plane's response. We created a cyber-physical system that uses a GPS, IMU (accelerometer & gyroscope), and a camera along with a microcontroller to record the flight. The camera uses an image processing system to read the dashboard dial information and the pilot's maneuvers. After the processing is done, a flight visualization application displays a 3D animation alongside the data values.



TEAM 12 - VOCL

Mia Hernandez, Charles Mo, Krishan Eskew, William Nilsen
Client Name: Dr. Andrey Vyshedskiy, CEO, ImagiRation

Abstract

Currently, there is a lack of educational and recreational resources for children with nonverbal autism that are engaging and informative. VOCL seeks to bridge that gap by developing virtual assets and sound processing algorithms in an app integrating educational software to provide a fulfilling experience for children that cannot receive it through traditional means. We will develop and modify Unity assets to provide an engaging experience for children in our product, as existing applications lack entertaining interactive character models specifically designed for children. The application will contain nonverbal communication processing algorithms, like clapping or moving the device, allowing children with any level of communication to have a fulfilling and interactive experience.

TEAM 13 - S.A.F.I. (Selective Audio Filtering Instrument)

Jose Assy, Tejasva Agarwal, Paul Rescigno, Yanbo Gao
Client: Cambridge Consultants

Abstract

The nature of this project is to enhance the auditory experience for those individuals who have trouble distinguishing between different audio sources in a noisy environment. The S.A.F.I is able to take multiple input audio signals from an array of microphones and process the inputs into a single desired output signal back to the user. The S.A.F.I exists as a portable headphone setup that uses beamforming in order to be able to isolate audio sources coming from defined “angles of listening”. The S.A.F.I can incorporate many different filtering techniques such as echo cancellation, compression, and equalization to give the user a customizable experience that fits their needs. This device can be used in lecture halls, concert venues, and even linguistics field research to allow the user to focus on what’s important and ignore any extraneous noise.

TEAM 14 - Augmented Reality Climbing Wall

Tom Panenko, Taylor Hartman, Ryan Smith, Michael Igwe
Client Name: Dr. Kenneth Sebesta

Abstract

Our project is focused on taking the current augmented reality climbing walls used today and optimizing them to create a smoother, mistake-free gaming experience for the user. To accomplish this, we plan on taking the skeletal tracking system that most augmented reality climbing walls already use and coupling it with our own active sensors that would be attached to the climbing holds. Doing this would remove the reliance on the inconsistent skeletal tracking system and add a second element that can actively sense which climbing holds the user is exerting pressure on. In addition to providing users a better gaming experience, we also plan on developing our own augmented reality climbing wall games that the user will be able to enjoy without error or delays while on the wall.

TEAM 15 - AM Radio Localization

Haoyan Zhang, Alejandro Roberto, Yidi Wu, Zhengyi Yang
Client: BetterBots

Abstract

One of the most important learning experiences for electrical and computer engineers is the hands-on interaction with the concepts and systems instructed during lectures. Being able to observe how the design of electronic systems comes together with coding implementations to understand, analyze and transform physical phenomena aimed for the resolution of problems serves as a great motivator for the continuous study of engineering and related STEM fields. With BetterBots we aim to make the resources needed to have this hands-on experience more accessible by developing a sensor package made from easy to acquire, discrete components.

The AM Radio Localization is a subsystem in an educational in-door robot, the project is to design an open-source and low-cost sensor package for indoor robotics developers that leverages AM radio signals for a localization system that can be utilized instead of GPS. The idea of utilizing AM Radio signals is inexpensive and the signal can penetrate through buildings, however the signal strength will vary on the material of the building. For our project, we are expected to develop circuits that use discrete components and improve the current version of AM Radio Localization subsystem circuits that our client provided on the website.

TEAM 16 - BlockMMP

Zhenglei Jiang, Mark Nudelman, Issam Haddad,
Lesly Alcantara, Maria Paula Fernandez Cortes
Client Name: BlockMMP

Abstract

BlockMMP is an underlying permissioned blockchain that tracks and records prescription dosage histories of medications used to treat patients with opioid use disorders. The overall problem BlockMMP is trying to solve is that conventional systems for monitoring and tracking methadone dosages, a medication used to treat opioid use disorders, fail to provide accurate relevant information across clinical sites. These existing systems come with logistical limitations leading to the inability to dispatch methadone doses. The mentioned logistical limitations include methadone not being a pharmacy drug, meaning individuals are required to visit specific clinical sites, so they are strictly limited to the site's business hours. Additionally, these sites are not interconnected like a blockchain, meaning that patient records are not available among sites, so dosage information is retrieved via phone or via writing by fax. In turn, patients are losing trust in the system so the purpose of this platform and service is to facilitate the secure transfer and recording of prescription information across healthcare providers in Rhode Island.

