JOSHUA DUARTE

DESIGNER | MAKER | MECHANICAL ENGINEER

Contact Information

Email: Joshua_Duarte@berkeley.edu
Cell: (704) 960-5071
Location: Waxahachie, Texas

Education

University of California, Berkeley, Berkeley, California — Graduation: May 2023
Master of Engineering in Mechanical Engineering — GPA: 3.861/4.0

Texas A&M University, College Station, Texas. — Graduation: May 2022
Bachelor of Science in Mechanical Engineering — GPA: 3.594/4.0

Skills

CAD-CAM: Solidworks, Fusion 360, CATIA V5, Autodesk AutoCAD/Inventor,
Programming: Python, C++, JavaScript, TensorFlow, matplot, OpenCV, HTML, CSS,
Experience: Rapid Prototyping, Additive/Subtractive Manufacturing, GD&T, DFMA, FMEA
Languages: English, Spanish

Gambit - Automated Chessboard

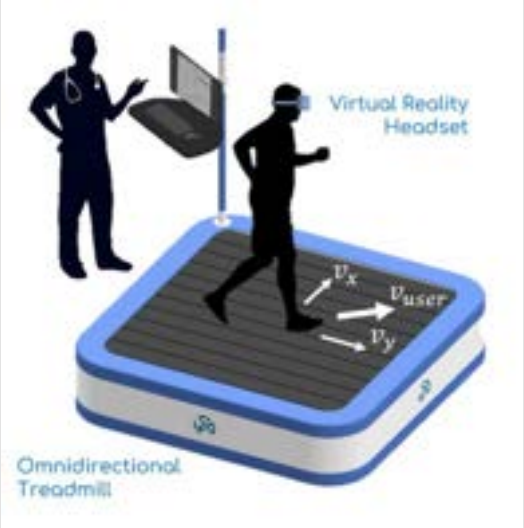
The idea for Gambit was born in January of 2021, at the height of the pandemic, when social distancing measures made it difficult to play physical chess with others. As a mechanical engineer, I saw this as an opportunity to not only scratch my itch for chess, but also to challenge myself by incorporating a range of mechanical, electrical, and computer science concepts into a project. Gambit represents the covergence of my interest in chess and passion for engineering. My goal was to create a product that not only satisfied my personal need, but could also benefit others who find themselves in similar situations.

Since the commencement of the project, there have been three iterations. The first was completed as a senior design project at Texas A&M University that I proposed and was accepted by senior staff. Here, I led a group of 4 other mechanical engineering students. We were able to create a fully functional board comprised of a core XY electromagnetic gantry, an array of reed switches, and a chess engine written in C++. This version of the chessboard had a footprint of 32 inches long, 27 inches, and stood about 5.5 inches tall. Although the board was functional, there were many areas that could be improved upon. This potential for a more consumer friendly product led me to continue to work on the project on my own.

In the next iterations, I chose to focus on reducing the overall footprint of the system, increasing the structural integrity, and minimizing the total amount of components necessary for ease in both in manufacturing and assembly purposes. The latest iteration of the chessboard has a footprint of 27x25x2.5 inches. The system itself is designed such that it accommodates a regulation size chessboard that is 18x18 inches. The allocated space at each side allows for the user and electromagnetic gantry to remove conquered pieces from the play area. The new system also utilizes linear Hall effect sensors that are calibrated to better detect pieces lying within the squares. This is due to the previous version utilizing reed switches that are binary in nature whereas the hall effect sensors utilize analog inputs that is interpreted over a range. The script concerning the chess engine controlling the decisions of the opponents was also altered to act as a better opponent for the user as it now competes at a level of around 1600. The project resulted in a greater understanding in electromechanical and computer science related topics while being able to grow as a player in the game of chess. In the future, I plan to revisit the project to encorporate a chess engine that can play at varying skill levels and have a user interface both on the device itself and potentially be paired with a mobile application.

