FIU Engineering & Computing

Biomedical Engineering

BIOMEDICAL ENGINEERING SENIOR design SHOWCASE

AN UNDERGRADUATE STUDENT CAPSTONE PROJECT COMPETITION

DISCOVER | DESIGN | DEVELOP | DELIVER

SPRING 2022

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

BIOMEDICAL ENGINEERING

Senior Design Project Showcase & Competition

Thursday, April 21, 2022

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 project 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 2022 COMPETITION – THURSDAY, APRIL 21, 2022

Panther Pit

7:30 AM

Breakfast

Room EC 2300

8:30-8:45 AM

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

Welcome Remarks from Dr. Riera,
Associate Professor of Biomedical Engineering
and Interim Chair

Introduction & Instructions to judges

8:45 AM – Team 1

9:00 AM – Team 2A

9:15 AM – Team 3

9:30 AM – Team 4

9:45 AM – Team 5

10:00 AM – Team 6

10:15 AM – Team 7

10:30 AM – Team 8

10:45 AM – Team 9

11:00 AM – Team 2B

Room EC 2300

11:15 AM-12:00 PM

Career and Talent Development Workshop

CAREERS AROUND THE WORLD

Panther Pit

12:00-1:00 PM

Lunch

Room EC 2300

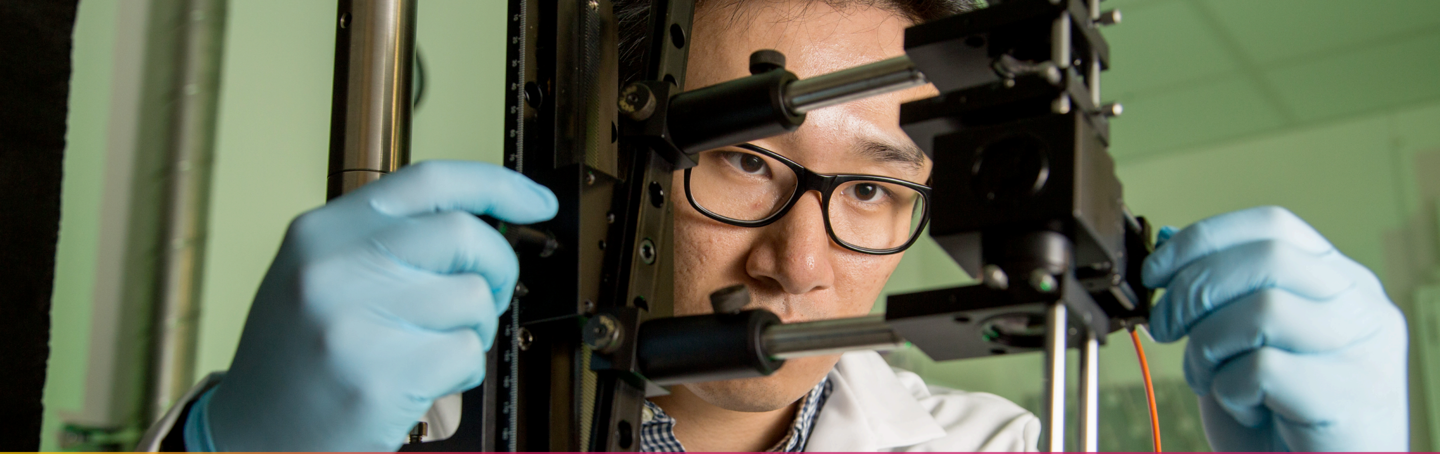
1:00 PM

Awards Ceremony with Dr. Godavarty,
Dr. Riera, Dr. Christie, and Dr. Shahrestani

Word of Thanks by Dr. Godavarty

Presentation of Awards

Concluding Remarks by Dr. Riera



WORKSHOP

Room EC 2300

11:00 AM

Nelly Leon

Assistant Director,
Career and Talent Development

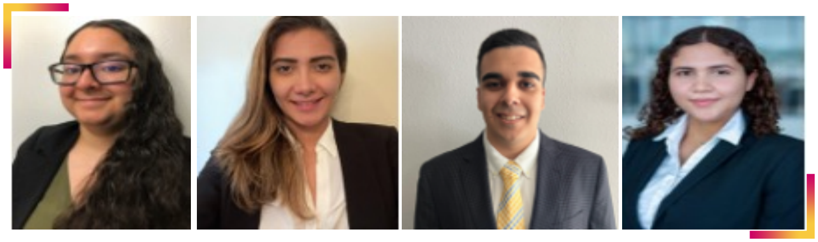
Seminar Title
CAREERS AROUND THE WORLD

Team 1

Seismocardiogram Sensor

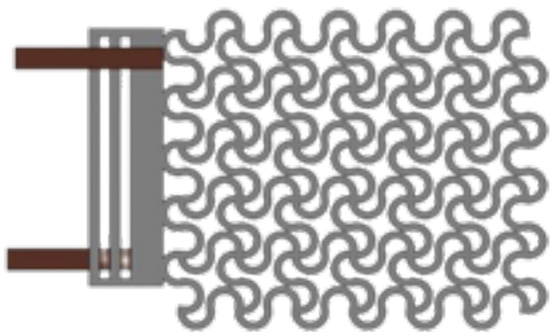
Faculty Advisor: Raj Pulugurtha, Ph.D.
Company Sponsor:

JABIL