The purpose of our involvement in BlockMMP endeavors is to improve the usability of BlockMMP's current platform from a client perspective, which involves building a mobile application, compatible with both iOS and Android, allowing patients a better sense of trust in the system as well as improving their overall treatment quality. In addition, we hope to incorporate the patient's input into the application by considering the patient's overall satisfaction with the service/dosage. We hope to gather data to send to medical facilities highlighting how the users feel in order to provide better insights.

TEAM 17 - Canine Tracking for Search and Rescue

Christopher Alonzo, Ayrton Reulet, Aanya Kutty, Ragib Ahsan
Client: Blair Burtan & Yavapai County Search and Rescue

Abstract

Search and rescue teams need GPS tracking collars for their dogs that work in all weather conditions, track multiple dogs at once, and can tell when a dog has found something. Currently, most GPS tracking devices on the market are designed for recreational use and are limited to tracking one collar at a time. This is not practical for search and rescue teams that have several trained dogs working together to find evidence.

We have created a collar that is equipped with GPS and Bluetooth capabilities, as well as specific functionality that will alert the handler when a dog has found evidence. All of this information will be mapped to a mobile application accessible to everyone on the search team. The application is compatible with SARTopo, a mapping platform used by the Yavapai County Search and Rescue Team in Arizona. By connecting the collar's GPS information with SARTopo, handlers can track the location of each dog in real-time and create a visual map of the search area, as well as analyze activity and location data after each search. Overall, our solution will streamline the search and rescue process, ultimately making it more efficient and accurate.

TEAM 18 - Coastline Prediction

Stacia Kolodziejski, Saif Alblooshi, Wenyu Hu
Client Name: MathWorks

Abstract

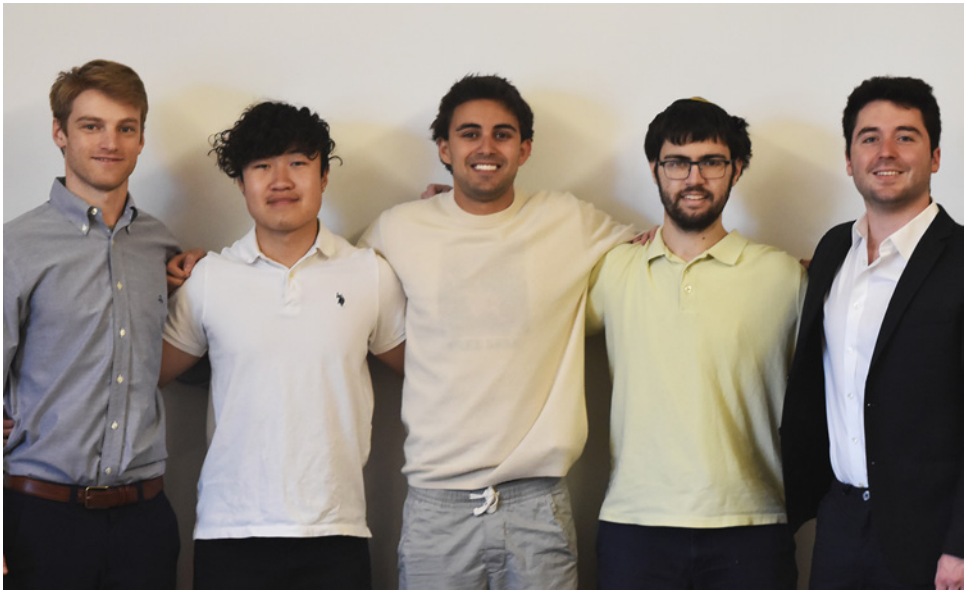
Global warming and melting glaciers are causing sea levels to rise which exposes coastal communities to risks of erosion and flooding. These communities would be greatly benefited if they knew in advance how and when their homes will be affected. To give these communities the information they need to prepare and adapt to the consequences of sea level rise, the Coastline Predictor visualizes what the coastlines will look like up to 100 years in the future. Our product, developed with MatLab, will use current elevation data with sea level prediction data, analyze this data, and then generate a predicted coastline. The Coastline Predictor displays new coastlines based on future time instead of water level rise depth, so that users do not need to look for predicted water levels themselves. We hope that our product can help coastal communities plan in advance, for what will happen to their homes.