Skills Used: Computer-Aided-Design (CAD), Tolerance Analysis, Structural Analysis, FMEA, C++, Circuit Design, PCB Design, Additive and Subtractive Manufacturing, Woodworking

Enhancing Rehabilitation using an Omindirectional Treadmill & VR



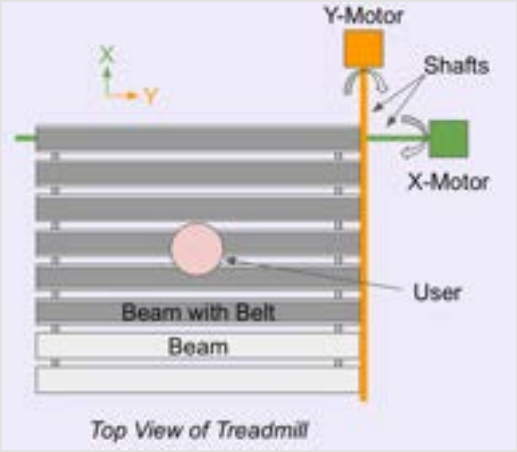
Walking rehabilitation is a common form of treatment for patients suffering from Alzheimer's, Parkinson's, and stroke. However, existing systems and equipment are monotonous and lack the ability to gather quantifiable data needed to enhance patient recovery. Virtual Reality can help break the monotony of physical therapy, but current VR options tend to cause motion sickness. An Omni-Treadmill addresses this problem by granting patients the ability to move freely in any direction, allowing for complete immersion minus the discomfort. This combination results in more engaged patients who are motivated to undergo more individualized rehabilitation exercises while optimizing their recovery.

For this project, myself and 9 other students in the Master of Engineering program at U.C. Berkeley were tasked with enhancing the design of an Omnidirectional treadmill to function in a smaller footprint, have a greater ease in manufacturability and assembly, and have real-time controls for the system. This was to be done in accordance with the programs capstone project guidelines and all within 8 months. The project was funded by Blue Goji, a company focused on combining rehabilitation with virtual reality.

In the team, I was the only individual who was a part of both the product design and controls sub teams. This made me a suitable candidate to serve as the project manager and treasurer. In doing so, I created and managed comprehensive project plans, including timelines, budgets, BOMs, and resource allocation for the duration of the project. By the end of the year, the team presented a functional prototype that incorporated numerous addictive and subtractive manufacturing methodologies that minimized the footprint of the system by 57% and allowed for real-time controls. It has now been carried forward through to the next cohort in the MEng. program.

Product Design

The four areas of focus for the product design team were the beams, x-drive, y-drive, and the chassis. Throughout the project, I was involved in the creation of the new beam, prototyping, architecture of the chassis, determining how the components would interact with one another, and manufacturing. In designing the new beam and architecture, I performed numerous structural analysis' to ensure deflection was limited, factors of safety were met, all the while reducing the footprint as much as possible.