Raquel Bojorquez, Haniyeh Alirezaei, Antonio Fernandez, Alessandra Jimenez

Coronary Artery Disease (CAD) results from the blockage of blood flow due to plaque buildup on the arterial walls, which causes the stiffening of the cardiac muscles. It is the leading cause of death among cardiovascular diseases and affects 18.2 million adults, predominantly males older than 45. Accurate monitoring of CAD requires the measurement of cardiac mechanical activities (valves opening/closing) and electrical activities (stimulus to the valves). One of the prevalent modes of monitoring is measuring electrical signals through wired/wireless electrocardiography (ECG), although these signals lack information on the heart's mechanical events. Alternatively, seismocardiography (SCG) focuses on the induced vibration from the heart, providing a clearer understanding of the valve's movements.



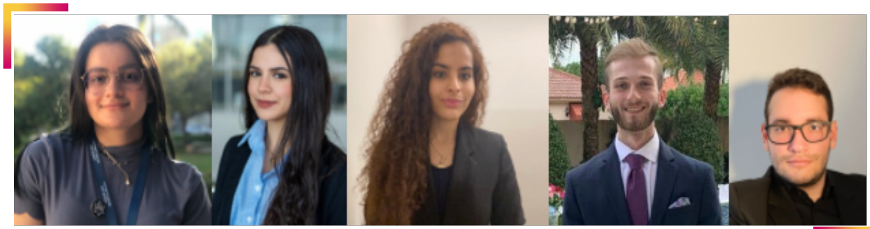
Flexible piezoelectric sensor patches are desirable due to their compatibility with skin's elasticity and their application in measuring SCG signals. The team's focus was to design and fabricate a soft sensor to capture SCG frequencies (up to 40 Hz), record real-time data noninvasively, and be placed over the apex of the sternum. The prototype consisted of a commercial piezoelectric (polyvinylidene difluoride) film metalized with a silver conductive ink. The film was patterned into a stretchable configuration, improving its compliance with skin and its sensitivity.

Team 2A

Adjustable Platform for Optimizing VCD Analysis

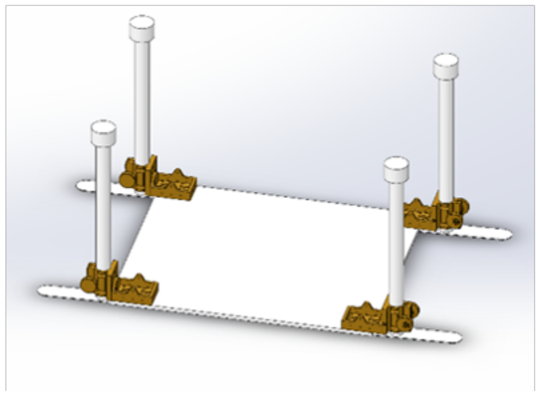
Faculty Advisor: Shuliang Jiao, Ph.D.
Company Sponsor:

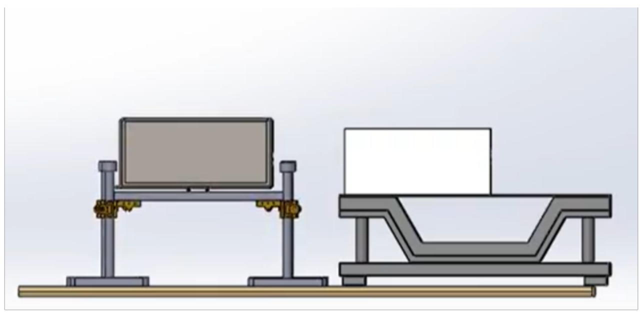
BioTools
Characterization Experts: Chirality & Biologics



Melissa Venedicto, Isabella Gonzalez, Reiwan Ali, Omar Alawa, Luis Bolivar

FT-IR spectroscopy is commonly used by pharmaceutical and research institutions for drug development. Protein samples and buffers are analyzed by loading one sample onto windows and then to the spectrometer. The use of Vibrational Circular Dichroism (VCD) allows for the determination of chiral molecules in antiviral drugs. This will directly mitigate the detrimental effects that utilizing the incorrect enantiomer may have on the metabolism and toxicity level of the drug. The current modality of having a VCD directly attached to an FT-IR spectrometer forces companies to buy two new units. The purpose of this project is to deliver a device that can house a VCD for any FT-IR system and to test the IR capabilities of the machine through protein analysis.



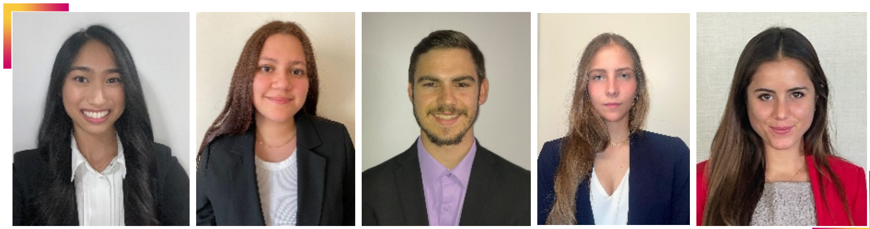


Team 3

Skin-on-a-Chip

Faculty Advisor: Nikolaos Tsoukias, Ph.D.
Company Sponsor:

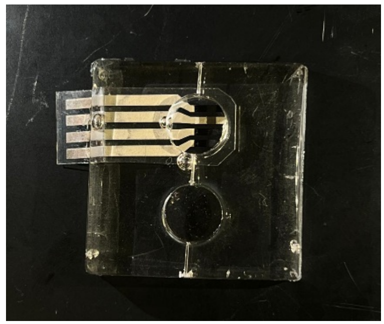
SSIST

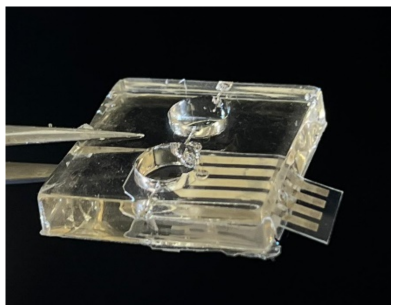


Caitlin Jacinto, Viviana Florin, Nicholas Lynch, Paula Martinez, Jazmin Lagier

Even though in vitro cell culture models and in vivo animal systems can be useful in facilitating a representation of the human skin, models that can reflect human-relevant responses are still lacking. The absence of a dynamic fluid flow in models in-vitro and of biological compatibility in models in-vivo result in a major gap between them and the expected human model. To address this gap, we have combined microfluidic devices, human skin cell cultures, and sensors.

Our "Skin-on-a-Chip'' device utilizes a three-dimensional environment to allow the proper cell-to-cell interactions and to capture the proper cellular environments of this organ. In addition, sensors are embedded to collect data for cell viability analysis, which confirms the success of this technique to emulate the cellular environment. A case study with wound healing was implemented to examine if the physiological properties of the skin were successfully present in the model. The introduction of this microfluidic device will provide a more cost-effective and accurate method to emulate a human skin model.