TEAM 19 - Glioblastoma Cancer Research Platform

Chris Gough, Dasha Smolina, Marlee Feltham, Meghna Murali, Jennifer Zhang
Client: Varshith Hakkithimmanahalli Anilkumar

Abstract

Over 13,000 Americans are diagnosed with Glioblastoma, an aggressive type of brain cancer, every year. Glioblastoma severely decreases their quality of life and is incurable. Current research methods for improving their treatment are heavily reliant on multi-omics and bioinformatics, which are compute and time-intensive. The goal of this project is to develop a computational platform to provide insights that can help in the treatment quality of glioblastoma cancer patients and advance glioblastoma cancer research. We aim to optimize the bioinformatic processes, model the evolution of cancer-causing cells, and produce a digital predictive model of the disease for individual patients.

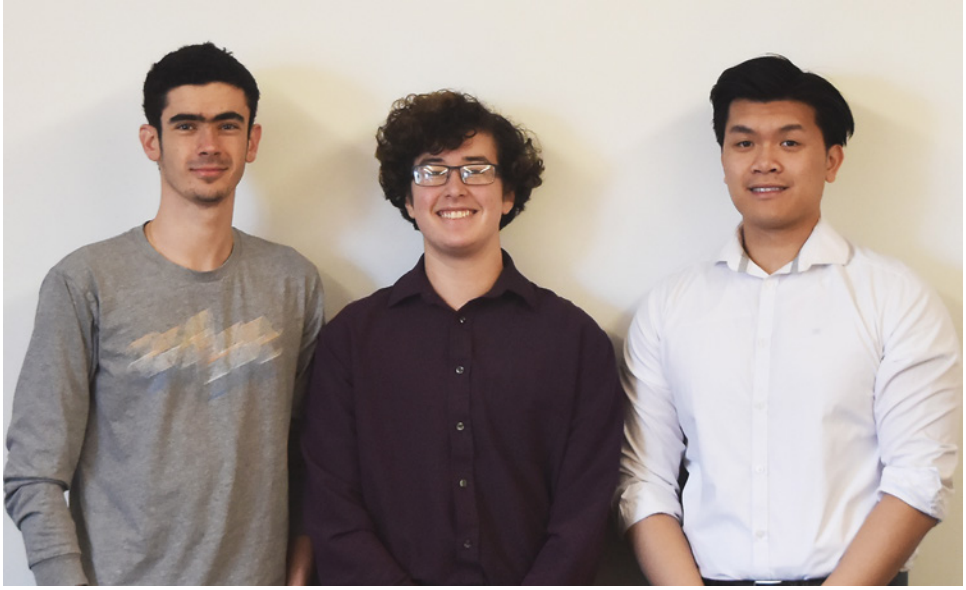


TEAM 20 - Develop an Application Without Writing a Line of Code

Andrew Brownback, Michael Xu, Timin Kanani, Benyamin Trachtenberg, Mark Vinciguerra
Client Name: Professor Osama Alshaykh

Abstract

Our team developed a web application that allows users to create their own custom application by simply specifying the features they desire in plain English. The application uses natural language processing (NLP) models and API calls to retrieve feature files from our Google Firebase data lake. Our final deliverable is a user-friendly web application that can accommodate the 20 most common features found in applications and accurately classify requested features with high accuracy. One of the most innovative features of this application is its use of NLP, allowing users to simply specify their desired features in plain English. This makes the application highly user-friendly, as anyone can easily create their own custom app without any technical expertise. We believe that this project has the potential to greatly streamline the process of application development and make it accessible to a wider audience. We are excited to bring this innovative solution to the market and look forward to seeing the impact it has.