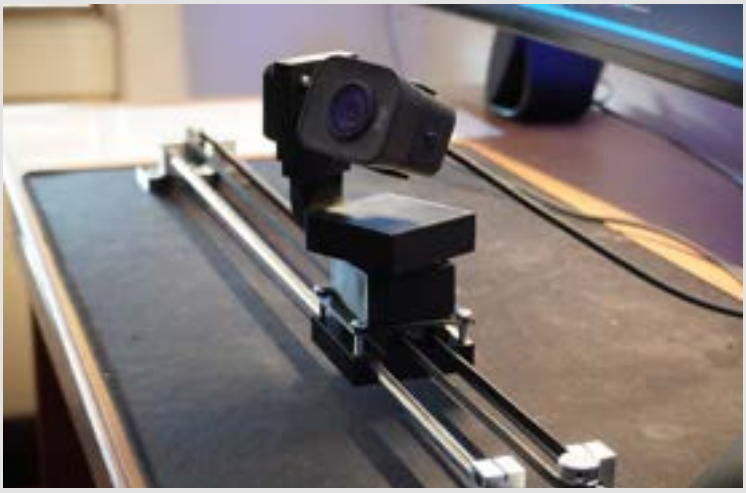
Top View of Treadmill

Controls

As one of the three members in the controls sub team, I was responsible for determining how a user would be tracked on the omnidirectional treadmill in real-time. In order to do so, I used computer vision and mediapipe to track the users position within the fixed environment. Using positional points with respect to time allowed for the determination of the users speed, direction, and acceleration which would be in turn used to drive the motors within the treadmill. Although this was functional, the team determined that for this years deliverables, it would be best to use load cells positioned underneath the treadmill. The load cells tracked the center of mass to provide a real-time control loop to actively maintain the user in the center.

Webcam Gimbal

As many meetings following the COVID-19 pandemic have turned to one of a virtual nature, I found that I would constantly need to change the location of my webcam to display different objects or position myself differently to account for better lighting conditions. As more meetings presented themselves, I found this task to be time consuming and quite distracting. Currently, there are various solutions to this problem available on the market. Having worked on projects that involved the use of motors and gantry like systems in the past, I thought that I would be able to create a solution of my own using materials I had laying around. This led to the creation of a 3-axis gantry that is capable of tilting a camera vertically (pitch), rotating a camera about its perpendicular axis (yaw), and slide horizontally across a 20 inch span. I chose to ignore the rolling of the camera as I never found myself using the camera in portrait mode for meetings of recordings.



The project utilized 3 stepper motors responsible for a specific movement, some off the shelf parts I had, as well as some low cost 3D printed parts. To ensure proper alignment, a structural and tolerance analysis was conducted to validate that the components experience little to no deflection and vibration as the camera was adjusted.

A circuit board was also designed and soldered together to accommodate the wiring of the three stepper motors as well as a joystick and buttons that are responsible for the movement of the webcam. In the future, computer vision may be utilized for automated face/object tracking. I would also develop a method for the system to be easily attached to both the top and underside of a monitor to reduce the amount of desk real estate needed for the system to function.

Portal: HP 'Phygitally' Connected

Being isolated from the real world, it's not easy to engage in social interaction or physical movement in a way that feels natural to most people. With this project, I worked with four other students and a product designer at HP to conceptualize, perform user and market research, design, and prototype a product that could directly tackle this problem. The Portal served as a device that could be utilized during virtual meetings to allow users to feel as if they were sitting at a round table. Each portal is equipped with a display, speakers, and camera to track user positions. When viewing the portal a user feels as if they are being talked to directly whereas current webcams and meetings have no sense of directional positioning of attendees which results in a lack of engagement. After performing test trials with users, we found attendees using the portal were more attentive in meetings. This project recieved praise from students and professors for its potential to make virtual meetings more bearable.

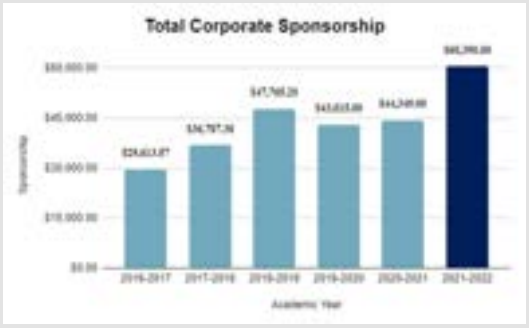
Society of Hispanic Professional Engineers (SHPE)

Director of Technical Affairs

Elected to serve as the Director of Technical Affairs for the 2020-2021 academic school year for the Texas A&M University chapter of the Society of Hispanic Professional Engineers. I was responsible for developing and maintaining the organizational website that would be used for recruitment and retainment purposes. Throughout the academic year, I grew a committee that averaged 7 members prior to my tenure to 47 members by the end of the year. This committee took on numerous new initiatives from creating a membership portal using Ruby on Rails, automating a point sheet that tracked member engagement using JavaScript, and developing personal websites using HTML, CSS, and JavaScript for professional development. My efforts along with those of the other executive board members led to being recognized as the National Large Chapter of the Year.