Team 4

EvenFlow

Faculty Advisor: Jorge Riera-Diaz, Ph.D.
Company Sponsor:

BetaBlue

Raquel Chotoo, Alexander Garcia, Fanilo Lambo, Timothy Lao, Isabelle Carpio

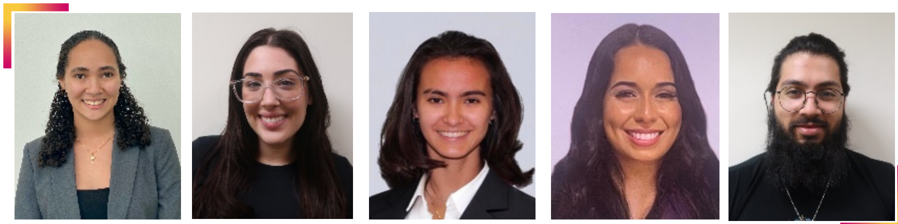
A cerebral vasospasm is the major cause of a poor outcome after an aneurysmal subarachnoid hemorrhage (aSAH), and effective treatments for vasospasms are limited. One common current modality used to aid with treatment is calcium blockers. However, complications frequently still occur after successful surgery or during as this is given as a measure to lessen the impact of CV as it does not fully prevent it from occurring. A cerebral vasospasm typically appears on the third day after aSAH, is maximal at 6–8 days, and subsequently lasts 2–3 weeks. A delayed cerebral vasospasm may cause clinical deterioration, cerebral infarction and death.

This device will prevent cerebral vasospasms at designated brain regions by targeting and electrically stimulating the ophthalmic division of the trigeminal nerve to limit blood vessel constriction and increase cerebral blood flow via parasympathetic nervous system innervation. This will be achieved with an electrical component consisting of a microcontroller and signal generator which creates the desired stimulus. The stimulus will be delivered transcutaneously using an electrode patch placed on the forehead directly above the ophthalmic division of the trigeminal nerve. Stimulating this region has been shown to increase cerebral blood flow in the prefrontal cortex.

Team 5

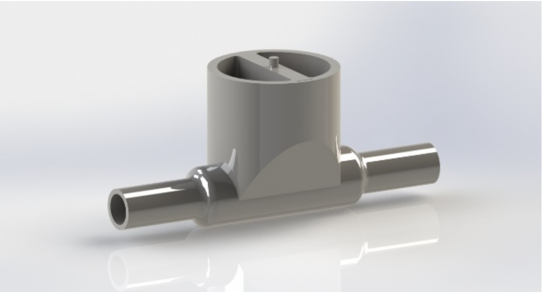
Hemodialysis Intravenous Access Device

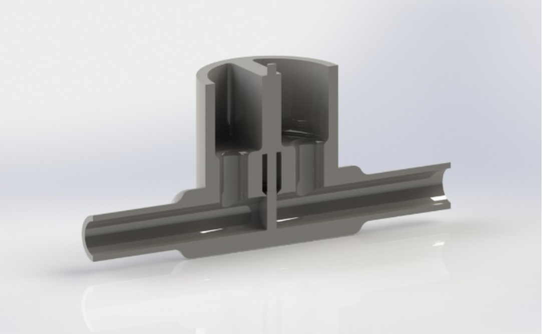
Faculty Advisor: Sharan Ramaswamy, Ph.D.
Company Sponsor:



Arianne Chung, Alexa Perozo, Alex Giles, Monica Niebles and Diego Midence

Chronic kidney disease is defined as having a glomerular filtration rate of less than 60 mL/min per 1.73 m2 over a three month period. When a patient is experiencing this type of progressive kidney function loss, one option is to undergo hemodialysis treatment. Hemodialysis is the filtering of blood through the use of an external machine called a dialyzer. This method requires the punctuation of the skin and blood vessels each time the patient needs to receive treatment which is on average 3 times a week. Constant and frequent puncturing causes the vessel to weaken over time and eventually, this area may no longer be used for blood access. The purpose of this project is to create a Hemodialysis Intravenous Access Device to eliminate the need for constant punctuation of the skin and blood vessel during hemodialysis treatment. SolidWorks was utilized in the design phase and the device functionality was verified through the use of a flow loop and porcine blood where regular blood flow and diversion of blood out to the dialysis machine was tested. A platelet count was completed to assess the hemocompatibility of the device and the dimensions of the device were also verified.