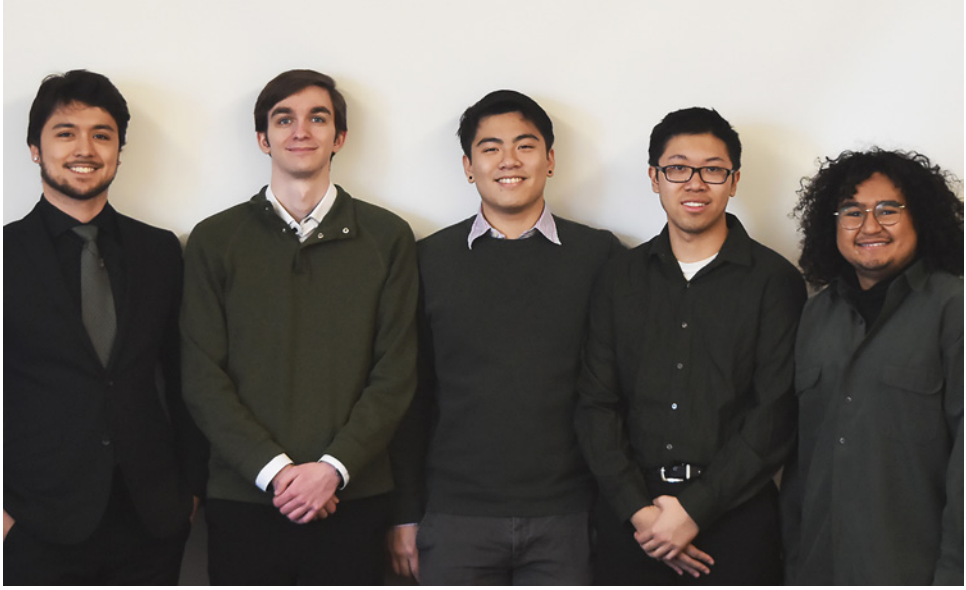


TEAM 21 - Efficient Solar Panels for Hot Water

Moises Bensadon, Hal Levin, Stanley Nguyen
Client: Professor Robert Kotiuga

Abstract

Solar Panels average between 20% - 30% efficiency which decreases when temperatures get too high. Although it may be the sunniest day out, this drop in efficiency means hot sunny days produce less energy than cooler less sunny days. By adding a cooling process with water to existing solar panels, we can increase efficiency and extend the cell's life. We can also use the waste heat from the solar panel to begin heating water for residential use. This can then be used in conjunction with a solar water heater, which has an efficiency of approximately 80%. Our system would be built and implemented with residential household electrical and piping systems. A smart monitoring system will be designed in such a way that it would be flexible and sufficient for a majority of houses. This is a heavy build project; requiring a mixture of electrical and plumbing skill sets to achieve a successful renewable energy system. The nature of the project will require modifications and/or changes to current or future designs in homes. By collecting data at different temperatures using our prototype, we can quantitatively show the energy and cost savings that our product can provide for the user.



TEAM 22 - SOL-R

Nicholas Simbaqueva, Dylan Quattro, Benjamin Ang, Tony Chau, Joshua Caban
Client Name: Professor Malay Mazumder

Abstract

Conventional solar panel installations generally use mono-facial panels which have silicon-based photovoltaic cells on one side and are opaque on the other. With the creation of bifacial photovoltaic modules (BPV), cells on both sides are capturing solar energy and producing more electricity per panel. The purpose of our project is to orient the reflectors in a way that conserves the least amount of space while generating the most amount of energy possible. Our intent is to create a linear stage in which the reflectors are motor-driven while the solar panels remain vertical and stagnant. The angle of the reflectors will be adjusted via code and data of solar azimuth based on longitude/latitude values. Not only would this generate energy more efficiently, but it also saves extra space in an agricultural setting. This is because the system is mounted up above the plants vertically instead of at an angle. The extra land can be used for additional food production or for satisfying any other needs. Our system will be able to capture more light and take up less space with the diffuse reflectors, a rather novel idea in the industry.

TEAM 23 - Halo Smart Drink Protector

Alan Dautov, Gabrielle Kuntz, Zirui Chen, Chenyuan Zhao, Pengyu Wu
Client: Ben Cootner

Abstract

Unfortunately, over the last few years, there has been an increase in drink spiking in Boston as well as across the world. Halo Smart Drink Protector is a battery-powered device that can seal the top of common glass types, it comes with a smartphone app and the ability to connect to the app via Bluetooth. Halo aims to reduce the number of drink spiking cases by introducing a smart drink cover that can effectively detect potential drink spiking and send a smartphone notification if potential removal is sensed, as well as providing users with an option to contact authorities in case of an emergency. Halo hopes to be accessible and affordable for everyone who wants to prevent the potential drink spiking and stop people from getting harmed by it. In addition to the app, there will be a website where users can submit feedback about their experience with the Halo Smart Drink Protector. This feedback will be used to improve the device and make it even more effective at preventing drink spikings.

