FIU | Engineering & Computing
Department of Biomedical Engineering

BIOMEDICAL ENGINEERING SENIOR design EXPO

AN UNDERGRADUATE STUDENT PROJECT SHOWCASE & COMPETITION

SPRING 2023

DISCOVER | DESIGN | DEVELOP | DELIVER

Presented through the generous support of the Wallace H. Coulter Foundation

BIOMEDICAL ENGINEERING PRESENTS

Senior Design Project Showcase & Competition

Thursday, April 20, 2023

The Biomedical Engineering Senior Design Showcase & Competition is the culminating experience for undergraduate seniors in Biomedical Engineering. Teams of senior students complete and present their capstone projects in which they design and prototype a product, device, process, or software system solution designed to address unmet biomedical needs.

Congratulations
Graduating Seniors!

Jorge Riera Diaz, Ph.D.
Associate Professor,
Interim Chair of Biomedical Engineering

CHAIRPERSON MESSAGE

As senior Biomedical Engineering students at Florida International University, you have come to the end of an incredible journey. Your Senior Design Projects are a reflection of your efforts and your capstone undergraduate experience.

Your work is an illustration of the many skills you have sharpened during the course of this yearlong project. You have discovered new ways of thinking, designed and developed an engineering solution for a practical problem, and collaborated with your teammates to deliver innovative solutions. It is encouraging to see your accomplishments and to have witnessed your growth as students.

As you embark on the next stage of your education and careers, keep the confidence that comes from having enhanced your knowledge, remain inquisitive and have the courage to achieve your dreams.

Best wishes for continued success,

Jorge Riera Diaz

AGENDA

SPRING 2023 COMPETITION - THURSDAY, APRIL 20th, 2023

Room EC 2300

7:30 AM

Breakfast

Room EC 2300

8:15 - 8:30 AM

Introduction & Orientation - Dr. Michael Christie, Associate Teaching Professor

Welcome Remarks - Dr. Jorge Riera Diaz, Associate Professor of Biomedical Engineering and Interim Chair

Instructions to Judges - Dr. Christie

8:30 AM - Team 1

8:50 AM - Team 2

9:10 AM - Team 3

9:30 AM - Team 4

9:50 AM - Team 5

10:10 AM - Team 6

10:30 AM - Team 7

10:50 AM - Team 8

Room EC 2300

11:10 AM - Team 9

11:30 AM - Team 10

11:50 AM - Congratulatory Messages (Video Compilation) & Senior Design Montage

Panther Pit

12:00 PM - 1:00 PM

Lunch

Room EC 2300

1:15 - 1:45 PM

Awards Ceremony with Dr. Wei-Chiang Lin, Dr. Riera, Dr. Christie & Professor Shahrestani

Certificates of Concentration - Dr. Lin, Associate Professor and Acting Undergraduate Program Director

Presentation of Senior Design Project Awards Spring 2023

Word of Thanks - Dr. Lin

Concluding Remarks – Dr. Riera

TEAM PROJECTS

SPRING 2023 COMPETITION - THURSDAY, APRIL 20th, 2023, ROOM EC 2300

8:30 AM - Team 1: A-NEW

8:50 AM - Team 2: Wearable Photobiomodulation Device

9:10 AM - Team 3: Project Zen

9:30 AM - Team 4: Therapeutic Hydrogel Delivered Via Intranasal Device

9:50 AM - Team 5: Wireless ECG Patch with Antenna Miniaturization and Component Reorientation for Surface Area Reduction

10:10 AM - Team 6: Pressure and Weight-Bearing Casting Device

10:30 AM - Team 7: Optimization of Superior Clavicle Fracture Fixation Plate

10:50 AM - Team 8: Flickering Light Therapy Device for Treating Symptoms of Alzheimer's Disease

11:10 AM - Team 9: Injury Risk Reduction Orthotic

11:30 AM - Team 10: NasoFX

11:50 AM - Congratulatory Messages (Video Compilation) & Senior Design Montage

Team 1

A-NEW

Faculty Mentor: Dr. Zachary Danziger

Alumni Mentor: Anthony Higgins

Project Sponsor:

Sydni Spencer, Rachely Cejas Morales, Pranavi Arman, Juan Andres Perez, Claude Paillant

Fecal incontinence (FI) is the inability to control one's bowel movements, resulting in involuntary release of stool. FI most afflicts geriatric patients (15%) and women who experience childbirth (9%). This project targets the external anal sphincter (EAS), which when weak, contracts with low pressures for reduced durations, thus decreasing continence. Initial treatment after diagnosing FI includes exercise for strengthening the EAS, however, without some form of monitoring and guidance, effectiveness is decreased due to patient incompliance.