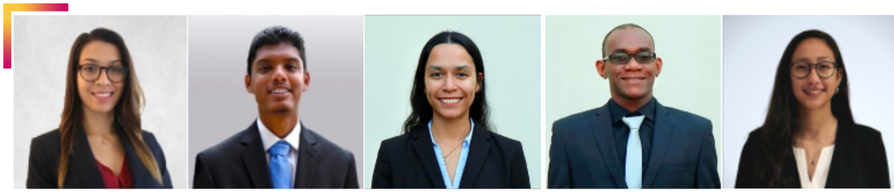


Team 6

Vibro Beats

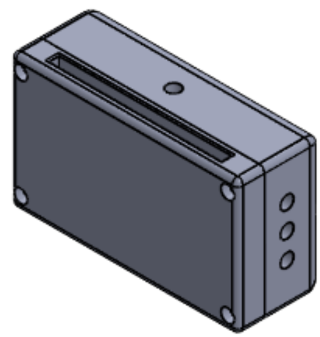
Faculty Advisor: Zachary Danziger, Ph.D.
Company Sponsor:

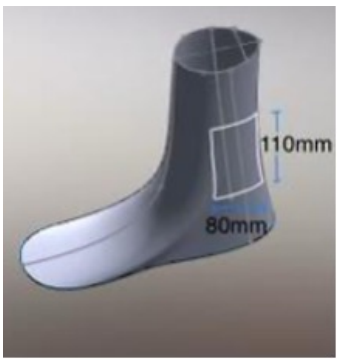
WEINSTOCK PHYSICAL THERAPY, P.C.



Bianca Castello, Jacob Bharat, Yency Perez, Mario Civil, Maria Chiang

Parkinson's Disease (PD) is a degeneration of the dopaminergic system that impairs motor function, resulting in an increased risk of falling and difficulty walking. There are nearly one million people in the US that are affected by Parkinson's Disease, with more than 60,000 people diagnosed each year. Several clinical studies focused on vibroacoustic therapy have demonstrated the effectiveness of targeted vibration, which is a form of treatment that specifically conducts vibration to a direct area of concern on the body. Target vibration alleviates loss of balance in Parkinson's patients. Moreover, separate clinical studies have shown that music therapy can potentially promote the release of dopamine and serotonin. The increase in dopamine benefits PD patients by bringing their dopamine levels to a normal range, minimizing the imbalance symptoms that occur from their lack of dopamine. Our proposed solution is to build a lightweight medical device that will slip into a pocket woven into a sock. This technology will conduct the vibrations synchronized with the rhythm of the music directly targeting the Long Flexor Muscle and the Achilles Tendon which surround the ankle. Stimulation of proprioceptors release dopamine to accommodate for the deficiency that causes loss of balance in PD patients. The music aspect of this treatment will trigger a release of dopamine that can compensate for the dopamine deficiency caused by Parkinson's Disease to improve motor function. Simultaneously, the vibration aspect of this treatment stimulate the proprioceptors to strengthen the proprioception pathway for patient's to regain the spatial awareness of the lower body.