TEAM 24 - E-Remote

Nicholas Gutierrez, Eunhye Kwon, Yumin Lisa Wei, Seok Young Choi
Client: Brandon Miller (Philips)

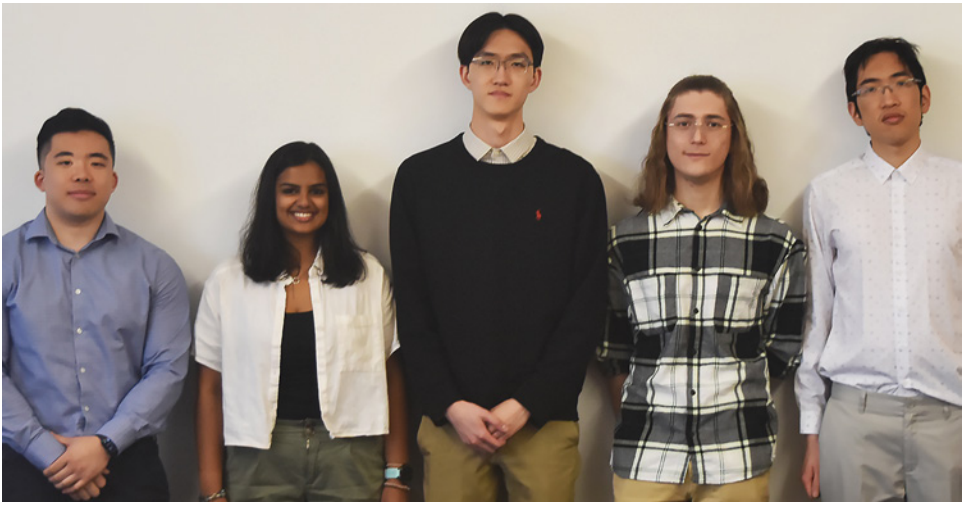
Abstract

Although the gaming community creates a space where people from all over the world can meet, joining the community is not as easy as switching the on button. Barriers of entry are prevalent, especially for those with physical disabilities. The purpose of our product is to lower those barriers.

E-Remote is an inclusive video game controller designed specifically to fit the needs of individuals with rheumatoid artritis. Not only did we keep our users in mind, but we allowed gamers with rheumatoid arthritis to be a part of our physical design process!

Our product is a fully functional video game controller, compatible with PC through Bluetooth connectivity with innovative mechanical features such as palm-controllable joysticks and touch sensor buttons. The controller has full compatibility with a multitude of video game genres. The user should play with minimal to no pain reported after 30 minutes.

These features will eliminate problems of conventional video game controllers and provide a fun and comfortable gaming experience. A controller rated E – for Everyone!

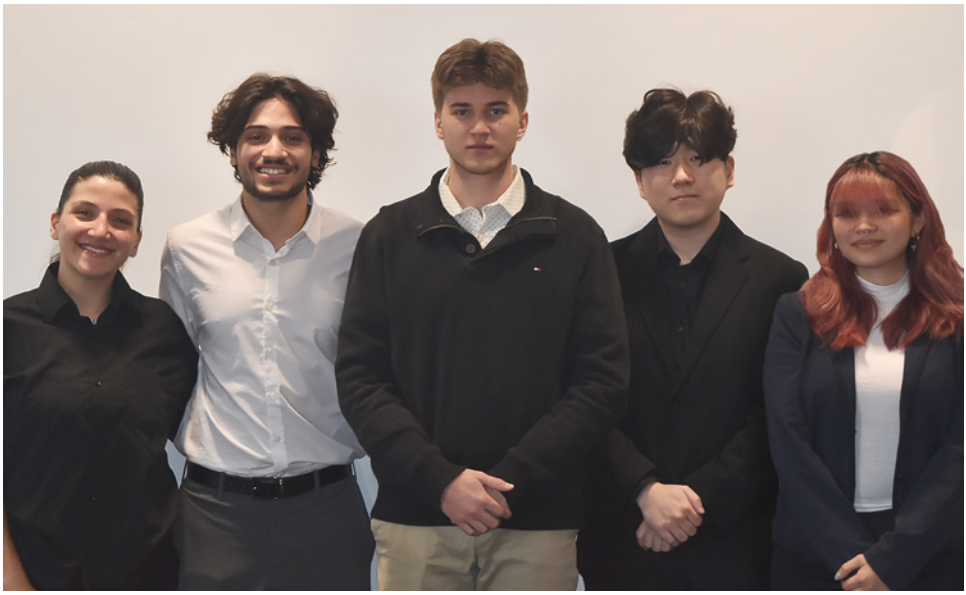


TEAM 25: LoRA Network Scanner

Quan Pham, Anjana Srivastava, Chia Jen Cheng, Alex Lee, Alperen Kitapçı
Client: Professor David Starobinski