President

Elected to serve as the President for the 2021-2022 academic school year, I oversaw 8 other executive board members to ensure the growth of the organization in aspects pertaining to sponsorship, membership, professional development, academic development, social development, and technical development. The year's efforts were particularly important as it was the first year that students would be returning to campus following the COVID-19 pandemic. With this in mind, the executive team put extreme focus into recruitment ventures. Ultimately, the organization reached new membership heights by obtaining 436 members by the end of the year, a 74.7% increase from the year prior, and the most seen in the organization's 27-year history. In order to keep the organization functioning for the years following the academic year, there are efforts to ensure sponsorship is obtained from companies. This sponsorship is used to support members in attending regional and national conferences, hosting events, and providing scholarships for members. Throughout the academic year, corporate sponsorship reached another all-time high of $60,390, a 36.2% increase from the previous year. With the record-breaking sponsorship the chapter obtained over the course of the year, we were able to sponsor 43 individuals for RLDC 5 ($4085), a 258% increase from the last in-person RLDC. Having been selected to host the RLDC, the planning committee was able to create a conference that saw more than 350 attendees. From the end of the semester survey, 100% of participating seniors received post-graduation opportunities, and TAMU SHPE directly assisted 37 individuals to obtain internships. We highlighted 14 graduating seniors who pursued post-grad opportunities associated with the likes of ExxonMobil, Medtronic, University of California, Berkeley, Boeing, Halliburton, Amazon, and Texas Instruments.



Throughout my time as the President of TAMU SHPE, I grew as a mentor, teammate, student, and a leader. I attribute my time at SHPE as being the most influential on my character and passion for growth. Since leaving the organization, my team and I have been recognized by previous and current members as individuals who have set the standards for what the executive team for the organization should strive for. As an alumni and past President, I am currently serving as a mentor to various students in the organization as well as the current sitting President and Vice-President.

Internships

The Boeing Company

Responsible for the design, prototypes, manufacturing, and installation of foreign object debris shields within the only 4 existing 777X aircraft. Developed parts, drawings, and assemblies using 3D modeling software CATIA V5, Enovia, and IVT to ensure the accurate alignment within the aircraft. In completing the work, I received recognition from executive leadership for safety through the installation of the 8 debris within the aircraft's. I also worked closely with lead design engineers in overseeing the project management for the installation of essential test equipment designed to manipulate the weight distribution and thus the center of gravity and electrical load throughout an aircraft during flight testing.. From my work, I received a full-time return offer.

ExxonMobil

I was recruited to ExxonMobil through the Future Leaders Academy as one of 40 students selected from across the nation. This conference allowed me to directly engage with senior executives across the organization and learn valuable information pertaining to self development and leadership. At this conference I was ultimately given an offer to become an intern for the Upstream Integrated Solutions Digital Innovation and Automation Team in Houston, Texas. Here, I developed and enhanced a Sharepoint tool that captured and distributed learnings found during the Well Construction Process. In doing so, I met and discussed with numerous Well Engineers to design a seamless user interface and data collection using Nintex Forms/Workflows, JavaScript, jQuery, HTML, CSS, along with VBA within Microsoft Excel. This tool was ultimately adopted by Well Engineering teams within Guyana and West, Texas. Given the execution and results of my work, I received a return offer.

Northrop Grumman

Top-Secret Clearance

Assembled and tested electronic, mechanical, and electromechanical systems to ensure consistency and quality. Constructed models, assemblies, and engineering drawings using 3D modeling and design software, CATIA V5, to fabricate solutions. Worked with sector leadership to facilitate the development of a Subsystem Design and Analysis Lab. Received return offer upon completion.

Apple Vision Pro Packaging

I spent 7 days designing the package for the unreleased Apple Vision Pro which is expected to be released in early 2024. The packaging was designed to resemble the style Apple has instilled within all of its recent packages for its products. The package should aim to be aesthetically appealing, simple, and intuitive to the user, and strive to be sustainable through the use of its material selection and design to align with Apple's goal of having a net zero carbon footprint by 2030.