The current market lacks an affordable, at-home treatment that provides adequate biofeedback and resistance training to the patient for increased comfort, compliance, and exercise effectiveness. A-NEW aims to solve this through a handheld and portable prototype that will use a fluid flow mechanism to detect fluid flow rates proportional to pressures applied by normal and weak EAS at a predetermined resistance to flow and provide progressive overload of the muscle by increasing resistance to flow of fluid during EAS contraction. Strength and duration biofeedback signals will be displayed, and there will be a provision for proper probe placement and comfortable operation; adequate power will be supplied for the duration of treatments. The project scope will be met if the prototype successfully achieves these.

Team 2

Wearable Photobiomodulation Device

Faculty Mentor: Dr. Jessica Ramella-Roman

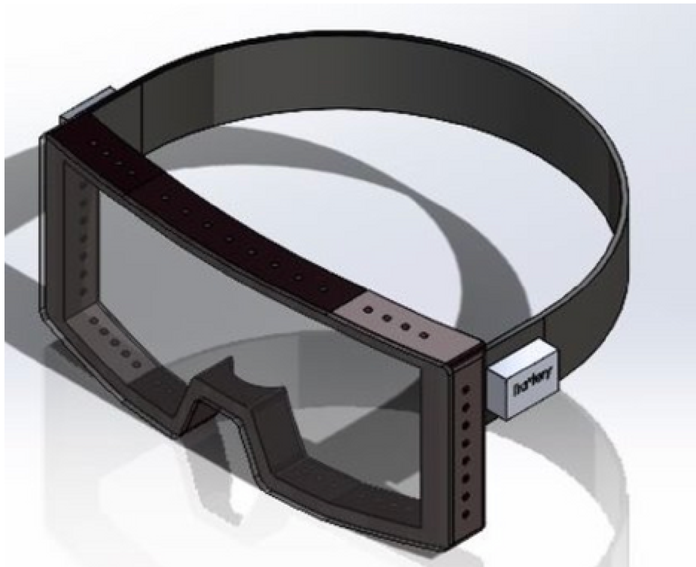
Alumni Mentor: Melissa Venedicto

Project Sponsor:

Reset Rewire Restore

Erika Casal, Jose Batista Guridi, Hillel Frank, Nelson Hernandez

Perhaps one of the most common mental health illnesses in the United States is anxiety, affecting 40 million adults yearly. The usual treatment modalities for people with anxiety include psychotherapy and pharmaceutical drugs. A combination of both is often recommended, as both have their advantages and disadvantages. A possible third treatment option for anxiety is Syntonic Light Therapy (SLT). At its core, SLT uses specific colored lens to treat neurological disorders. Therefore, for a patient with anxiety this form of treatment may be deemed preferable as the eyes are biomarkers, as anxiety impacts the visual system. This is due to the high levels of adrenaline that result, causing an increase in pressure on the eyes, dilating the pupils and resulting in blurred vision. However, it is not without issues, as it is bulky, immobile, highly restrictive to a patient's sight, and involves very expensive equipment.



Therefore, the purpose of this project is to design a device that is wearable and capable of producing the wavelengths that result in the Alpha-Omega color, a combination of what appears to be red and blue, to balance the Parasympathetic and Sympathetic Nervous systems to regulate the hormones directly associated with Generalized Anxiety Disorder (GAD). The device will employ SLT principles, benefiting patients with alpha-omega pupils, as their pupils are under constant chronic stress.

Team 3

Project Zen

Faculty Mentor: Dr. Markondeyaraj Pulugurtha

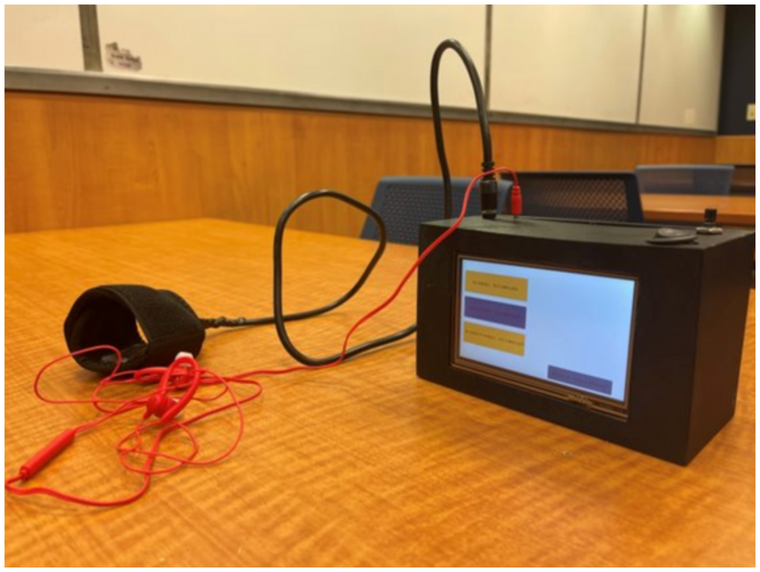
Alumni Mentor: Noble Amadi

Project Sponsor:

BetaBlue

Melanie Villamar Molina, Sabina Mazumdar, Laura Ahl, Martin Vera Santiago, Abraham Monzon

Project Zen's role in society will be to provide an affordable and non-invasive alternative to traditional treatment methods for Major Depressive Disorder (MDD). This wearable, over-the-counter device will treat MDD by using light, sound, and vibrational stimuli to manage MDD. Treatment methods like anti-depressants leave patients with inadequate symptom relief, unwanted side effects, and/or a financial burden. With all of this in mind, Project Zen will minimize the financial burden of MDD treatment and offer an effective method to manage symptoms.



Previous studies that used light, sound, or vibrational stimuli to manage MDD symptoms were considered when designing the device. Studies have shown that emitting light, sound, and vibration at different frequencies improves the systems of MDD when used individually. However, studies also showed that patients report more significant relief when individual stimuli are used in conjunction with other treatment methods. There is currently no device that offers all stimuli in one device to treat MDD. The successful construction of the device will allow the user to receive any combination of treatment stimuli while adjusting the frequency and intensity of each. This device will enable users to manage their symptoms effortlessly throughout the day and avoid unwanted side effects.

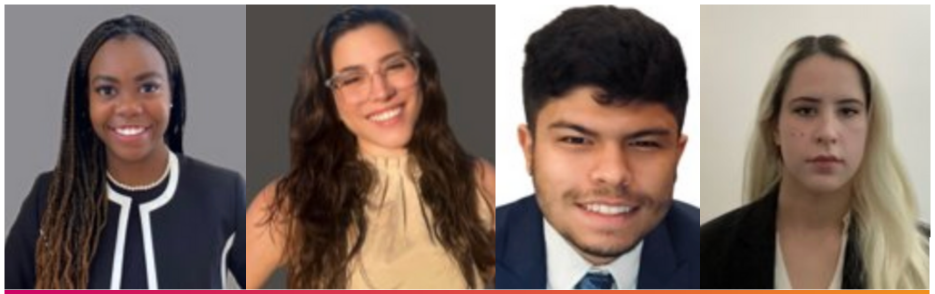
Team 4

Therapeutic Hydrogel Delivered Via Intranasal Device

Faculty Mentor: Dr. Oleksii Shandra

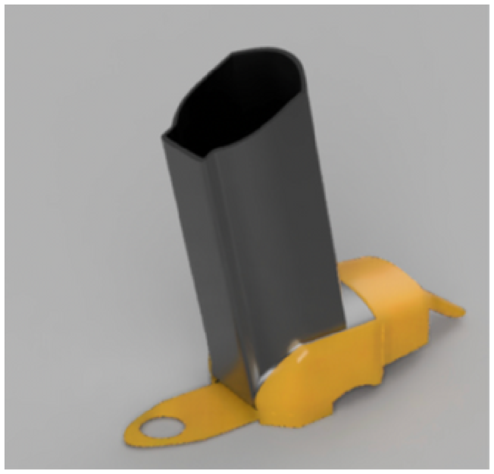
Alumni Mentor: Julia Silva

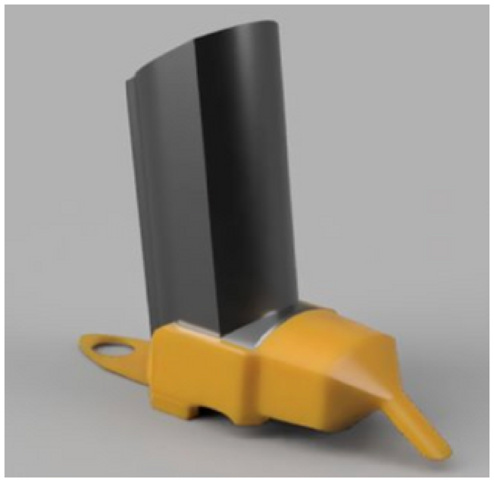
Project Sponsor:



Elizabeth Chery, Mariana Montoya, Chandler Wilson, Anna Grigorian

Traumatic brain injury (TBI) affects approximately 3 million Americans. There is a wide range of effects on individuals suffering from TBI depending on the severity and location of the injury such as cognitive changes, communication changes, and emotional changes. TBI can result in long term disability, therefore it detrimentally impacts the economy as well as the workforce management. After an individual has experienced TBI, recovery is centered around management of hemorrhage and coagulation due to direct damage of the cerebral vasculature. There is a lack of clinical modalities treating TBI intranasally because the link between cerebrovascular repair in conjunction with using therapeutic hydrogels is understudied. The objective of this project is to deliver a therapeutic hydrogel to create a microenvironment that promotes the growth of new blood vessels. By delivering the therapeutic hydrogels, a thermo-sensitive scaffold, the molecules would be allowed to effectively penetrate the blood brain barrier and be absorbed by the brain tissue. Moreover, intranasal drug delivery is non-invasive and would provide rapid onset action thus avoiding the first-pass metabolism effect. As a result, this method of drug delivery provides safe and fast alternative to intravenous and subcutaneous methods of drug delivery.





Team 5

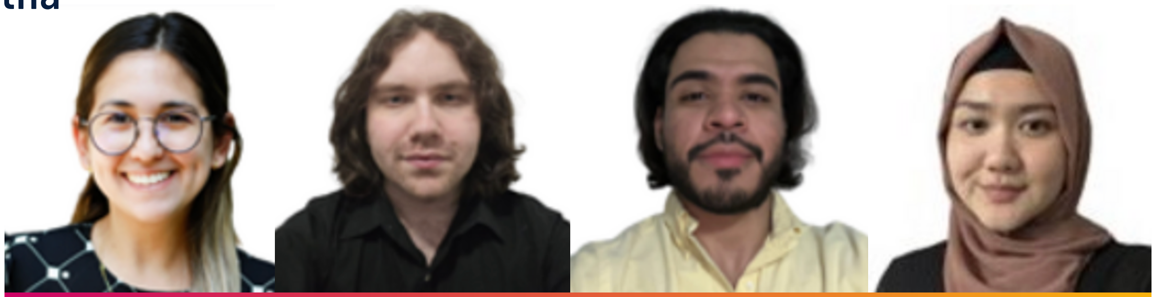
Wireless ECG Patch with Antenna Miniaturization and Component Reorientation for Surface Area Reduction

Faculty Mentor: Dr. Markondeyaraj Pulugurtha

Alumni Mentor: Ife Adejugbe

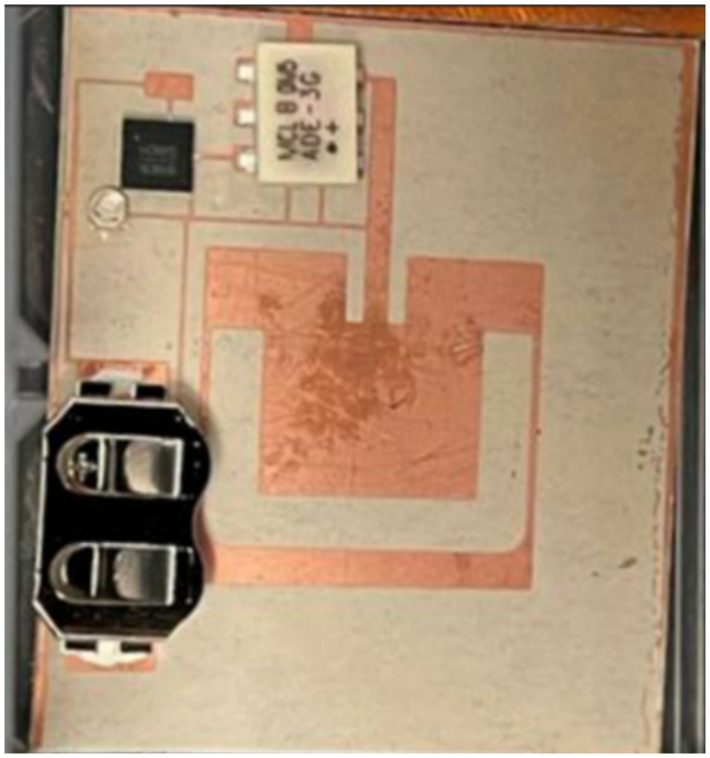
Project Sponsor:

JABIL



Daniela Hernandez, David Ramirez, Diego Banegas, Faiza Nazir

The electrical system of the heart synchronizes the pumping of the four chambers of the heart and controls the heart rate so that the heart speeds up and slows down as the demands of the body change. Irregular heart rhythms are dangerous as they can be life-threatening and require quick diagnosis and treatment. According to the Centers for Disease Control and Prevention (CDC), heart disease is the leading cause of death for people aged 45 and over. Thus, monitoring heart rate is crucial to the health of the patient. The heart's rhythm and electrical activity can be recorded by employing an electrocardiogram (ECG). Additionally, users who seek preventative measures for cardiovascular diseases may also benefit from utilizing continuous heart rate monitoring devices. There is no current device that provides both a wearable, simple, and compact solution while also meeting signal quality expectations. Our proposed solution is to design and package a compact prototype, improving on a previous senior design team's version, that serves as the proof of concept of the transmitter circuit of a simplistic ambulatory ECG patch that will monitor heart electrical activity with the ability to transfer recorded data for those needing continuous heart activity surveillance.



Team 6

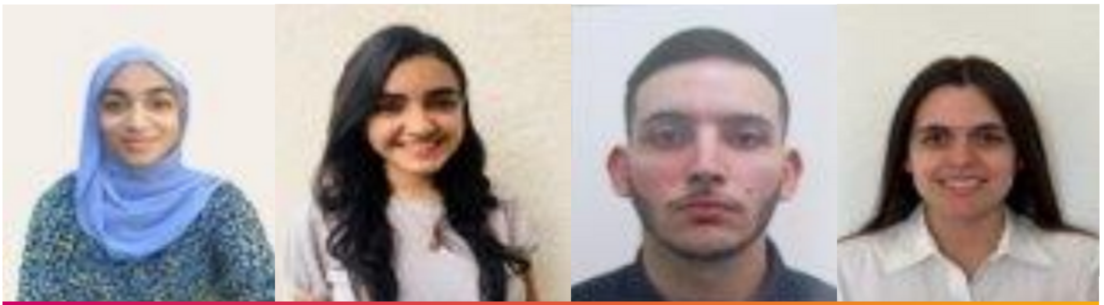
Pressure and Weight-Bearing Casting Device

Faculty Mentor: Dr. Anamika Prasad

Alumni Mentor: Jacob Bharat

Project Sponsor:

BioSculptor innovative solutions



Misbah Rafiq, Maria Andere, Javier Rodriguez, Angelica Garcia del Rio

There is a high incidence of worldwide lower extremity amputations, with approximately 185,000 amputations occurring in the United States each year. Patients with limb loss may be evaluated for a prosthesis. This socket is the primary and critical interface between the amputee’s residual limb and the rest of the prosthesis, and therefore, a good, comfortable fit is required to ensure a positive outcome is reached in an amputee’s rehabilitation. Current casting techniques rely heavily on the prosthetist’s experience and result in poorly fitted sockets, additional modifications, and increased costs for patients.

Our solution improves the objectivity and accuracy of prosthetic sockets through the integration of weight-bearing forces and precise pressure during the casting process. The device consists of a pneumatic component made of three individual air bladders that selectively apply pressure to pressure-tolerant areas of the limb. The weight-bearing component of the device consists of modular prosthetic components and three panels that provide support for the patient and the bladders throughout the duration of the casting process. The aim of this solution is to make the casting process more objective and decrease the frequency of socket modifications, reducing cost and discouragement for patients, while maintaining proper socket fit.

Team 7

Optimization of Superior Clavicle Fracture Fixation Plate

Faculty Mentor: Dr. Michael Brown

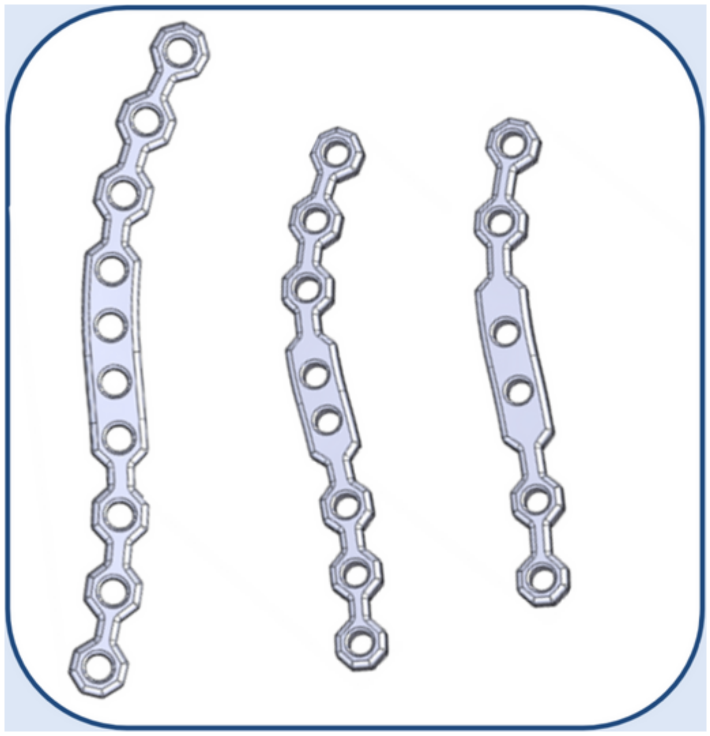
Alumni Mentor: Rosalia Morales Salinas

Project Sponsor:

skeletal dynamics®
Innovation Based on Science

Abraham Cisneros, Melissa Miranda, Tiffany Moreno, JC Carstens

Clavicle fractures affect 36-45 people for every 100,000 worldwide, with up to 80% of these occurring in the midshaft section of the clavicle bone. Surgical repair is typically required when there is significant fragmentation or displacement of the bone. The current standard of clavicle plates used for fracture fixation fit optimally less than 37% of the time due to the high variability of clavicle shape. The result is a harrowing re-operation rate of up to 40% to remove the device, mainly due to discomfort. By conducting a thorough morphometric and statistical analysis on key clavicle dimensions, an algorithm can be developed to better predict bone variability. The scope of this project is to establish the relationship between the critical bone features used to design a superior midshaft plate system. The optimized plate system will comprise of three sizing options, incorporate a rotatable design to facilitate repositioning on different fracture locations along the clavicle midshaft, and reflect the natural curvature of the clavicle shape. This will provide a comprehensive solution to patient clavicle variation; reducing in-situ bending of the plate required by the surgeons, soft tissue irritation, and costly second surgeries, while minimizing product cost and devices per kit.



Team 8

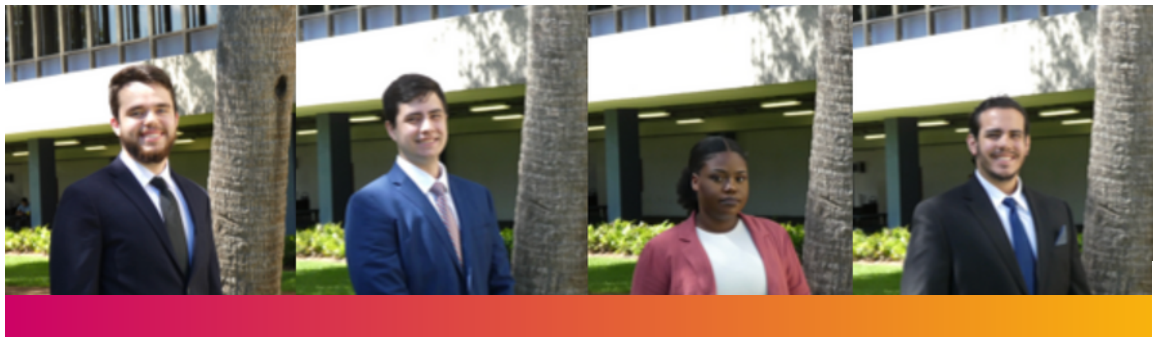
Flickering Light Therapy Device for Treating Symptoms of Alzheimer's Disease

Faculty Mentor: Dr. Wei-Chiang Lin

Alumni Mentor: Anderson Milforte

Project Sponsor:

BetaBlue



Daniel Figueroa, Joshua Nodarse, Angie Pierre, Victor Barreto

Alzheimer's Disease (AD) is one of the most prolific neurological diseases on a national and global scale. Despite the lack of conclusive results solving this crisis, certain factors have been correlated with AD, one of them being a decrease in gamma wave activity. Gamma waves are a group of brain electrical waveforms associated with higher cognitive function and memory and are found in the 30 –100 Hz range. AD research has honed its sight on a new methodology that uses this pathway as a therapeutic known as flickering light therapy (FLT). In essence, a visible light source flickers at 40 Hz in front of the patient’s eye from which light is transduced into electrical waves in the brain, generating gamma waves and providing subsequent cognitive benefits.

Current FLT modalities obstruct user’s eyes with a light source, therefore limiting patient’s daily activities. Our project aims to design and verify a wearable & flexible FLT device that allows patients to receive treatment while continuing their indoor activities with sight unobstructed by attaching to pre-existing eyeglasses. Although not tested, our design shows strong indications that our device will pass verifications, testing specifications such as delivery of FLT to the retina and flickering frequency.