Abstract

The LoRa (Long-Range) is a wireless communication protocol that allows low-power endpoint devices to send long range radio transmissions. with the use of LoRa gateways connected to the internet - this part of LoRa is usually referred to as LoRaWAN (Wide area network). This is commonly used with devices such as door and leak sensors, pet tracking, garbage collection, etc. - referred to as LoRa end devices. Because the LoRaWAN specification is open and loosely defined, currently there is no consumer available network scanning software available on the market. Our project aims to create a network scanner compatible with a lot of different LoRa end devices by utilizing a software-defined radio; specifically, the USRP B210 SDR. This way, even though we're developing our project with this SDR in mind, it should be possible to later port it to different SDR's further down the line. Our project will be capable of displaying nearby LoRa devices and information about these devices, such as the SNR, device ID, frame count, and possibly a distance estimate.



TEAM 26 - Playroom of the Future

Jude Kamoona, Ahmad Beydoun, Alexander Mackanic, Jason Kim, Madeline Clare Hain
Client: Dr. Andrey Vyshedskiy, CEO, ImagiRation

Abstract

The Playroom of the Future is an innovative project that seeks to create a more inclusive world and equitable playing field by providing support to neurodiverse children. It is designed to help accelerate the cognitive and physical development of children diagnosed with Autism Spectrum Disorders. Our program focuses on teaching children with learning differences life skills that will empower them to reach their full potential. Using a combination of patented technology, interactive and immersive environments, and a simple code that can be modified to add new characters, the Playroom of the Future is designed to help bridge the gap between neurodiverse children and their peers. By allowing children to explore, play, and interact with their environment, the Playroom of the Future gives children the opportunity to develop a full syntactic language, and gain the confidence needed to be successful in life.

We believe that it is our responsibility to ensure that all children have the opportunity to participate in activities that will help them reach their highest potential. This is why we strive to create an environment that is accessible to all. We provide a space where children can feel safe, secure, and accepted regardless of their cognitive or physical abilities. Our goal is to create an equitable learning experience where neurodiverse children can develop life skills, build relationships, and gain the confidence they need to succeed. With the Playroom of the Future, we are working to create an inclusive world for all.

TEAM 27 - EZRider

Haoming Yi, Jason Wang, Aymane El Jerari, Luke Bacopoulos, Balaji Sathyanarayanan
Client: Professor Alan Pisano

Abstract

Rough roads have been an issue plaguing New England and other regions since the invention of the automobile. Potholes and other imperfections on a road's surface can cause damage to a vehicle and make routes unsafe. The problem is that they are a product of weather and natural deterioration of roads due to vehicles passing by. They appear annually at a rate much higher than the rate they are being repaired. The systems in place to report rough roads in Boston are insufficient. The city relies on citizens to manually report rough roads, which is entirely unreliable. We are creating "EZRider" to replace the outdated and inefficient reporting system by fully automating the process. Our application allows users to place their phone in a dashboard mount and records the condition of the road as they are driving. The collected data is fed into multiple machine learning models that locate the potholes and determine its severity. The location and size of the potholes are presented to the user through our clean user interface. Through our application, we hope to collect an extensive list of undesirable road surfaces in the Boston area. Thus, we can hold the city accountable and uphold the integrity of our roads.

TEAM 28 - SharkCam: Autonomous Photography Accessory for Shark Vacuum Robots

Brett Senders, Sophia Delia, Liron Dubin, Kevin Vasquez, Alex Hureaux-Perron
Client: SharkNinja

Abstract

The SharkCam is a hardware accessory and app for the Shark® AI Ultra 2-in-1 vacuum robot that autonomously photographs events and parties using a smartphone camera. SharkNinja tasked Team 28 with designing an accessory for their robot that augments the device's functionality and takes advantage of its existing sensors and autonomous capabilities. The rise of apps designed around capturing spontaneous photos, and the resurgence of retro camera technologies such as instant and disposable cameras have demonstrated the growing demand for novel ways to create and share pictures, especially at social gatherings. The SharkCam system will autonomously traverse an indoor event space, capturing candid photos which are uploaded to a database for easy viewing and sharing through a mobile application. The app allows users to set parameters such as capture time and capture interval, takes photos by accessing the phone's camera, and sends commands to the robot through a network-connected Raspberry Pi. A rotating motorized phone holder facilitates photo-taking in all directions, ensuring the action is captured no matter the robot's orientation. The phone holder is connected to a detachable telescoping column mounted to a semi-permanent base. An auxiliary obstacle avoidance system utilizes a laser sensor to prevent collisions with the column. The SharkCam accessory is user-installable, removable, and non-destructive to the stock robot.