The package was designed using scarce product specification resources that describe the product and its respective accessories. For the accessories, an assumption was made that there will be a 30W power adapter and a 1-meter-long USB-C cable along with the expected battery and power tether all contained within the package. Regarding the headset itself, it was assumed that it could be broken down into 4 components: the main display, a light blocker, audio/charging bands, and the headband.

With the headset, various accessories, and packaging components themselves, the final dimensioning of the designed package is 308mm x 248mm x 168mm (LWH), and weighs approximately 2.346 kg or just around 5 lbs.

The package is created using a laminated fiberboard and various molded pulp trays in the hopes of creating something that is aesthically appealing, easy to assemble, manufacture, and most importantly, sustainable. These materials were selected based on other Apple packages that were studied. The package was also designed using a tolerance and structural analysis to ensure that the components arrive safely through the various environments that it would be exposed to by shipping and that the components within the package can be removed as satisfying as they are in other Apple packages. This is most notable in the removal of the first outer shell which limits the speed at which a user can remove it. This is done through the tight tolerances as it forces gravity to overcome a slight vacuum and surface tension.

Although much was accomplished in the 7 day timeframe of this project, I would like to revisit the package to spend more time on details that include the embossed wrap of the outer shells as well as creating the drawings for each component. I will most definetely revisit when the Apple Vision Pro is released.

Skills Used: Computer-Aided-Design (Fusion 360), Tolerance Analysis (GD&T), Structural Analysis, User and Market Research, FMEA, Drafting, Material Science, Graphic Design

Machine Learning & Data Science

Photovoltaic Solar Cell Neural Network

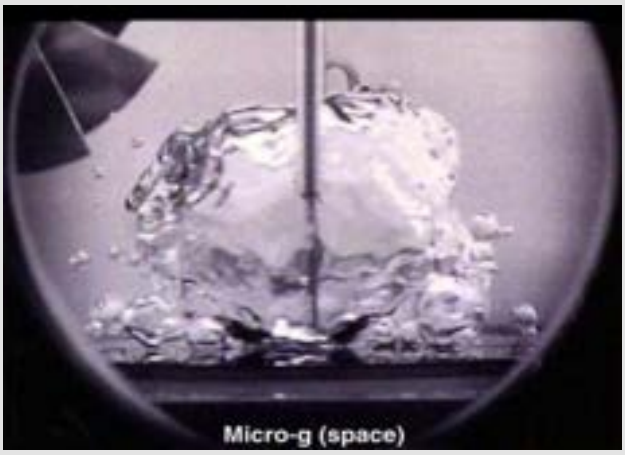
Successfully developed and trained an artificial neural network to determine the best layout of photovoltaic cells (solar panels). This was done by obtaining low flux operating conditions and standardizing the data set using the mean and standard deviation. A study concerning the performance characteristics of the photovoltaic cells was conducted.

Boiler Modeling Neural Network

This project revolved around the design of a boiler for converting captured incident sun rays by an array of heliostats into electricity. It is modeled similarly to the P510 solar thermal plan 15 km west of Seville, Spain. An artificial neural network model was developed and trained using a data set at a saturation pressure of 4.0 MPa. The model was also used to determine the optimal placement of electron components for a desired performance.