Team 7

Manufacturing Process of a SCOBY Bio-Thread

Faculty Advisor: Anuradha Godavarty, Ph.D.
Company Sponsor: POLARITY VENTURES

Nathaniel Alexander, Megan Boge, Rene Elvir, Catalina Zambrano, Sydney Zamorano

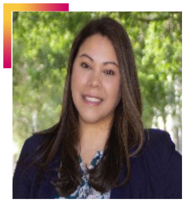
About 6.5 million people experience chronic non-healing wounds. Currently, there are few cellulose-based wound dressings capable of aiding in the treatment of chronic wounds. Cellulose has shown to promote epithelial regeneration or healing. Recent studies performed on bacterial-composed cellulose have demonstrated cellulose's beneficial characteristics including high tensile strength, flexibility and biocompatibility. Our objective was to develop a cellulose-based SCOBY (Symbiotic Culture of Yeast and Bacteria) Bioactive-Thread towards wound dressing applications. The kombucha tea and proceeding fermentation produces a solid cellulose pellicle byproduct called SCOBY. Our design consists of a four-step process along with the construction of a silicone mold basin for the growth of the bio-thread. The designed and developed SCOBY Bio-Thread was 51.5 cm in length, 1.073 +/- 0.019 mm in diameter, spooled on a 1.0 cm in diameter spool, endured a tensile stress of 6.41 MPa, had a pH of 7.4, and contained cellulose. The successful verification of these properties show the potential for this Bio-Thread to be an excellent alternative material for wound care dressings.

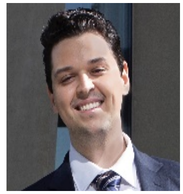
Team 8

Wearable Neuromuscular Electrical Stimulation (NMES) Device for Hip Rehabilitation - HipStim

Faculty Advisor: James Schummers, Ph.D.
Company Sponsor:

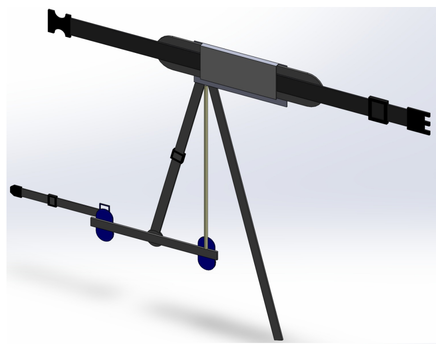
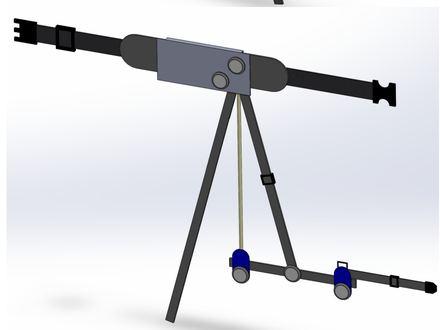
ARTICULATE LABS




Virginia Gacharna Mattice, James Ametepe, Lia Paolino, Christopher Trujillo, Aashiya Kolengaden

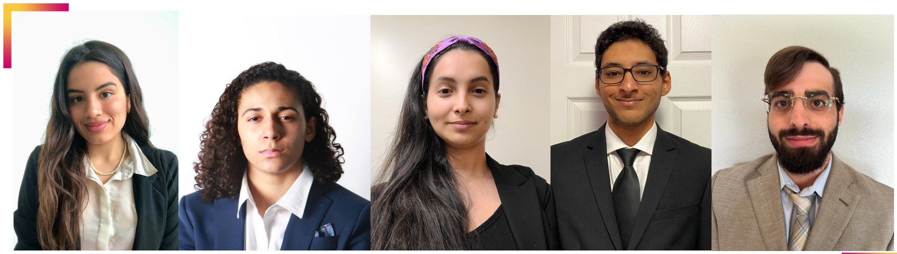
According to the Agency for Healthcare Research and Quality, more than 450,000 Total Hip Arthroplasties (THA) are performed each year in the United States. Studies have shown that the surgical trauma from THA can lead to delayed muscle rehabilitation and persisting atrophy. Neuromuscular electrical stimulation (NMES) is commonly used at high intensities to produce muscle contraction to prevent muscle disuse atrophy after injury, surgery, or illness. Current NMES modalities neither adapt to the patient's movement nor provide targeted stimulation based on their daily activities. Our team designed a light weight, wearable device that can provide at-home, personalized NMES therapy to post-THA patients. This device can optimize rehabilitation for each individual by adjusting stimulation to their unique anatomy and lifestyle while also collecting data on patient progress and compliance. Our goal is to make physical therapy portable, faster, cost effective, and more convenient for our end user. The team was able to adapt the existing KneeStim device from Articulate Labs, Inc. along with its code in order to provide mobile NMES therapy for the targeted hip and thigh muscles by ensuring secure electrode placement throughout the range of motion of the affected hip on all three planes.