TEAM 29 - Smart IoT Watering System

Kaede Kawata, Karin Luna, Inés Saavedra, Nyah Madison, Jordan Remar (not pictured)
Client: MathWorks

Abstract

Our group's project aims to optimize water usage in crops for farmers by developing an IoT device. The device collects real-time data on soil moisture levels, temperature, humidity, and other environmental parameters to optimize irrigation schedules. The data is then analyzed by machine learning algorithms to determine the optimal irrigation schedule for each crop. The device, charged by solar panels, communicates with a cloud-based platform that provides farmers with insights into their crop's water usage and enables them to adjust irrigation schedules remotely. The device is designed to be low-cost, durable, sustainable, and easy to install, making it accessible to small-scale farmers. The project is expected to result in significant water savings, increased crop yields, and improved farmer livelihoods, while also contributing to sustainable agriculture and water conservation.

TEAM 30 - The Art of Valuation

Ignacio Nunez Gomez, Suyash Bhatia, Prithika Ganesh, Zen Mae Lee
Client Name: Brendan Cahill (Workshop Finance)

Abstract

Workshop Finance is a deal idea generation tool, allowing users to quickly build valuations. The application provides a way for a user to evaluate a given company based on a variety of metrics, (e.g. similar companies, trading multiples, time periods) to arrive at the relative valuation for the given company. Workshop then performs the necessary calculations and presents results through a visualization called a football field, a graphic which typically appears in investment banking pitch books. The mobile application allows users to view, refine, and share this football field directly through the app. Workshop will enable deal idea generation, client communication (i.e. pitching to clients, initializing cases), and deal execution. Workshop Finance will become the primary medium through which users "tell the story" of a company's valuation—the key point in any corporate finance discussion. This first-of-its-kind application will power the *art of valuation* through a combination of strict corporate finance theory and innovative user experience.

THESIS STUDENT
Basil Chin Ting Ng

ADVISOR: PROFESSOR MARTIN HERBORDT

"Dynamic Infrastructure Services Layer For Reconfigurable Hardware (DISL)"

Abstract

Products with embedded computers are pervasive in modern life. Technological advances enable ever more complex applications, but simultaneously make it more difficult to create designs that are portable, performant, and programmable. The goal of the parent project – A Dynamic Infrastructure Services Layer for Reconfigurable Hardware, or DISL – is to address this problem, by providing a framework that allows developers to generate on-chip system support that can be either generic or customized based on user requirements such as the target workload or system hardware. The final deliverable of this project would be a component of the larger DISL system that will be integrated into the rest of the project.

THESIS STUDENT
Vikrant Sharma

ADVISOR: PROFESSOR CHEN YANG

"Artificial Hearts: Photoacoustic-mediated heart organoid deveolpment for cardiovascular disease modeling"

Abstract

Growing cardiovascular disease incidence, particularly involving irreversible myocardial cell-death, drives novel pharmacological therapy and surgical intervention research. However, state-of-the-art treatment lags demand due to a fundamental technical mismatch between therapy screening preclinical models and clinical trials. To develop a preclinical cardiac model with clinical sensitivity, specificity, and biomimetic complexity, this thesis proposes a novel thin-film photoacoustic scaffold that exposes pluripotent cells to an embryomimetic pulse train and stimulates in vitro cardiac organogenesis. Cardiomyocytes directly cultured on the scaffold rapidly self-organize into an embryonic body and mature into a heart organoid morphology without sensitive growth factor concoctions or significant resultant size variance. As a preclinical model for cardiac therapy validation, this device may be a precursor for future regimens that repair myocardial insults and significantly improve long-term patient outcomes.