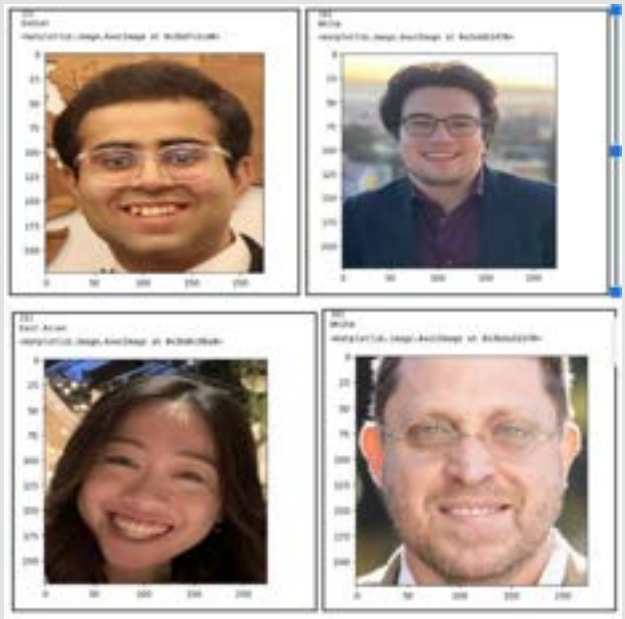
Modeling the Gravitational Effects on Boiling

Successfully trained genetic algorithms to study and interpret the gravitational effects on the boiling of a water-alcohol mixture i.e. water/2-propanol mixture. It was discovered that at lower gravity conditions, the Marangoni effect acts as a supplement for the absence of the buoyancy effect presenting higher gravitational acceleration conditions.



Ethnicity Prediction Neural Network

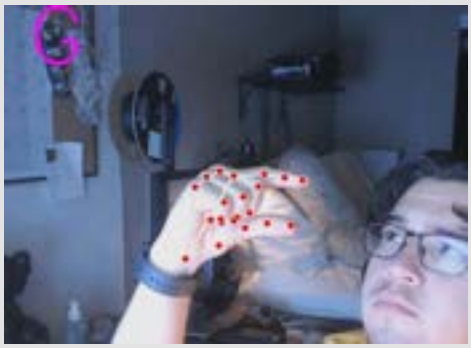
Explored how various neural network models are used to help predict ethnicity while keeping in check the ethical concerns pertaining to the test cases. The neural networks used were VGG-16, a deep convolution neural network architecture mode with multiple layers that help with object recognition. Resnet50, a variant of the ResNet model has that has 48 convolution layers. VGG Face was also tested for it is trained on a dataset that contains 2.6 million facial images. The FairFace data set comprised of 100k images was used for training and validation. Measured accuracy on training loss, validation loss, training and validation accuracy, and a confusion matrix. With over 20 tests done, we saw over 80% accuracy in the prediction. It was clearly seen that the failed tests were having biased features for the right prediction. Three out of the four fails were between white and Latino Hispanic races.



Other Projects

Sign Language Tracker

Using Python, OpenCV, mediapipe, and tensorflow, this project detects gestures in ones hands that resemble those in the sign language alphabet. This is accomplished by recognizing numerous points within ones hand in relation to one another. Ultimately, all letters within the alphabet were able to be detected from the users hand gestures.



Fermii

An iOS application that allowed users to know when and where their fellow classmates would be studying the same material. This would encourage people to work with one another and learn through teaching. Not only would one benefit from learning from one another, but would be rewarded for it too. This application was created using Swift. Ultimately, the application won the PwC Challenge at the 2020 TAMUHack hackathon for tackling resource and income inequality.

Scissor Lift

Created a scissor lift that aimed to familiarize creators with additive and subtractive manufacturing methods like that of 3D printing, lathe operations, mill operations, and other metal working tools. Successfully met the design specifications as the end product held 6 kg with less than 2.5 millimeters of deflection. This was recognized for being in the top 10% of delivered projects.

The Right Left

The right left is a sensor based system that was created during a 24-hour hackathon that tackled the dreaded problem of unprotected left hand turns. This system tracked the speed of oncoming traffic and would use pre-measured data to inform the driver. This system utilized an Arduino and varying light sensors and LEDs. This project resulted in winning the 2019 TAMUHack CBRE Social Good and Best First-Time Hack Challenges.

Nissan Design Challenge

Worked with two others to create a augmented reality platform that would allow Nissan to increase sustainability efforts in both the environmental front as well as the customer front as it aimed to better the vehicle purchasing experience. I was responsible for delivering presentations and working on creating the augmented reality model which resulted in a second place recognition.