Team 9

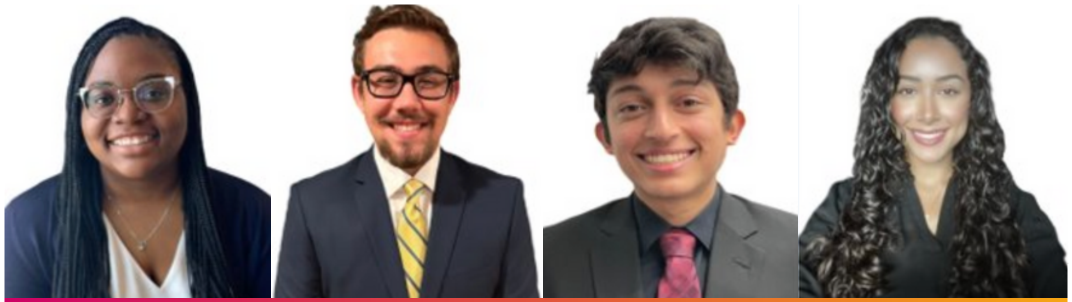
Injury Risk Reduction Orthotic

Faculty Mentor: Dr. Anuradha Godavarty

Alumni Mentor: Victor Arteaga Barrios

Project Sponsor:

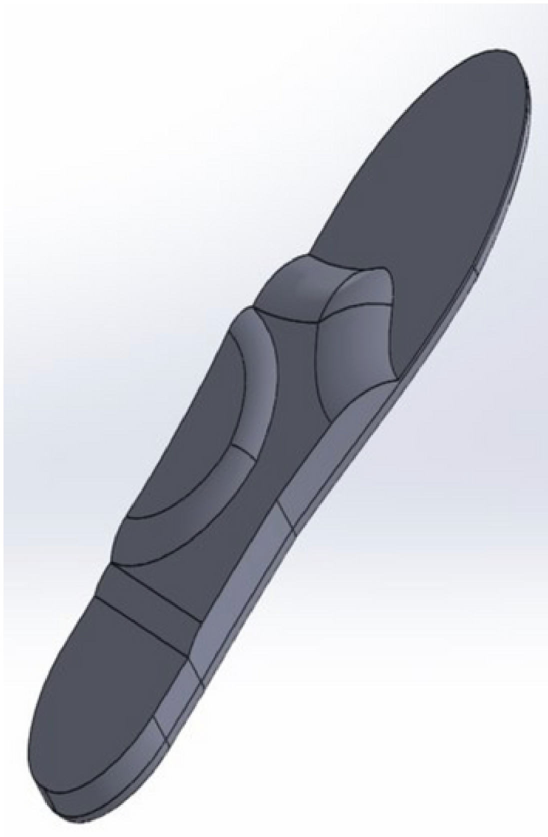
FIU PHYSICAL THERAPY



Acaydia Campbell, Joseph Gambin, Ashwin Lahori, Camila Padilla

Foot pronation is a natural movement that distributes weight towards the medial aspect of the foot. While some degree of pronation is necessary for proper gait, overpronation can have detrimental effects, particularly in athletes. Athletes with overpronated feet experience increased stress and strain on their lower extremity chain, which can lead to injuries such as meniscus tears, knee arthritis, and knee stress syndrome.

To address this issue, this project produces a cost-effective, custom orthotic that will alleviate peak overpronation, degree of peak dynamic valgus, and ultimately reduce the risk of injury in athletes. The custom orthotic provides additional support to the foot, more evenly distributing pressure throughout the lower extremities. The device's ability to bear weight and its ability to reduce the angle of pronation and genu valgum were determined to be the key market requirements. This led to the identification of related design inputs and verification tests. To ensure that all market requirements were satisfied, single-leg drop tests, bilateral-leg squat tests, compression tests, pressure tests, and pre- and post-orthotic situation monitoring were performed. The results of the testing showed that the custom thermoplastic polyurethane (TPU) orthotic prototype improved the risk factors associated with injury for athletes, namely angle of overpronation and angle of genu valgum.



This custom orthotic represents a practical solution to alleviate the overpronation of the feet and reduce the likelihood of lower extremity injuries. By reducing stress on the lower extremities, athletes will be able to train and perform with greater confidence and less risk of injury.