THESIS STUDENT
Joshua Shterenberg

ADVISOR: PROFESSOR BRIAN KULIS

"Track-Vertex Fitting in Primary Vertex Reconstruction for pp-Collisions at the CMS"

Abstract

I propose a Gaussian Mixture Model (GMM)-based modification to the track-vertex fitting in the Primary Vertex Reconstruction (PVR) phase of the software for the Compact Muon Solenoid (CMS) detector at the European Laboratory for Particle Physics (CERN). The CMS Collaboration experimentally probes high-energy physics in CERN's supercollider, researching dark matter, the Higgs Boson, and more. The practical analysis of CMS data for these contexts necessitates extreme precision and accuracy of the detector itself, particularly in signal (vertex/collision) detection. Through the research of faster and more memory-efficient solutions to PVR, a significant improvement in the CMS software (CMSSW) was found in modifying the fitting step. This modification was tested on Monte Carlo simulation data in the full CMSSW pipeline, and improves both the efficiency of the system by 3% and the false-positive rate of vertex reconstruction by 44% on the CPU-based algorithm. Similar improvements due to this modification can be shown on the GPU-based algorithm, with additional spatial and temporal benefits due to hardware-based parallelization and acceleration techniques.

THESIS STUDENT
Roy Xing

ADVISOR: PROFESSOR JOHN BAILLIEUL

"Multi-Agent Mobile Manipulation Methods"

Abstract

Mobile manipulation is a relatively new term in robotics, being first coined in the 1990's as compared to the fields that comprise it; robot manipulation and autonomous mobile robots that emerged in the 1950's. As such there are still many avenues to explore about the full functionality of robots with mobile manipulation capabilities. Aspects of promising research paths include integrating visual sensing in the motion planning and execution of mobile manipulation as well as how to fully exploit the additional degrees of freedom (DOF) that a mobile base brings to a robot arm. Specifically, a largely unexplored research direction is that of multi-robot mobile manipulation in which different mobile agents will plan together to complete a manipulation task that would be challenging or impossible for a single agent. Formulation of principles of decentralized multi-robot cooperative motion planning and control is needed. As research in robotics continues to advance enabling robots to function in the real world, it is important that robots be given the ability to work with other robots or humans to accomplish a task. This thesis explores foundational principles of multi-agent mobile manipulation. The mobile manipulators under consideration exhibit kinematic redundancy, meaning they are capable of more degrees-of-freedom of movement than the minimum required to operate in the task space. In what follows, we explore approaches to to resolving kinematic redundancy so as to create consistently repeatable behaviors and predictable motions. For task in which multiple agents cooperate, principles of dynamic task partitioning are proposed. Empirical validation of the work is carried out using two sophisticated platforms consisting of Kinova Gen 3 Lite manipulator arms mounted of Clearpath Dingo-O omni-direction mobile bases. Software and engineering challenges are described.

SENIOR DESIGN FACULTY

ALAN PISANO Associate Professor of the Practice

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

OSAMA ALSHAYKH Lecturer & Asst. Research Professor

Dr. Alshaykh is CEO of NxTec. He was CTO of Packetvideo corporation, Scientist at Rockwell and Visiting Researcher at UC, Berkeley. Osama received a Ph.D. in Electrical and Computer Engineering from Georgia Institute of Technology in 1996. Osama received a Fulbright Scholarship and served as associate editor for IEEE Transactions on Circuits and Systems, Video Technology. He served as consultant, board member and advisor for several companies and groups.

MICHAEL HIRSCH Adjunct Professor

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

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

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

STUDENT SUPPORT

VINEETHA ASHOK **Graduate Teaching Assistant**

Vineetha Ashok is a second year PhD student working on Nonlinear fiber optics who spends most of the days in dark rooms aligning light and dealing with spools of fibers (and breaking them occasionally). Vineetha received her integrated BS/MS in Photonics from Cochin University of Science and Technology, India in 2021. She loves photography, cooking and travelling!

GUANGRUI DING **Graduate Teaching Assistant**

Guangrui Ding is a second year PhD student working with Professor Jixin Cheng on chemical imaging. He received his BS degree from University of Science and Technology of China, majoring in physics.

DANCHEN JIA **Graduate Teaching Assistant**

Danchen Jia is a third year BU ECE PhD student working on infrared photothermal spectroscopy and microscopy. She received her BS degree majoring in optics from Zhejiang University, China in 2020.

STUDENT SUPPORT

CHUAN LI Graduate Teaching Assistant

Chuan Li is a second-year Ph.D. student working with Professor Jerome Mertz on confocal microscopy. He received his B.S. in Optics from Tianjin University, China. In his spare time, he loves traveling.

FAIRUZ ABUSHGARAH Laboratory Assistant

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

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

THANK YOU, ALUMNI JUDGES
Special thanks to our ECE Alumni judges, who took time from their schedule to be here with us today.

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

and finally, THANK YOU, STUDENTS
Thanks to all the seniors for the hard work and dedication put into these projects every day, from the day they walked in to EC463 at the start of the Fall semester.

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