Team 9

FUSIOPSY

Faculty Advisor: Michael Brown, Ph.D.
Company Sponsor:



Claudia Paredes, Deborah Powers-Dyer, Kimberly Medina, Hosam Ali, Austin Jimenez

Skin punch biopsy devices are currently a primary conventional means of treatment in response to the large number of cases of melanoma cancer and non-melanoma skin diseases. These biomedical devices feature a blade that creates circular skin lesions upon penetration into the skin. However, the shaping of this incision comes with the disadvantages of increased probability of scarring, increased likelihood of blood loss during the procedure, long recovery time, as well as cosmetically unappealing results.

In light of this, the tangible product proposed by Senior Design Team IX involves a fusiform elliptical biopsy punch device, which features a unique geometric blade that provides the means of penetrating into the skin through a downward angular cutting mechanism. The component(s) of the device will have minor axis sizes of 6 mm and 8 mm, and a depth of 3 mm and 4 mm. These are to be manufactured and prototype tested as per established verification protocols.

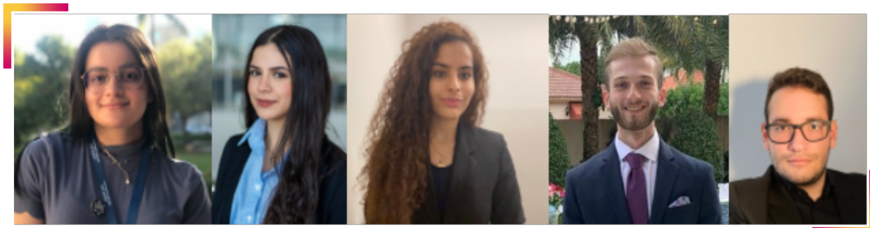
The proposed biomedical device allows medical professionals to produce skin incisions that yield improved cosmetic results in comparison to conventional biopsy devices, while also facilitating diagnoses of the prognosis of non-melanoma and melanoma skin cancer, as well as the early assessment of other skin conditions.

Team 2B

Semi-Automated Needle Insertion Device

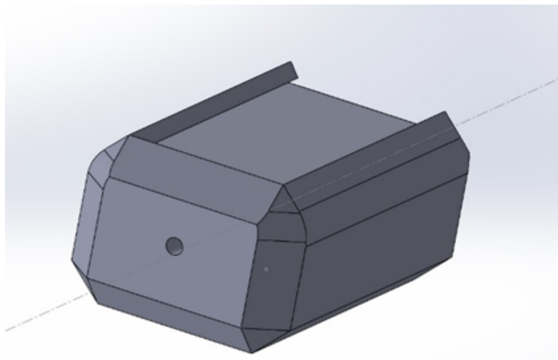
Faculty Advisor: Shuliang Jiao, Ph.D.
Company Sponsor:

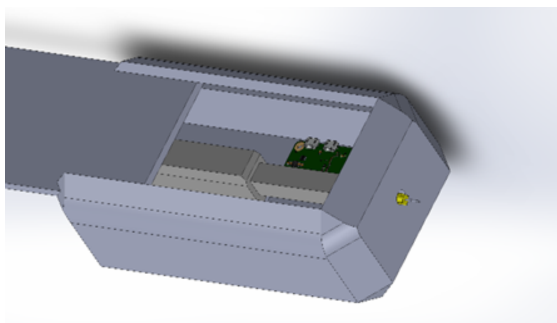
Panther Biomedical
Cardiovascular Solutions



Melissa Venedicto, Isabella Gonzalez, Reiwan Ali, Omar Alawa, Luis Bolivar

Acute stroke is one of the leading causes of death worldwide. Only strokes with a large vessel occlusion (~30–40% of all strokes) should be considered for intervention. The restoration of antegrade blood flow in the acutely occluded artery is the most effective therapy, where timely reperfusion is necessary to halt the progress of necrosis and preserve viable tissue (cerebral penumbra) from irreversible ischemia that permanently damages brain functions. Ischemic stroke patients only have a four-hour window from the moment the patient experiences the first symptoms of a stroke to introduce a catheter through the femoral artery and access the stroke to perform the necessary procedure to open blocked vessels. Preparing a semi-automated needle insertion device that would penetrate the artery accurately and quickly, this device would be lightweight and have the ability to be handheld. The software would be developed to ensure a proper calculator of distance and the angle for the needle to be applied.