Team 10

NasoFX

Faculty Mentor: Dr. Joshua Hutcheson

Alumni Mentor: Yency Perez

Project Sponsor: Dr. Scott Schaffer

Oriana Cardenas, Juan Barboza, Omar Lopez, Paulwin Arancherry

Epistaxis, also known as nosebleeds, affects mostly elderly adults over 60 who suffer from hypertension or are required to take blood thinners. There are approximately 50 to 60 million people in the US who are on blood thinners and about 1.28 billion adults worldwide have hypertension. If the nosebleed lasts more than 15-30 minutes, the patient must seek medical attention immediately. The mean total hospital charges for epistaxis treatment are approximately $6,000 in the US; also, they require readily available means of transportation to the nearest medical facility, and longer wait times to get treated. Current modalities have also been criticized for being extremely painful for the patient and not allowing nasal breathing. There is an increasing demand for a comfortable, low-cost, at-home treatment solution. The focus of this project is to address this clinical problem by creating a nasal packing device, NasoFX, that efficiently stops anterior nosebleeds with the use of existing nasal dressings that expand and compress the bleeding site, achieving hemostasis. The incorporation of a device carrier made of a plastic polymer allows the patient to easily insert and remove the device in the comfort of their home. Also, it provides adaptability to individual anatomic variations and allows nasal breathing thanks to its hollow nature.

To Our Funder

Project Sponsors

Dr. Scott Schaffer

Project Judges

On behalf of the entire Biomedical Engineering staff, we'd like to thank our judges for their dedication and skill when it came to the judging of our Senior Design Expo oral and poster presentations. Without your generosity, knowledge and patience, this celebration would not have gone as smoothly as it has.

To Our Dedicated and Distinguished Faculty


Michael Brown, M.D., Ph.D.


Michael Christie, Ph.D.


Zachary Danziger, Ph.D.


Anuradha Godavarty, Ph.D.


Joshua Hutcheson, Ph.D.


Shuliang Jiao, Ph.D.


Wei-Chiang Lin, Ph.D.


Anthony McGoron, Ph.D.


Raj Pulugurtha, Ph.D.


Sharan Ramaswamy, Ph.D.


Jessica Ramella-Roman, Ph.D.


Jorge Riera, Ph.D.


James Schummers, Ph.D.


Nikolaos Tsoukias, Ph.D.


Anamika Prasad, Ph.D.


Oleksii Shandra, Ph.D.

This academic event is made possible by the generous support of the Wallace H. Coulter Foundation. To learn more about the Wallace H. Coulter Foundation, please visit whcf.org.

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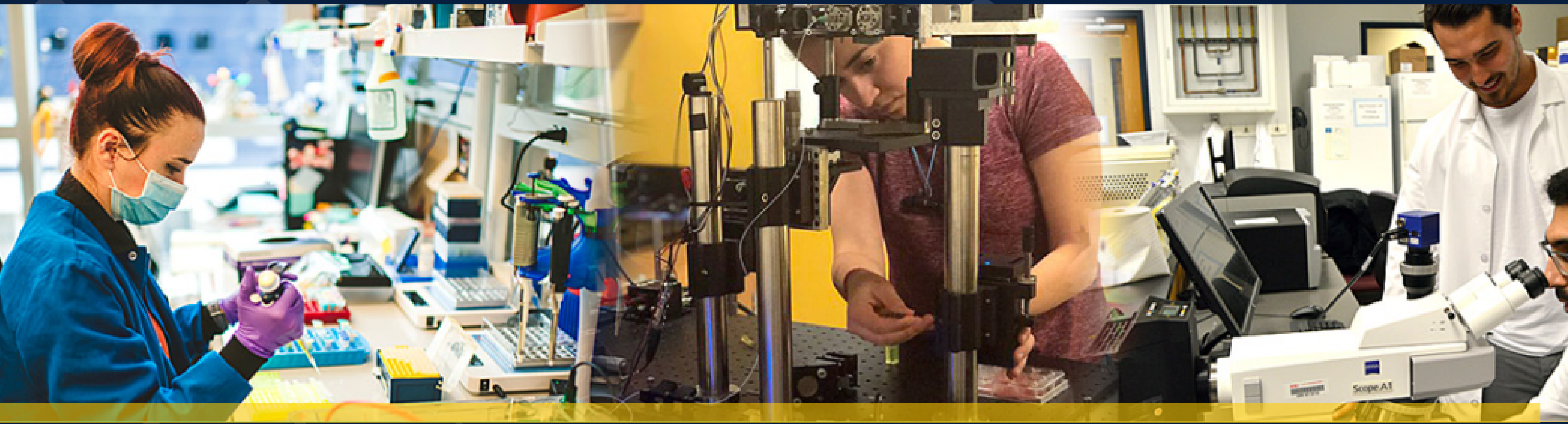

FIU | Engineering & Computing
Department of Biomedical Engineering

The Department of Biomedical Engineering at Florida International University (FIU) located in Miami is committed to preparing ambitious students who want to combine their love of problem-solving with their desire to help others through this fascinating growing field that applies cutting-edge technologies and modern engineering techniques to improve healthcare.

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