To Our Funder

Project Sponsors

JABIL · BioTools (Characterization Experts: Chirality & Biologics) · SSIST · BetaBlue · Panther Biomedical Cardiovascular Solutions · Polarity Ventures · Articulate Labs · Weinstock Physical Therapy, P.C. · DDE Lab Inc. · Doc on the Rock

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.

Guest Speakers

On behalf of the entire Biomedical Engineering staff, we wanted to express our paramount gratitude to Ms. Nelly Leon for presenting your seminar during Senior Design Expo.

To Our Dedicated & Distinguished Faculty


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


Michael C. 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.

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.

BIOMEDICAL ENGINEERING SENIOR design expo

AN UNDERGRADUATE STUDENT PROJECTS SHOWCASE & COMPETITION

SPRING 2022

DREAM, DISCOVER, INSPIRE, INNOVATE

ABOUT OUR

Biomedical Engineering Program

The Department of Biomedical EngineerinThe 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.

#41 among best graduate biomedical engineering programs

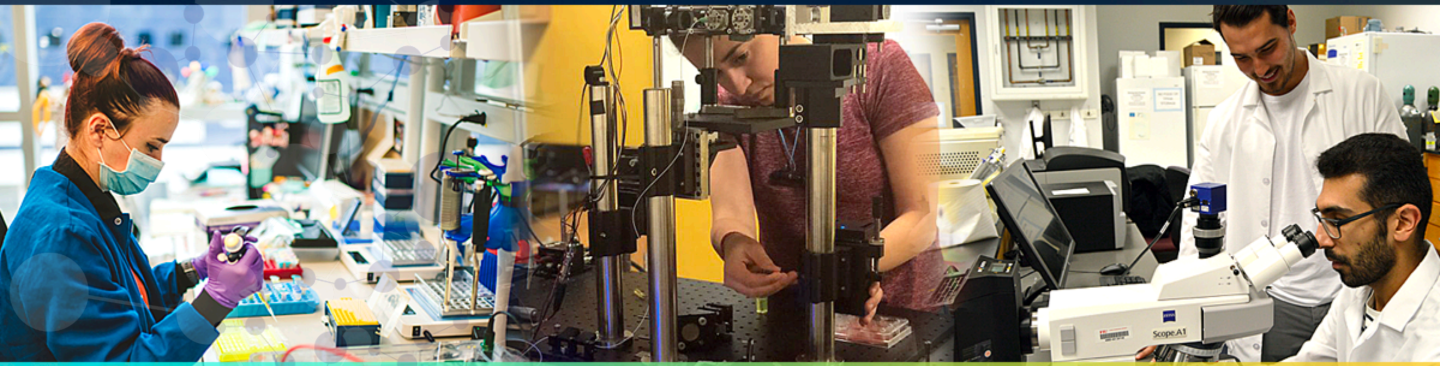
Top 50 Top 50 public research university

BEST COLLEGES U.S.News & WORLD REPORT RANKINGS

Our Biomedical Engineering department is ranked #1 for bachelor's degrees awarded to Hispanics and #6 for bachelor's degrees awarded to African Americans. Nationally, we are among the Top 20 to offer BS degrees, Top 65 for research expenditures, and considered in the Top 30 of the most popular in the country.* Florida International University is designated a Carnegie Highest Research (R1) and Carnegie Community Engaged Institution.

*ASEE 2019, NSF HERD 2018, and College Factual 2020

DREAM, DISCOVER, INSPIRE, INNOVATE



FIU | Engineering & Computing

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.

bme.fiu.edu

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Florida International University | College of Engineering & Computing

Department of Biomedical Engineering

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